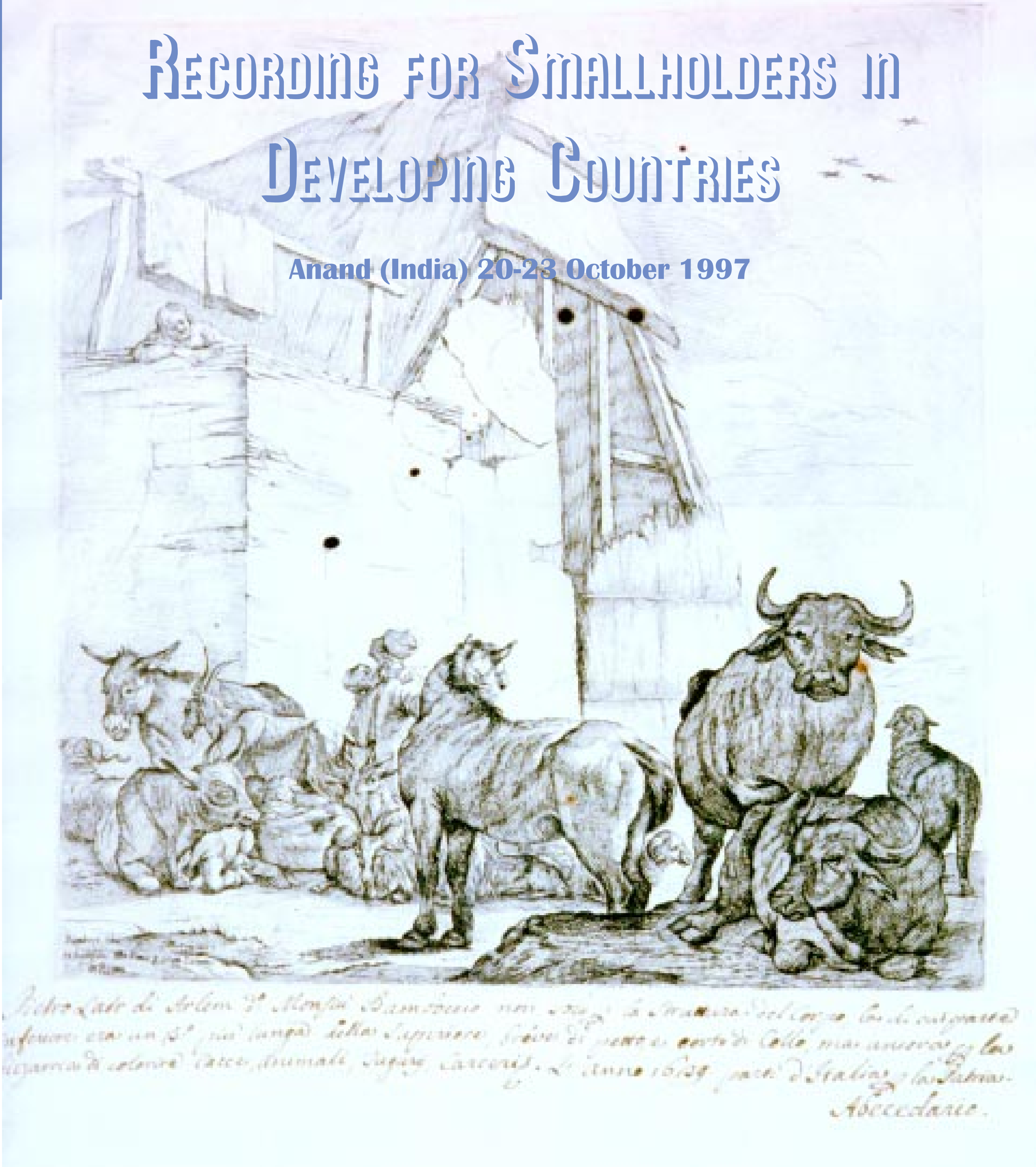
ICAR Technical Series No. 1

International Workshop on Animal Recording for Smallholders in Developing Countries

Anand (India) 20-23 October 1997



May, 1998

Editor: K.R. Trivedi

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Preface

It has been long recognised that animal recording is a prerequisite for any serious effort to develop livestock production at both the farm and at the industry level. Such organised recording has been practised for long in most of the developed countries and it was, indeed the basis for the genetic improvement realised and the understanding and evolving of production systems. However, animal recording is not common in developing countries and where it has been attempted, frequently developed-country technology was inappropriately employed. In the desire to achieve food security in many parts of the world where the great bulk of animal products comes from low-to-medium input production systems, development of a range of adapted livestock production systems and animal genetic resources will be essential. This will commonly involve the use of appropriate recording methods for these medium-input systems.

Animal recording systems in general and in medium input-animal production systems in particular, is a challenging task for it has to take into consideration a wide range of basic factors like what records to use to achieve what objectives, the socio-economic context, the structure of the livestock sector etc. The International Committee for Animal Recording's (ICAR), main concern is the progressing of animal recording world-wide on solid scientific and technical basis and in collaboration with other organisations. Since 1994, ICAR has also established a Development Fund Task Force to lend support to sustainable recording systems in developing countries. The Food and Agriculture Organisation of the United Nations (FAO) sustains this initiative within its mandate of assisting countries in developing and better managing their genetic resources which requires appropriate recording systems in a range of production environments.

Therefore ICAR and FAO, along with India's National Dairy Development Board (NDDB), collaborated to organise this Workshop held at Anand, India. The Workshop, attended by experts from more than 25 countries and organisations, was an appropriate medium for discussing issues related to animal recording with special reference to medium-input production systems.

These Proceedings include national experiences in the form of country reports, seminal papers dealing with basic aspects of recording and recommendations addressed to different international and national bodies.

On the part of ICAR, FAO and NDDB great efforts were made in preparing for and organising the Workshop and producing the Proceedings.

ICAR wishes to thank FAO for its financial and technical support and very constructive collaboration during the execution of this activity and NDDB for making their facilities at Anand available to the Workshop and its logistical support. The efforts and major inputs by Ing. Wim Wismans (ICAR), Dr. Salah Galal (FAO) and Dr. Kamlesh Trivedi (NDDB) are greatly appreciated. The organisers of the Workshop wish to thank in particular the Swiss Agency for Development and Co-operation (SDC) and the Technical Centre for Agricultural and Rural Co-operation (TCA) of the Netherlands for their generous financial support without which the participation of a large number of experts from the less developed countries of the world would not have been possible. Dr. Cesare Mosconi is thanked for his editorial and graphics works involved in producing the Proceedings.

Prof. Jean Boyazoglu
ICAR Secretary General

Foreword

In the 29th ICAR Session held in Ottawa, Canada, the ICAR decided to set up a Task Force on ICAR Development Funds with an objective to further the development of animal recording in the developing countries. Later, the Task Force was constituted with a representative each from Latin America, Africa, Asia and Europe and a representative from the FAO. The Task Force initially carried out a survey on animal recording and genetic evaluation in developing countries.

From the information received, it was found that a lot of work has been done and a great deal of experience exists in Zimbabwe, India, Egypt, Venezuela and other countries on animal recording. In the 30th ICAR Session in The Netherlands, therefore, ICAR decided to organise a workshop in India. A list of developing countries and organisations involved in animal recording in developing countries was prepared and the ICAR invited the concerned persons from these identified institutions and requested them to prepare a paper on the current situation of animal recording, the constraints that they are facing and the future possibilities for improvement in their countries.

The workshop hosted by the National Dairy Development Board (NDDB) of India was a unique event as it was the first time that a workshop was organised on the aspect of animal recording in developing countries. Delegates from more than 25 countries participated in the workshop. Delegates shared experiences and discussed the ways in which recording programmes could be established and sustained in developing countries. Delegates also got an opportunity to visit some village co-operatives, participate in a cattle show and see the integrated animal recording and genetic evaluation programmes run by the NDDB.

The proceedings of this workshop will be a very useful document for policy makers and people engaged in implementation of animal recording programmes in developing countries.

Ir. Wim M. G. Wismans
Past President, ICAR

Introduction

Animal recording organisations in developed countries have amply demonstrated that the productivity of animals could be increased through development of animal recording systems. The data collected by these organisations is often used for a variety of purposes including estimation of breeding values and selection of bulls and bull mothers to produce bulls and replacement heifers, development of extension systems, making national strategies for livestock development etc. Some of these organisations have a very long history. They have constantly improved their services through adoption of national and international quality control measures.

A very few organisations in developing countries, however, have established and sustained animal recording systems. Many social, economical and environmental constraints that these countries face make it difficult for them to develop and sustain animal recording systems. Many even question the utility of developing animal recording systems for low-to-medium input and high stressful production systems in developing countries. They argue that the benefit derived from recording systems are very marginal and not worth putting efforts they need. Some other question the utility of information to smallholders who have just one or two animals. This may be true for many developing countries, but there are a few organisations in developing countries which have proved all these wrong and demonstrated that development of animal recording systems in developing countries could also be very rewarding. They could lead to increase in productivity of animals. They could also provide very valuable data for making national livestock development strategies.

Considering the fact that the development of animal recording system can help many developing countries to increase productivity of their animals, ICAR decided to organise a workshop at the National Dairy Development Board, Anand and invited some scientists and practitioners from the developing countries involved in animal recording and requested them to prepare a status paper on animal recording in their countries. Some 45 delegates from 25 countries participated in the workshop. For many participants the interesting parts of the workshop were the group discussions. During the workshop all participants were divided in three working groups. Each group discussed a set of questions in three different rounds covering all aspects of animal recording. The summary of discussions of three rounds and the recommendations emerged from the discussions are given at the end of the chapter on Summary and Recommendations of the Workshop. The contribution as presented in these proceedings, I am sure, will provide very valuable information to practitioners and policy makers concerned with livestock development in the developing countries.

On behalf of ICAR, I would like to thank the NDDB for hosting this workshop at Anand and in particular Dr. Kurien, Chairman, NDDB and Dr. Amrita Patel, Managing Director, NDDB for their encouragement and support. I would also like to thank my colleagues at the NDDB in particular Mr. J S Patel, Mr. J P Patel and Dr. M Namjoshi who provided me all support for successful organisation of the workshop.

ICAR is very grateful for the technical and generous financial support of the Food and Agricultural Organisations of the United Nations (FAO) and the financial support of the Interco-operation and the Swiss Agency for Development and Co-operation, the Technical Centre for Agricultural and Rural Co-operation, The Netherlands and the National Dairy Development Board, Anand for the workshop. Thank you.

I am grateful to ICAR and especially Ir. Wim Wismans, President, ICAR with whose initiative, support and encouragement, we could organise this workshop.

I am also thankful to the Chairmen of the different sessions who kept things moving during the workshop. I am also grateful to all participants for preparing and presenting their papers and also for their participation in all discussions.

Dr. Kamlesh R Trivedi
NDDB, Anand, India.
Member, ICAR Board.

Part I
Recommendations and Summaries

Recommendations

1. FAO/ICAR should initiate pilot projects to demonstrate the economic benefits of animal recording.
2. FAO/ICAR should promote establishment of regional networks to exchange ideas, methods and experiences on animal recording and to assist in governmental arrangements.
3. The ICAR member organisation should co-ordinate recording systems nationally.
4. ICAR should provide guidelines for standardisation of data collection, communication and evaluation of animals of all species and products. These guidelines should address:
    - Quality of data
    - Low and medium input production systems
5. FAO in conjunction with ICAR should develop guidelines for initiating and structuring national animal recording systems. The following principals should be included in these guidelines:
    - Farmers should participate in conception, design and maintenance of the scheme.
    - Local management of the recording programme should be encouraged through promotion of farmers' groups and co-operatives.
    - The recording systems should be designed to meat the needs of farmers, planners, policy makers, breeding schemes and consumers.
    - Government or other organisational funding is necessary to initiate and possibly to sustain recording. However, farmers should pay at least some cost of recording either directly or through their organisations.
    - Cost of the programme should be borne proportionally by the beneficiaries.
    - Recording should preferably be a part of an integrated local service / extension package
    - Recording activities (animal health recording, performance recording, animal resource characterisation, etc.) should be integrated among appropriate agencies and organisations.
    - The recording system should include all measures necessary for economic evaluation of animals.
    - The schemes should be no more complex than necessary to achieve the programme goals.

6. FAO in conjunction with ICAR should promote training activities in animal recording including training of field level extension staff, country co-ordinators of recording and extension, and university and ministry of agricultural personnel in small farm recording for management advise and record interpretation.
7. FAO should encourage government to use appropriate animal recording procedures to better characterise, utilise and monitor local animal genetic resources.
8. FAO / ICAR should promote the use of animal recording to government as a general mechanism for animal production and agricultural system development.

K. R. Trivedi

Summaries

1. Introduction

Many recording organisations in developed countries have shown that the participating farmers are able to increase productivity and genetic merit of their animals and raise the quality of their produce. They have shown that animal recording helps farmers in decision making and optimising use of their existing resources, increases the value of their animals and their produce, and improves the overall income of their farms.

A very few organisations in developing countries, however, have established and sustained animal recording systems. Many constraints that the developing countries face make it difficult for them to develop and sustain animal recording systems. However, there are a few organisations in developing countries which have shown that the development of animal recording systems in developing countries could be very rewarding. They have shown that it could help farmers in increasing productivity and genetic merit of their animals and that it could be a very effective management tool to help farmers in decision making.

Considering the importance of developing animal recording systems in developing countries, ICAR decided to organise a workshop at the National Dairy Development Board, Anand in India and invited some selected persons from developing countries who are actually involved in animal recording in developing countries. Each invited person made a presentation of animal recording situations in their country in the workshop. All participants also discussed various aspects of animal recording in developing countries. A brief summary of the significant efforts made by some selected countries in developing animal recording systems, the constraints faced by the developing countries, the discussions that took place among participants, and the recommendations emerged from the discussions is given below:

2. Animal recording organisations in developing countries

A brief description of the milk recording efforts made by eight countries one each from Asia and Europe and two each from Sub-Saharan Africa, North Africa and Middle east, and Latin America is given below highlighting in each case the purpose of milk recording, institutions and operating systems, and management and sustainability of programmes. Eight countries have been selected only for the purpose of describing the different animal recording situations in four continents. This does not mean that successful animal recording programmes are not being carried out in other developing countries.

2.1 Brazil

The official pedigree and milk recording are the responsibility of the Ministry of Agriculture, Provisioning and Agrian Reform (MAAR) which has delegated its responsibility to breeders associations. The main milk recording organisations have been the Holstein-Friesian Breeders Associations in several states, the Brazilian Zebu Breeders Association and the Brazilian Breeders Association. All associations send their data files to the National Dairy Cattle Research Centre of the Federal Research Organisation (EMBRAPA) which estimates breeding values and publishes sire summaries. The important milk recording organisations include: Parana Holstein-Friesian Breeders Association in the state of Parana ; an Extension Programme run by the School of Agriculture ESALQ in the state of Sao Paulo; a milk recording programme initiated by MAARA with co-operatives; a crossbreeding experiment conducted by EMBRAPA/FAO/UNDP etc. (Madalena, 1997). The milk recording programme implemented by the Parana Holstein-Friesian Breeders Association in co-operation with the Federal University of Parana is the largest programme. In 1995 it provided milk recording service to 385 herds covering 17 176 cows. The organisation has 32 recorders and one supervisor. Recording is done on two normal milking per day. Fat, protein, lactose and somatic cell counting are done at a central laboratory. Data are processed for herd management and certification of yield of individual animals. Farmers pay for the services offered by the association. The government does not provide any financial support.

2.2 Egypt

The Animal Production Department, Faculty of Agriculture, Cairo University in 1989 started a research project financed by IDRC, Canada to establish a 'Pilot Cattle Information System in Egypt' to provide information to farmers for management of their herds. Extension workers of Animal Production Sector, Ministry of Agriculture and Land Reclamation (MALR) acted as recorders and staff and postgraduate students as supervisors. Data were collected based on once a month visit by extension worker to each farm. Monthly reports were produced by the Animal Production Department and sent to each farm. To encourage farmers to join the programme, the Department also started offering a package of technical service on cost like feed, veterinary service, pregnancy diagnosis, treatment for infertility cases etc.. Most of the participating farmers are small farmers with animals less than 5. April to October season is very hot with temperature reaching 42°C. In July when floods come in Nile River the humidity also rises. The area get almost no rain.

In 1994, the university transferred the project to 'Centre for Studies on Dairy Cattle Information Systems ' which carried out the activities that the department was doing. The centre has enrolled some 364 herds and 4 604 animals. A National Dairy Herd Improvement Programme (NHIP) has been proposed to be established for milk recording and genetic evaluation of animals. A Technical Co-operation Programme between MALR (represented by CISE) and FAO was also initiated in 1996 to plan for establishment of National Dairy Herd Improvement System.

2.3 Greece

The official performance recording in dairy cattle, sheep and goats has been implemented in Greece for the last fifty years by the Ministry of Agriculture with the primary purpose for the genetic improvement of animals and secondary to provide management and technical information to farmers. Presently, the programme is being carried out by the Direction for Inputs to Animal Production, Ministry of Agriculture and its five regional Animal Genetic Improvement Centres namely Drama, Thessaloniki, Karditsa, Ioannia, and Athena. The Agricultural Universities in Thessaloniki and Athena help in analysis of data and producing feedbacks for the farmers. They also provide technical advise on feeding, breeding and selection of animals. The official method of milk recording is A4 - once a month two time a day. Milk is measured volumetrically. The individual animal data with samples for measuring milk fat, protein and lactose content are sent to nearby Animal Genetic Improvement Centre. The agency responsible for milk recording and genetic evaluation of animals is the Ministry of agriculture and the financial support also comes from the Ministry of Agriculture. Farmers do not pay for the service, on the contrary till 1993 the government gave considerable premium to farmers to join the recording and genetic improvement scheme. The government is thinking now to involve the co-operative organisations for milk recording under the supervision of the Agricultural Ministry.

2.4 Kenya

The first official milk recording in Kenya started in 1949. The scheme was named as East Africa Milk Recording Service. Its operations were confined to large herds. The main objective of the scheme was to provide information for management of farms. This scheme was closed in 1970. However in the same year a new scheme called Kenya Milk Records (KMR) was started to provide milk recording service to farmers. Milk yields of individual cows were recorded by farmers daily on official milk sheets and sent to the central office weekly. Official recorders visited the farms bi-monthly intervals to take milk samples for butter fat test and to check whether the recording rules were followed. The central office supplied feed back on lactation certificate, herd and breed averages and butterfat test results. KMR faced financial problems and dissolved in 1994. The livestock farmers set up the Dairy Recording Service of Kenya (DRSK) in 1994. This the current organisation which is providing milk recording service to farmers. Till June 1996 DRSK had recorded 10 492 cows in 120 herds with an average herd size of about 88 animals.

2.5 India

Three totally different types of organisations, one, dairy co-operative organisations promoted by the National Dairy Development Board (NDDB), second, a semi-government organisation (the Kerala Livestock Development Board (KLDB) and third, a non-government organisation) the Bharitya Agro Industries Foundation (BAIF), have developed and sustained more or less similar milk recording and genetic evaluation programmes in different parts of the country.

2.5.1 NDDB

NDDB has initiated its Dairy Herd Improvement Programme Actions (DIPA) in six districts in Gujarat; in Mehsana district for Mehsana Buffaloes, in Kheda district for Murrah buffaloes and in Sabarkantha, Baroda, Panchmahals and Surat districts for Murrah buffaloes and crossbred cows. These all programmes were initiated with the purpose of milk recording of daughters for progeny testing of bulls. The other components like feeding and management of animals have been integrated into the programme of progeny testing of bulls.

The DIPA programme in each district is implemented by the respective district co-operative milk producers' unions. These dairy co-operative unions are owned and managed by farmers representatives. At the village level, these unions have independent village dairy co-operative societies owned and managed by farmers' representatives. The village level dairy co-operative society buys milk from farmers and supplies it to the district co-operative union. The society buys cattle feed from the union and sells it to farmers. It employs an inseminator and provides AI service to farmers. Semen doses are supplied by the union. The union also provides emergency veterinary service directly to farmers. The DIPA programme is integrated into the several activities of union and village dairy societies. The union collects milk from each village, processes it into milk and milk products, generates revenue through sell of products and pays to dairy co-operative societies for the milk supplied by them. These unions do not get any assistance from the government.

For effective implementation and control of DIPA programmes uniform rules and procedures have been evolved. Under each programme some 15-20 bulls are put to test every year. To generate roughly 100 completed records, about 2 000 semen doses of each bull are distributed in selected villages. Each union selects 30 to 35 villages. All breedable animals of the selected villages are ear-tagged with plastic ear tag with eight-digit unique number. Semen doses of bulls put test are distributed in the selected villages in a way that maximum number of bulls produce their progenies in each selected village. All events of AI, pregnancy diagnosis, calving and monthly morning and evening milk recording are recorded through the information system developed for this programme (DIPA-MIS). Project monitoring reports as well as estimation of breeding values of bulls and recorded progenies are produced using DIPA-MIS. Most of the farmers in these villages are small farmers having 1-5 animals. About 20% of them will be landless and the rest following mixed farming systems. These villages are in hot and dry climate with moderate rainfall . Some of them have irrigation facilities. Every year about 40 bulls are put to test and about 2 500 animals are put under recording.

The DIPA programme is implemented by the respective dairy co-operative union and managed by a Management Committee represented by the union and the NDDB. NDDB provides full financial support for first five years. After five years each union carries out the DIPA programme from its own internally generated funds. Farmers are not charged for any service provided by the union under DIPA programme. Each union has also created a corpus fund for this programme. Each DIPA programme now meets its expenditure from the interest earned out of the investment of the corpus fund and does not depend on any external agency for funding. For the long term participation of farmers in the programmes, the programme needs to be reoriented from its present emphasis on progeny testing of bulls to performance recording and use of information for both extension and planning.

2.5.2 KLDB

KLDB, a fully Kerala State Government-owned company formed in 1976 integrating the Indo Swiss Project, has been implementing milk recording and genetic evaluation of bulls through progeny testing since 1977. The programme was initiated and funded by the erstwhile Indo Swiss Project. The purpose of the scheme is to estimate breeding values of bulls on the basis of performance of their daughters and to use the top 10% of bulls for the production of the next generation of breeding bulls. Every year 40 bulls are put to progeny test. Some 1 500 test inseminations are carried out to obtain at least 50 complete first lactation records. Inseminations are carried out by the AI centres manned by the department of Animal Husbandry and the cattle improvement assistant of the Dairy Development Department. On an average 2 000 animals are registered every year for recording their first lactation yield. Milk recording is done once a month morning and evening by unemployed youth and/or workers of the nearby village co-operative societies. Supervision of milk recording is done by supervisors of KLDB. So far 614 bulls have completed their test mating. Since 1984 some 21 061 cows have been enrolled for milk recording of which 16 124 cows have completed their first lactation records. The average standard first lactation yield of daughters completed their lactation in 1996 was 2 2.5.3 BAIF 192 litres. The average increase in milk production has been 3.72%. Most of the farmers are small farmers with 1-5 animals. In coastal areas the climate is hot and humid, in mid land it is hot and sub-humid and in high land it is cool and dry. All farmers are mixed farmers The whole programme is managed by KLDB and funded by KLDB and the Government of India. Farmers do not pay any thing for the service provided by KLDB.

2.5.3 BAIF

BAIF is a non government organisation which takes up developmental programmes with the focus on income generation activities and improvement of quality of life of rural population. Crossbreeding of indigenous cows with semen of exotic bulls of Holstein and Jersey breeds has been one such activities of BAIF covering some 7 000 villages distributed over 7 states in the country. Crossbreeding programme initiated in Ahmednagar district in the state of Maharastra is the oldest crossbreeding programme initiated by BAIF. BAIF has initiate milk recording and progeny testing of crossbred bulls in 143 villages of the Ahmednagar district. The farmers in this district are small farmers. The climate of the district is hot and dry. The main purpose of the programme is to increase the average productivity of the crossbred cows of the Ahmednagar district through progeny testing of crossbred bulls. AI services to farmers are provided by the employees of BAIF. They collect information on AI, PD and calving. For carrying out milk recording in 143 villages, 10 permanent and 10 contractual recorders have been employed. Milk yields are recorded fortnightly morning and evening alternate fortnights. Random checking of milk yields and fat testing in 2nd, 5th and 8th month of lactation are carried out by supervisors. The average first lactation yields of crossbred progenies was 2 671±60 kgs. The entire programme is managed by BAIF and funded by BAIF and supported by the government of India.

2.6 Morocco

Dairy record keeping in Morocco is a government programme controlled and fully funded by the Ministry of Agriculture. It is basically for genetic improvement of animals. The dairy recording started in 1968 by one public management company. The service was extended to public and private farms which later resulted in the formation of four herd books one each for Holstein, Friesian, Red and White, and Tarentaise at the Ministry of Agriculture. From 1973 to 1985, the recording was limited to public and a few private farms covering some 120 herds and 5 000 cows (mainly Holsteins and Friesians). In 1985 the recording was extended to all farms referred to as “nursery units” which received subsidies for each selected animal to reduce heifer importation. Now, the number of these “nursery units” is about 390 with 11 000 cows which represent about 9% of the total pure breed dairy cows. In general, the recording is used for genetic improvement only, and the farmer does not receive any feedback for herd management. Agents of the Ministry of Agriculture weigh milk yield and take a sample for fat test once a month. Some 15 000 cattle have been registered in the herd book between 1985 and 1995. A progeny testing programme was also initiated in 1989. It started with 30 bull calves from which, in 1995, 10 bulls were selected. In 1992, 1995 and 1996, 18, 16 and 16 bulls were put under test.

2.7 Venezuela

The project on performance recording of dual purpose cattle was started in 1990 by the Universidad Central de Venezuela with the financial support of IDRC, Canada with the objective to define traits to be measured in dual purpose cattle - milk and beef, to develop methodology for field recording appropriate under tropical climate and to develop appropriate software to provide information to participating farmers.

The number of farms participated in the programme varied from 12 to 20 over the year with cows between 1 552 and 3 077. Initially milk and cows were actually weighed by project technician during his monthly visit to the farms with the help of farm worker, but later this was done by farm workers themselves. During monthly visits, the technician supervises the records collected by farmers, does some direct recording like weighing of calves, discusses the previous month report and the future work programme with the farmer. The software developed for the programme provides a variety of information on the performance of individual animals and also for the whole herd. It also provides a specific action list for the farmer. Every six months farmers also get estimated breeding values for their animals.

The programme was entirely implemented by the university staff with the assistance of IDRC, Canada in the first four years. Later, the programme was partly funded by the participating farmers and partly by the university.

2.8 Zimbabwe

Presently the Zimbabwe Dairy Services Association (ZDSA) provides milk recording services and carries out genetic evaluation of cattle in the country. ZDSA is governed by a ZDSA council consisting of representatives of all stakeholders in the dairy industry such as the government, producers, processors, and the Zimbabwe Herd Book (ZHB). ZDSA and the government (Dairy Services) have made an undertaking to operate in a 'joint' venture in administering the milk recording services. The main purpose of the programme is to carry out performance recording of animals and provide information to farmers to manage their farms.

The participating farmers have two options; one is fully supervised by ZDSA and second is an owner sampler option. For the fully supervised herd option a milk recorder of ZDSA visits the farm ten times in a year. During his visit herd owner or he himself extracts data on all events and records on specially designed input formats. He records an individual cow milk yield and collects milk samples. The collected milk samples and formats are sent to the central office of ZDSA by courier. The milk samples are analysed for butter fat, lactose, total solid and somatic cell counts and results are transmitted electronically to the data processing centre. All formats received from the field and the results from the central laboratory are processed by the data processing centre of ZDSA. The reports are sent to the participating farmers within ten days. For the owners' sampler option, the only difference is that milk recording is done by farmer himself.

The farmer collects samples and fills up formats and sent them to the central office for processing. For smallholders a special group recording scheme has been evolved. It is a modified form of the owners' sampler option. Owner sampler herds are tested every month, with milk recorders visiting them four times a year. On the test day all cows milk yields are recorded every milking. Samples are collected for each cow. All relevant information of all cows is recorded in a single format. All formats and samples are sent to the central office of ZDSA for processing. The genetic evaluation of animals is carried out by ZDSA using the BLUP sire model methodology. Some 23.9% of the total 410 large herds and three smallholder groups with a total of 129 cows are participating in the performance recording programme. All these herds are in a central plateau. It has a temperate climate. The mean summer temperature is 27°C during day and 16°C at night and the mean day time winter temperature 18°C. Humidity is low for much of the year. It has very favourable climate for dairy production.

The entire programme of performance recording and genetic evaluation of animals is done by the ZDSA. ZDSA is governed by a ZDSA council representing all stakeholders of the dairy industry. ZDSA meets its cost by charging farmers partly for their services, by levies from the dairy industry and by the contribution from of the government. Technical assistance for the programme has been received from the Canadian International Development Agency (CIDA) and the Netherlands Royal Cattle Syndicate (NRS).

3. Constraints for animal recording

The main constraints pointed out by many persons involved in animal recording in developing countries include the following topics.

3.1 Low awareness of benefits of recording

Low awareness among farmers about benefit of recording is a limiting factor in many developing countries. Several reasons have been given why farmers pay less attention to recording efforts; two important reasons among them include: low productivity of animals and small herd size. As productivity improves or herd size increases or both happen, farmers pay more attention to animal recording and look for information to improve productivity of their animals. The farmers who have participated in performance recording in Zimbabwe, Kenya, Venezuela or Brazil are large farmers and have comparatively high producing animals mostly Friesians. On the other hand the milk recording systems developed and sustained for many years by KLDB, BAIF and NDDB in India were all for small farmers and they all were initiated for the genetic improvement of local buffaloes or crossbred populations. Those who are implementing animal recording programmes for smallholders in developing countries find it extremely difficult to motivate farmers to participate in such programmes. Chacko (1997) points out this as one of the limiting factors for extending milk recording. He says: "the farmers are yet to find a use for records and this makes the milk recording programme not a welcome one, but an imposed hazard". Nevertheless, through implementation of their milk recording and genetic evaluation programme, the average standard milk yield in first lactation in crossbred cows increased from 1 480 to 2 100 at an annual rate of 3.42% between 1983 and 1995. In the programmes implemented by the producers' co-operative organisations in India, it was realised that a report produced for an individual farmer who has just one or two animals may not be that informative to him, but when a report is produced for the whole village co-operative covering all participating farmers and their animals, it becomes very informative to him. He compares his performance with other farmers in the village and tries to adopt practises followed by the farmers having better performing animals. These organisations even give incentives to farmers to make them participate in milk recording programmes.

3.2 Lack of right organisations for animal recording

Bachmann (1997) points out that organisations with technical know-how and finance are a prerequisite to take up breed improvement programmes in developing countries. In developed countries animal recording activities had been initiated by farmers' co-operatives or breeders' associations with support from the respective governments. Even in developing countries some effective animal recording systems have been developed and sustained perhaps because they have been initiated by right organisations and interested people. The success of the milk recording programme implemented by KLDB is because a separate organisation was set up with the technical and financial assistance of the Swiss Agency for Development and Co-operation. Similarly the successful implementation of DIPA programmes by NDDB was because these programmes had been implemented through powerful farmers' co-operative organisations and technically and financially supported by NDDB. In Zimbabwe the government formed a separate organisation the Zimbabwe Dairy Services Association (ZDSA) to provide milk recording services and carries out genetic evaluation of cattle in the country. ZDSA has been given complete freedom to operate and is partly supported by the government. In many developing countries there are no organisations providing animal recording services to farmers and carrying out genetic evaluation of animals. Often some interested people from agricultural universities initiate milk recording programmes, but such programmes either remain confined to providing services to a very small group of farmers or die in absence of continued finance support.

3.3 Lack of technical know-how

Low literacy rate in developing countries is often mentioned as a limiting factor in implementing performance recording. If farmers cannot read computer outputs sent by recording organisations, they cannot make use of information provided in the outputs. Some simplified systems will have to be developed if reading and interpretation of results would be a problem. The information that recording organisation provides to farmers must also be relevant to them for their day-to-day operations and for planning of their future activities. Analysing local situations and advising farmers need special technical skills. In developing countries often trained people may not be available. Developing recording systems also needs expertise in information technology which also may not always be available locally.

3.4 Lack of finance

Lack of finance is frequently mentioned as the most critical factor for initiating and sustaining animal recording systems in developing countries. Many recording programmes have been closed for want of financial support.

4. What ICAR can offer to developing countries

4.1 Appropriateness of Animal Recording organisations

On the experiences of implementing animal recording programmes in developing countries three basic principles could be arrived at on whether an animal recording programme would succeed or not: (i) Whether it provides the information or service important to farmers; (ii) whether the operating system developed meets the purposes important to farmers; and (iii) whether there is an institutional environment which ensures that the operating system functions at its best.

4.1.1 Information or service important to farmers

Any animal recording organisation must work towards providing information or service important to farmers. If animal recording systems are developed for purposes which are important to organisers or to governments or to any other external institutions other than farmers, howsoever noble the purposes could be, such organisational efforts would not last long. Many programmes initiated by governments or universities for the purpose of progeny testing of bulls have failed when they did not consider to include a component of providing information for improving management, feeding and health care of farmers' animals. For example the Official Milk Recording Services (ROPL) run and financed by the Ministry of Agriculture and Breeding (MAC) between 1956 and 1994 in Venezuela for the purpose of progeny testing of bulls. Some organisations like KLDB and some co-operative organisations in India have set up milk recording schemes for the purpose of progeny testing of bulls and have run them successfully for a number of years. In case of KLDB, it is because very dedicated people were involved from the beginning and it received technical and financial support of the Swiss Agency for Development and Co-operation. In case of the DIPA programmes, the success is because these programmes were implemented by very large dairy co-operative organisations providing a variety of technical service including AI, cattle feed, health care etc. and were technically and financially supported by the National Dairy Development Board. The very fact that these co-operative organisations are now putting more emphasis on generating information at the village dairy co-operative society level covering all animals of the participating farmers, explains that for the long term sustainability of the programme farmers must get information important to them, it would not be enough that they collect information for estimating breeding values of sires. When farmers find the information or service important to them they would not mind paying for it and implementing organisation then can charge for their service and generate funds for their organisations. In other words, when the organisation ensures that it provides the information the farmers need, it also ensures its long term sustainability.

4.1.2 Operating systems meet the purposes important to farmers

Although, the type of organisations which implement animal recording programmes and the traits they measure may be different in different countries, the operating system followed is surprisingly similar. The main components of the operating systems are: identification of animals by applying a plastic ear tag having a number readable from a distance; collection of initial information on birth or age of animal, reproduction and lactation details if any available etc.; collection of individual animal information on AI, pregnancy diagnosis and calving; registration of new born with necessary pedigree details; visit of official recorder once a month to farmer's place and record individual animal's milk yield and or body weights and collect milk samples for testing of fat and other components like protein, lactose, somatic cell counts etc.; forwarding the collected data to a central data processing centre which analyses data and sends feedbacks to farmers on monthly basis; the data processing centre also creates databases of all animal records and estimates breeding values of all animals at a regular interval of time and publishes the results. Some time all these functions are done by a single organisation like the DIPA programme implemented by the dairy co-operatives in India or different functions by different organisations say breeding factions by one organisation, data collection and extension activities by other organisation and data processing by third organisation. Systems of multiple organisations is found in many countries like in Kenya, Brazil, Zimbabwe etc. The success depends on how efficiently these services are provided by different organisations to farmers. More co-ordination between different functions is ensured when all activities are carried out by a single organisation than when they are implemented by different organisations. Single organisation, however, is not able to employ people of different skills required for the variety of activities to be carried out and therefore the quality of service provided by it may suffer.

4.1.3 Promoting organisation

An organisation with technical know-how and fiancé is a prerequisite for development of effective animal recording organisations in the country. In a big country such an organisation should take up the responsibility of promoting animal recording organisations in the country. In a small country such an organisation can itself take up the responsibility of implementing animal recording services. In many developing countries recording activities have been initiated by agricultural universities. Universities usually have technical skills, but they do not have funds to carry out such activities. Hence, animal recording activities initiated by universities either get closed after sometime or they remained confined to very small area. When animal recording services are initiated by producers' co-operatives or by developmental institutions or by breed organisations, they are able to expand their activities. Such organisations, however, need to be supported with technical know-how and initially with funds. The promoting organisation can provide the technical know-how and fund. It can also take up the responsibility of giving training to their staff. They may also help in estimating breeding values at the national level and publishing sire summaries of all bulls used in the country.

4.2 Role of ICAR

4.2.1 Providing standards and guidelines

As the operating system followed for implementing animal recording services is very similar across many developing countries, ICAR can prepare standards and guidelines for milk recording, dual purpose (milk and meat or milk and draft) or multipurpose recording, recording for certain additional traits, quality of data, genetic evaluation of animals in small herds etc. specifically for developing countries.

4.2.2 Develop guidelines for initiating and structuring national animal recording systems

ICAR in conjunction with FAO should develop guidelines for initiating and structuring national animal recording systems and circulate them to governments of all developing countries. Such guidelines should list down the broad principles that should be followed in initiating animal recording programmes which should include: all recording programmes must provide information or service important to farmers; the recording systems should be designed in a way that while it serves the primary purpose of providing information to farmers, the data collected is also used by breeders for genetic improvement of animals, by governments and planners for developing national livestock development programmes, and by consumers for ensuring quality control of livestock products; description of all components of the operating system; establishment of an organisation for promoting animal recording in the country or delegating this responsibility to some existing institution; all animal recording services should be provided through promotion of farmers groups, dairy co-operatives, breeders associations etc. and not by the government; government funding will be necessary to initiate and possibly to sustain; animal recording organisations must charge for their services and work towards recovering full cost over a period of time etc.

4.2.3 Training and consultancy for developing animal recording organisations

ICAR can organise training programmes in animal recording for field level extension staff, country co-ordinators, university and ministry of agricultural personnel from developing countries at a suitable place of one of their member organisations in developing countries. The training should cover practical aspects of animal recording including management advise, data processing and interpretation of results. ICAR can also provide consultancy services for developing animal recording programmes in developing countries.

4.2.4 Establishment of regional networks

ICAR can establish regional networks of institutions and people in Asia, Sub-Sahara Africa, North Africa and Middle East and South America. The people from different countries participating in regional networks can exchange ideas, methods and experiences on animal recording. ICAR can also organise regional workshops for promoting animal recording activities.

4.2.5 ICAR News letter for developing countries

ICAR can start a news letter specifically for developing countries.

4.2.6 Homepage for animal recording information in developing countries

ICAR can develop a home page on Internet to provide all information on animal recording in developing countries. Such a page could be updated regularly to provide all new information collected by ICAR.

K.R. Trivedi

Part II
Country Reports

A Case Study of Buffalo Recording Systems under the Dairy Co-operative Organisations in India

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1. Summary

This paper first describes the institutional structure through which the programme of 'Dairy Herd Improvement Programme Actions' (DIPA) being carried out by the five District Co-operative Milk Producers' Unions in the state of Gujarat and secondly, it delineates the main components of the DIPA programme including the procedures followed for registration of animals, distribution and use of semen doses of bulls put to test, milk recording, supervision of milk recordings, collection and analysis of data, etc. The paper also gives a brief account of the progress made by these institutions in implementing the DIPA programme in their districts. While describing the future directions, the paper emphasises the need to bring together institutions carrying out animal recording and genetic evaluation of animals in the country and establish uniform standards and procedures for animal recording and genetic evaluation of animals.

2. Introduction

The National Dairy Development Board (NDDB), a statutory non-profit organisation of the Government of India, has been implementing a comprehensive programme for dairy development in India known as 'Operation Flood' (OF). NDDB was set up in 1965 with its head quarter at Anand in the state of Gujarat to develop dairy co-operative organisations on a model that was successful before NDDB launched its OF programme. As this model co-operative is around Anand, the model has come to be known as 'the Anand Pattern Dairy Co-operative' (APC). NDDB provides technical, engineering, advisory, training, research and support services in milk production, procurement, processing and marketing for the development of dairy industry in India through establishment of 'the Anand Pattern Dairy Co-operative' organisations. The APC institutions have been established in 170 milk sheds covering 266 districts, 74 000 villages and some 9.4 million farmers. These institutions together process some 12.2 million litres of milk a day. They together have milk processing capacity of 26.5 million litres a day and milk drying capacity of 990 MT per day.

Beginning in 1987, NDDB has initiated a few comprehensive programmes of milk recording and genetic evaluation of animals referred to as 'Dairy Herd Improvement Programme Actions (DIPA)' in the selected milk sheds in the country where the infrastructure for artificial insemination (AI) has been well developed. The first DIPA programme was started in Mehsana district in the state of Gujarat. Subsequently, the programme was extended in Kheda, Sabarkantha, Baroda and Panchmahals districts in Gujarat, Mysore, Mandya and D Kanada districts in Karnataka and Salem, Erode, Coimbtore, Dharmapuri, and South Arcot districts in Tamil Nadu. This paper describes the experiences of implementation of DIPA programmes in Buffaloes in Gujarat. Before the main components of the DIPA programme are described, it may be worthwhile to look at the organisational structure through which these programmes are being implemented and the animal resource-base intended to be improved in each district.

Exhibit I

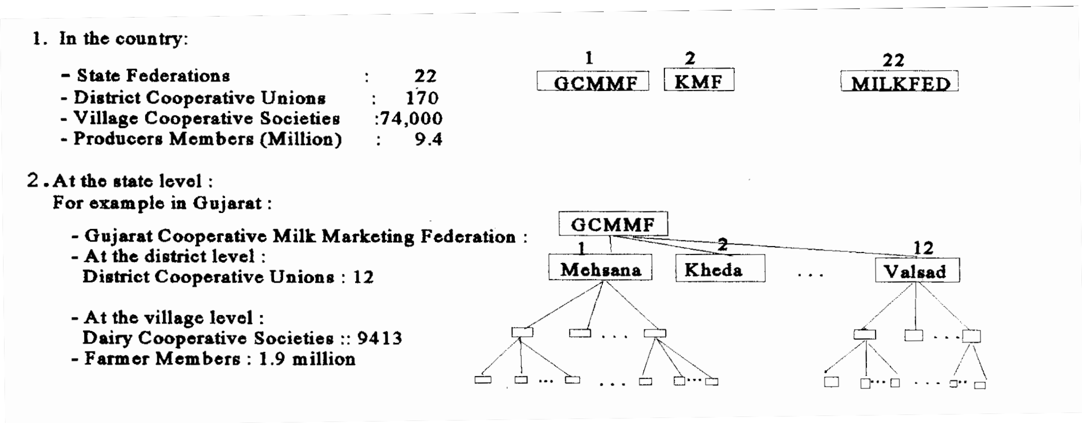
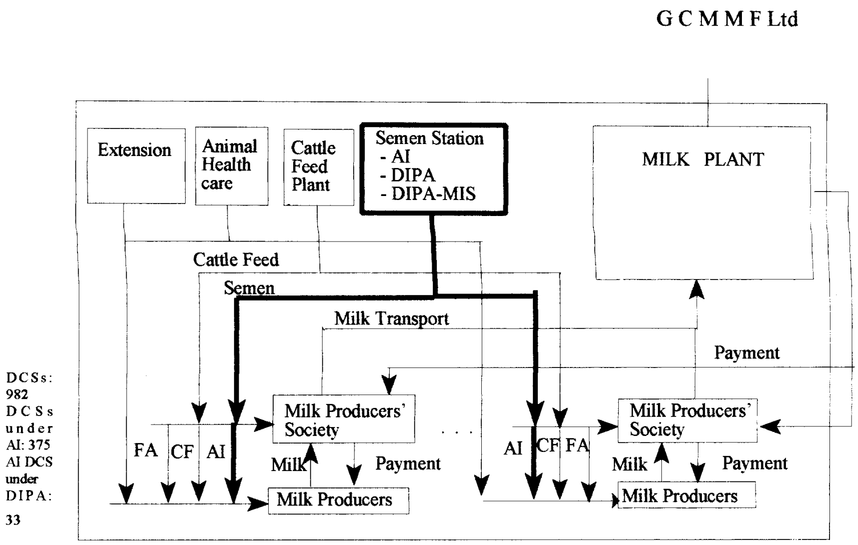


Figure 1. Structure of the dairy co-operative organisations in India



FA:First aid; CF: Cattle Feed; AI : Artificial Insemination

Figure 2. Mehsana District Co-operative Milk Producers' Union Ltd.

3. Organisational structure

The DIPA programme in each selected district is being implemented through the respective district milk producers' co-operative union. These co-operative organisations are truly co-operative institutions owned and managed by farmers' representatives. They all have been evolved with farmers' own initiatives. They support all their activities from the funds generated internally from their milk businesses. They do not get any assistance from the government. All district co-operative milk producers' unions have been organised on the model of 'the Anand Pattern Co-operative'.

The basic design of the APC is depicted in Exhibit I and briefly described here. Milk producers of a village are organised into a village milk co-operative society managed by their elected representatives. All village producers' co-operative societies in a district federate into a district co-operative milk producers' union. A Board of Directors manages the union; the chairman of the village co-operative societies elects most of them. The unions, in turn, are federated into a state dairy federation which is managed by elected representatives of the district unions.

The village milk society collects milk twice daily from milk producers and pays for it based on a fat test. The milk purchased from the producers is bulked in cans that are collected twice daily at a pre-specified time and taken to a dairy plant of the union. The society also sells balanced cattle feed and fodder seeds purchased from the union to the producers. It provides first aid veterinary and AI services to producers. The activities of the society are carried out by the staff employed by the society. Three to six persons usually run the society. One of them will be an inseminator cum a first-aid worker.

The district union organises collection of milk from village co-operative societies twice daily and makes payment to village societies. The union owns a dairy plant for processing of milk and milk products. The union also provides all the inputs required by the farmers like cattle feed, fodder seed, veterinary service and artificial insemination. Many unions own cattle feed plant. Some unions also have their own semen station and liquid nitrogen plant and some others buy semen and liquid nitrogen.

On the behalf of its members' unions, the federation undertakes marketing of milk and milk products and quality control. Some state federations own cattle feed plants and semen stations and supply cattle feed and semen to their members' unions.

In all districts where the DIPA programme is being implemented, it has been integrated into their normal AI programme (See Exhibit I).

4. The milk production environment in five districts in Gujarat

Dairying is an important source of supplementary income to most farmers in these districts; more than 70% of households have cattle and/or buffaloes. The cattle and buffaloes are also more equitably distributed than any other asset. The marginal, small and landless farmers together hold more than two thirds of milch animal stock. Like agricultural holdings, livestock holdings are also very small. Usually farmers have one to five dairy animals. Large stock holdings are exceptions (See table 1).

Milk production takes place in many households each contributing a very small quantity. Together, however, they produce a very large amount of milk. Farmers in a village live near to each other in conglomeration and keep cows and buffaloes with them. Since they live together they learn from each other and often follow common management practices. Livestock are managed by family labour and fed largely on crop residues and supplemented with green fodder and concentrate. The size of livestock holdings in fact are governed by the availability of family labour and crop residues. In the Indian context, the DIPA villages included in the programme could be put into the category of medium input production system. Most of other villages in these districts, however, could be classified as low input production system.

These districts have proportionately more buffaloes than cows: the proportion of breedable cows to buffaloes is 3:7 and the proportion of cow milk production to buffalo milk production is 1:4. Some 7% of the total breedable cows are crossbred cows, but they produce some 31% of the total milk produced by cows. This explains that the buffaloes and crossbred cows are kept for milk production, while indigenous cows contribute very little to the total milk production. In fact local cows are kept for production of drought animals and not for milk production. The five unions together collect and process an average of 2.00 million litres a day, 70 per cent of which is buffalo milk and the rest cow milk.

Of the total 7 042 villages in the five districts, 5 108 villages or 73 per cent of villages have dairy co-operative societies. Of the total 5 108 dairy co-operative societies, 2 566 societies or 50% of the dairy co-operative societies have been covered under AI and 148 societies have been included under the DIPA programmes. This means that about 40% of the total animals have been covered under AI and about 2% of the animals have been covered under milk recording.

5. Main components of DIPA programme

For effective implementation and control of the progeny testing programmes uniform rules, standards and procedures have been followed for all programmes. Exhibit-II explains one district level programme.

As shown in Exhibit-II, the programme concentrates on increasing genetic gain through the selection of sires to breed sires and the selection of dams to breed sires. Higher genetic progress on the sire to sire path is sought to be achieved through increasing selection intensity of sires to produce sires,

Table 1. Certain district level information for the five milk sheds implementing DIPA programmes.

Particulars	Mehsana	Kheda	Baroda	Panchmahals	Sabar
1. Area (Sq. Km)	9 027	7 194	7 794	8 866	7 390
2. No. of villages	1 103	973	1 653	1 908	1 387
3. No. of towns	37	37	36	22	11
4. No. of Households (000)	550	643	567	463	325
5. Total population (000)	2 938	3 441	3 090	2 956	1 761
6. Livestock (in 000): Cows	106.4	88.3	97.8	175.6	104.1
Buffaloes	345.0	401.1	163.7	230.0	216.4
7. Milk Production (000 tones): Cows	109.1	115.7	57.42	59.1	83.8
Buffaloes	409.4	322.65	135.35	146.8	169.5
7. No. of DCS	995	956	823	1 001	1 333
8. No. Of members (000)	296	549	163	141	202
9. DCSs Under AI	372	845	316	511	522
10. AI DCSs under DIPA	33	30	30	30	25

increasing accuracy of selection of sires by producing as many daughters per bull in as many villages possible and reducing generation interval to the extent possible by putting sires to test as early as possible. On the dams to sire path, the high genetic progress is planned to be achieved through increasing selection intensity on dams to produce sires (about 200 elite dams every year out of available recorded dams), and increasing accuracy of selection of dams by having at least two lactation records. The superiority of the selected bulls is transferred into the base population through selection of the best 50% of tested bulls for normal artificial insemination programme once they complete their test mating (about 50% of the dairy co-operative societies have been covered under AI).

A set of twenty bulls are put to test every year under each programme. To generate roughly 100 completed first lactation records of progeny per bull, some 2 000 doses of frozen semen of each bull are distributed in the selected villages. The semen doses of bulls put to test are distributed in a way that the number of daughters born for each bull in each village across all villages would roughly be the same. To ensure this, a bull wise semen distribution schedule is prepared. In each society, semen of only one bull is used in a month. Each month bull is changed in each society. Semen of all bulls is used in one or other society in all months. This ensures production of daughters of bulls put to test in most of the villages and in all months.

Apart from release of test doses, some 5 000 doses per bull are stored till results of bulls put to test are available. The stored semen doses of the top two bulls are to be used for nominated service on the elite recorded animals to produce the next generation of bulls.

For recording performance of daughters in the field an effective infrastructure of milk recording and systems of data collection and data analysis has been established.

Once a dairy co-operative society (DCS) is selected under a DIPA-programme, all breedable animals of the selected villages are ear-tagged by the village level inseminator with a plastic ear tag having eight digit unique identification number. The last digit of the number is the check digit. At the time of registration of animals, breed, number of lactations completed, whether in milk or dry, and date of birth are collected in the Registration Format. When the registered animals are brought for artificial insemination at the village DCS, they are inseminated by the village level inseminator using semen doses of the bulls put under test. At the time of insemination, number of service bull, batch number and inseminator code are recorded in the AI Format. The information on the name of sperm station, breed, name and number of bull and batch number representing the date of collection of semen of the bull is printed on the straw. Subsequently, at the time of examination of animals for pregnancy diagnosis, the code number of the person who carried out pregnancy diagnosis, the results of pregnancy diagnosis and the date of examination are recorded in the Pregnancy Diagnosis Format. Later, when animals calve, date of calving, sex of the calf, ear tag number of the calf and any genetic defects observed are recorded in the Calving Format. Sex code includes male, female, twin males, twin females, twin male and female, abortion and still birth. When a female calf is born, a new ear tag is assigned to the calf and applied within 15 days.

Exhibit II

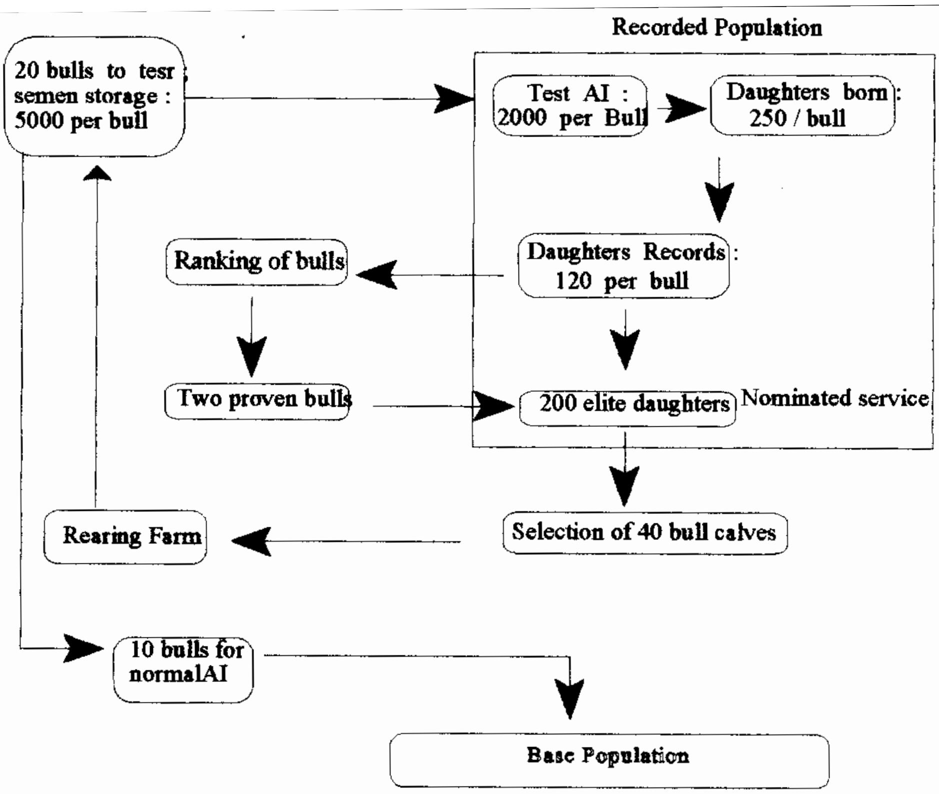


Figure 3. Schematic presentation of a DIPA programme

All female calves born are followed for growth. As an incentive to the participating farmers, all farmers having a female calf born in the programme are given five bags of cattle feed (About 350 kgs.) for the daughters born over a period of one and a half year. When these daughters come in heat, they are inseminated and all events of AI, PD and calving are recorded in the respective formats. All daughters coming in first lactation are milk recorded once a month both morning and evening for the whole lactation. A sample of milk is collected in the sample bottle and tested for fat percentage at the dairy co-operative society both the times. The monthly recording of each daughter continues till it completes lactation or till ten monthly records are obtained. In the first four years of implementation of the programme, initially some dams registered under the programme are also put under milk recording. The designated milk recorder is paid for every milk recording. The participating farmers do not pay for recording.

Each union assigns one supervisor for 7 to 10 DIPA villages exclusively for DIPA programme. The supervisor visits at least once in 15 days in each of his assigned DIPA villages. When he visits any village, he selects randomly some farmers and checks for milk recording. He visits the houses of farmers whom he has to give cattle feed. He measures heart girth and body length of the calf by a measuring tap and estimates body weight. If he finds the estimated body weight within expected weights, he sanctions the next instalment of cattle feed. He supplies ear tags to inseminator and checks the formats filled by him. He advises farmers on feeding and management of animals and acts as an extension agent.

In all 148 villages or about 2% of the total animals have been covered under the DIPA programmes and milk recording in Gujarat. This means bulls are evaluated based on 60 to 100 daughter records per bull covering some 2 per cent of the animals. However, some 50% of the societies or about 40% of the total animals covered under AI get benefit of evaluated bulls produced under the DIPA programmes.

All data of artificial insemination, pregnancy diagnosis, calving and milk recording are collected through the management information system (MIS-DIPA) developed for this programme.

6. MIS DIPA

MIS-DIPA is a user-friendly, integrated management information system covering all components of the DIPA programme such as maintenance of bulls, production, processing and supply of semen, field artificial insemination, milk recording etc. The data collected in different formats are processed at the computing centre of the unions. Many reports are produced through the system. Since farmers have just one or two animals, village wise and within village animal wise performance reports are produced for all animals registered under the programme together and not for each individual participating farmer. Whenever the supervisor visits his assigned village, he carries with him the village wise performance report and the action list. He discusses the performance report with inseminator and farmers and advises on feeding and management of their animals. MIS-DIPA also produces performance reports on bulls, animals, and sperm stations. It maintains animal wise information on age at calving, days from calving to first service, days open, total lactation yields, fat yields, lactation length, dry period, inter calving period etc. The system also has a provision for estimating breeding values of bulls and cows using the best linear unbiased prediction (BLUP) method.

7. Progress made so far

As these programmes were initiated at different points of time, each is at a different stage of its implementation. The details of progress made under each programme are summarised in table 2.

The DIPA programme at Mehsana was started in 1987. Most of the buffaloes in this district (about 96% of the buffaloes) are Mehsana buffaloes. This breed is intermediate between Murrah and Surti breeds of buffaloes. Though, it is now a distinct breed, initially it had been evolved through many generations of crossing of Surti and Murrah buffaloes. So far six batches of Mehsana buffalo bulls have completed their test mating (in all 84 bulls) and the semen doses of the seventh set of bulls are being distributed. The overall simple average standard 305 days first lactation yields of daughters born under the programme based on 2 810 daughters observations was 1 917 litres with the standard deviation of 380 litres and the coefficient of variation of 19.8%. The simple average of age at first calving was 42.8 months with the standard deviation of 8.07 months and the coefficient of variation of 18.8%.

The average yields of daughters across all villages and the number of bulls used in each village are given in table 3.

The breeding values were estimated using the following model:

$$Y = Wa + Xb + Zc + e$$

where:

Y = an observation vector consisting of 305 days standard first lactations yield of daughters (Number of observation: 2 655)
a= effect of age at first calving; assumed to be a continuous variable (a quadratic function assumed)
b = a vector of village-year-season effects (Total village-year-season effects : 243)
c = a vector of random sire effects (Total sires: 45)
W, X, Z = are known matrices, and
e = a vector of random residual effect.

The heritability for milk yield was estimated to be 0.12. The best linear unbiased estimates of the top ten sires obtained using the above model are given in table 4.

In Kheda District the programme of testing of Murrah buffalo bulls was started in 1988. The base population of buffaloes in this district consists of Surti and nondescript buffaloes. The buffaloes in this district are now being upgraded with Murrah buffaloes. So far, two sets of Murrah bulls have completed their test mating and the third set of buffalo bulls is under the test. Some 334 daughters of the first set of buffalo bulls and 68 of the second set are under milk recording. The average production of these daughters in Kheda was 1 539 litres based on 117 observations.

Table 2. Summary of status of implementation of DIPA programmes in the five districts.

Set no.	No. of bulls	AI per bull	Daughters born & registered	Daughters under recording	No. of bulls	AI per bull	Daughters born & registered	Daughters under recording
Mehsana: Mehsana Buffaloes; since 1987					Kheda: Murrah Buffaloes, Since 1989			
1	13	1 714	2 537	983	13	5 032	1 786	334
2	20	1 392	2 708	1 118	16	4 844	2 959	68
3	12	2 716	3 149	700	17	3 817	1 711	
4	15	1 493	2 437	200				
5	12	1 831	475					
6	12	1 600						
Sabarmati Ashram Gaushla, Bidaj; for Murrah buffaloes since 1992								
Set no	No. of bulls	AI per bull	Baroda		Panchamahals		Sabarkantha	
			Daughters born & registered	Daughters under recording	Daughters born & registered	Daughters under recording	Daughters born & registered	Daughters under recording
Buffalo:								
1	10	1 909	815	2	981	2	716	31
2	10	2 016	1153		530		665	
3	10	2 058	1008		534		685	
4	10	1 721	126		59		133	

Table 3. The average yields of daughters in different villages under the DIPA programme of Mehsana.

Village	No. obs.	Mean	CV %	No.of bulls used	Village	No. obs.	Mean	CV %	No of bulls used
1	158	1 908	15.2	30	10	222	1 820	21.2	27
11	104	2 023	16.5	21	12	94	2 018	16.6	18
15	154	1 778	19.3	28	17	50	1 829	18.1	18
23	186	2 145	17.5	31	27	178	1 921	19.7	28
28	74	1 933	23.6	14	32	72	1 921	17.9	19
33	22	1 984	25.7	10	35	164	1 845	15.3	26
37	150	1 908	14.9	24	39	58	2 107	13	15
41	122	2 067	12.6	19	42	24	1 936	16.1	8
47	56	1 989	22.8	12	48	3	1 911	9.7	3
49	76	1 841	26.5	12	51	52	1 789	22	11
53	52	2 013	20.6	15	55	46	1 869	22.4	14
57	36	1 962	26.9	10	58	18	1 832	15.9	6
59	42	1 715	25.6	15	60	30	1 781	18.8	9
63	30	1 805	15.7	10	64	48	1 792	20.5	12
67	64	1 737	17.7	11	70	36	2 093	24.2	10
73	20	1 962	20.7	5	74	48	1 854	18.7	15
77	40	1 744	15.6	12	81	20	2 288	5.3	4
82	54	1 833	19.7	9	83	22	1 688	13.3	6
84	12	1 631	21.9	4	85	11	1 752	25.7	5
86	4	2 114	12.7	2	87	3	1 505	22.4	2

Table 4. Best linear unbiased estimates of the top ten sires.

Bull No.	No. obs	No. of villages where bull have daughters	Breeding value	Bull no.	No. obs.	No. of villages where bull have daughters	Breeding value
85	43	15	+ 152.7	20	81	10	+ 151.0
88	72	15	+ 120.2	64	58	16	+ 109.6
24	39	9	+ 108.3	49	28	9	+ 108.1
54	90	16	+ 97.7	27	59	15	+ 96.8
75	32	10	+ 85.0	73	57	13	+ 67.1

The Joint-DIPA programme being implemented by the Sabarmati Ashram Gaushala, Bidaj and the Baroda, Panchmahals and Sabarkantha District Co-operative Unions together was initiated in 1992. These districts have nondescript buffaloes that are being upgraded with Murrah buffaloes. Under this programme, Murrah buffalo bulls are put under a test programme. So far 40 buffalo bulls have completed their test mating and another 10 buffalo bulls are under test. Some 3 179 buffalo dams are under milk recording. The daughters of the first set of buffalo bulls are just coming in production. The progeny test results of the first set of buffalo bulls will be available in a year's time. One more co-operative union - Surat District Co-operative Milk Producers' Union- has joined this programme since April 1997.

8. Management of DIPA programmes

NDDB provides all technical guidance for carrying out DIPA programmes and takes up the activities that improve the overall performance of DIPA programmes. When NDDB takes up a DIPA programme in any co-operative union, initially a memorandum of understanding is signed between union/federation and NDDB. A project manager is made overall in charge of the DIPA programme. He implements the programme under the overall guidance, supervision and control of a Management Committee comprising the Chief Executive of the Union/Federation, a representative of NDDB and the Project Manager of DIPA programme. This committee meets every three months and reviews the progress made and takes decisions on implementation of the programme.

NDDB has also constituted three working groups viz. i) Milk Recording Group, ii) Information Technology Group, and iii) Semen Station Group. These Groups have been working on establishing standards for all aspects of DIPA programmes and on developing a mechanism to ensure that the standards set are implemented.

9. Funding of DIPA programmes and sustainability

The most important factor for success of any milk recording programme is how it funds its activities. In case of the DIPA programmes, NDDB provided full financial support for first five years. After five years of implementation of the programme, each DIPA programme created a corpus fund for its programme with contribution from the union and the NDDB. Each DIPA programme now meets its expenditure from the interest earned out of the investment of its corpus funds and does not depend on any external agency for funding. This has made the DIPA programmes self supportive and independent. Only those costs related to DIPA programmes are met from the DIPA funds. These include cost of ear tags and tagging, milk recording, supervision, collection and processing of data, semen storage, nominated service etc. It does not meet the cost of AI. Union from its milk business meets the cost of AI. Of course the farmer is charged 5 to 10 rupees per AI, but that covers only 1/3 to 1/2 of the actual cost incurred by the union. This means the union subsidies AI. However, the union does not get any money from the government for AI. It meets its cost from its milk business. In other words, the farmer pays something directly and something indirectly from its milk revenue for AI.

The other key factor for the long term continuation of such programmes is how the project ensures the large participation of farmers in the programme. At first, convincing farmers to participate in a performance recording programme would be very difficult, as they do not see any tangible benefits in doing so. So, giving some incentive to farmers to ensure their participation is very important. One incentive scheme introduced from the very beginning in each DIPA programme was supply of five bags of cattle feed (about 350 kgs.) in kind over a period of 18 to 24 months for each calf born under the programme. All calves were also given free treatment for deworming and vaccinations. This not only encouraged farmers to join the programme, but also ensured proper growth of calves and some uniformity in management of calves. The results of this programme demonstrated to other farmers that if they feed their calves well and take care for deworming and vaccination, calves grow well, they mature early, come in heat early, conceive early, calve early and give much more milk in their life time. The lesson learned from this experiment was that in small holder farming systems, the component of care and management of calves should be made an integral part of any milk recording and genetic evaluation programme and some incentive should be given to farmers to ensure their participation in the programme.

The other idea tried for participation of farmers in the programme was formation of a Farmers' DIPA Programme Monitoring Committee represented by a select few chairman of DIPA village dairy co-operative societies in each district. This committee meets every two to three months in different villages and explains the importance of this programme to other farmers. Often committee members took the responsibility to ensure that the cattle feed supplied to farmers was fed to calves and not used any other way by farmers. They also took the responsibility to supervise milk recorders to get accurate milk yield and fat test data. This committee also provided good response to the various DIPA activities and put pressure on the officers involved in the programme.

Sustaining interest of staff and officers involved in the programme for a long time is also an important aspect for the long term continuation of such programmes. Special training programmes need to be developed for milk recorders, supervisors and officers involved in implementation of the programmes. Under DIPA programmes, NDDB organised special training programmes for inseminators, supervisors and officers.

Developing an appropriate information system for monitoring performance of various components of the programme and collecting reliable data for selection of animals is equally important. Direct adaptation of available softwares may not always meet the requirement of the programme. Developing appropriate softwares in-house would always be convenient as they could be modified depending on the users' needs.

10. The future directions

Although the rules, procedure and standards followed by the three DIPA programmes are the same, these programmes are being carried out independently. It has been planned to implement all DIPA programmes jointly so that each bull put to test will be evaluated with many daughters spread over many villages in five districts. This will also provide an opportunity to select top one or two bulls out of the bulls put to test in all DIPA programmes for producing the next generation of bulls against the present practise of selecting top one or two bulls out of bulls put to test under each DIPA programme separately. Similarly, the intensity of selection of bull mothers can also be increased many folds when all programmes are jointly implemented. NDDB is also planning to provide the service of estimating breeding values of all animals covered under DIPA programmes and publish a common sire directory of bulls used under these programmes. NDDB will also provide the service of quality control of all DIPA activities. This service will be provided through the three working groups constituted.

India has become a member of the International Committee for Animal Recording (ICAR). NDDB is the member organisation of ICAR. There are other five institutions in the country carrying out milk recording and genetic evaluation of animals. They are: (i) Kerala Livestock Development Board in the state of Kerala, (ii) Bharatiya agro-Industries Foundation (BAIF) in the state of Maharastra, (iii) Indo-Swiss Project Andhra Pradesh in the state of Andhra Pradesh, (iv) Punjab Agricultural University in the state of Punjab, and (v) Kerala Agricultural University in the state of Kerala. All these institutions are working in isolation. To bring them together and to establish uniform standards and procedures for animal recording and genetic evaluation of animals in the country, it is necessary to evolve a mechanism of co-operation among these institutions. NDDB could facilitate in bringing these institutions together.

Milk Recording and Genetic Improvement of Sunandini Cows in Kerala

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1. Introduction

India has emerged as the second largest milk producer in the World, with an estimated production of 69 million tons. The milk production is growing at an average rate of 6.9% annually since 1981-82. About 55% of the total milk produced in the country are from buffaloes. The crossbreeding programme taken up for converting the non-descript local cattle to crossbred using exotic dairy breeds, mainly Jersey and Holstein Friesian, has yet to stamp its impact in the milk production scenario of the country.

Exception to this general pattern is the milk production programme in Kerala where almost 90% of the milk produced is from cattle and the remaining shared equally between buffaloes and goats. Kerala is one of the states of India, having an area of 38 883 km^2 and forming 1.2% of the total area of the country. This state popularly described as God's own land is green all through the year, densely populated (747 people/km^2) with 90% literacy, and cultivated intensively with cash crops and spices. However, dairying was not worth mentioning an occupation of the people and the cattle belonged to the local non-descript variety yielding less than 400 kg milk annually. But intensive efforts that started from early seventies have significantly altered the milk production sector of the state as can be seen from table 1.

Table 1. Indicators of growth in the dairy sector in Kerala (1970-1996)

Parameter	1977	1996	% growth/year
Total cattle & buffalo population (million)	3.46	3.56	0.16
Breedable female cattle population (million)	1.37	1.80	2.24
Percentage of crossbred cattle	45.07	67.33	2.48
No. of adults buffaloes	0.16	0.06	-3.32
Ratio adult male to female	0.213	0.074	-3.43
Milk production (m. tons)	0.78	2.42	11.07
Av. first std. lactation milk (kg) of CB cows	1480	2196	3.72
Milk availability g/day/person	87	197	6.65

This paper presents the milk recording programme implemented in the state for enabling the genetic selection among bulls used in artificial insemination.

2. Cattle Breeding operations in Kerala

Crossbreeding of the local non-descript cattle and subsequent inter se mating, between crossbreds is followed, since early 1970 with AI using frozen semen as the means to propagate the germplasm, under the organised sector. The breeding operations of the state is explained in figure 1.

2.1 Breeding programme

AI net work is estimated to cover around 45 to 55% of the population and the remaining is left with non-selected bulls, both Sunandini and local, for carrying out natural service.

Jersey and Holstein Friesian are the exotic breeds used for breeding the local cows. They are procured from best sources from India and abroad. Sunandini cows are bred with Sunandini bulls produced and selected from within the breed. Around 160 Sunandini bulls and 80 exotic bulls are maintained for the AI programme of the state.

The bulls are maintained in the bull stations for an average period of four years. Annually around 2.5 million doses of frozen semen are produced of which 1.6 million doses are utilised with in the state and the remaining sold in other states of the country.

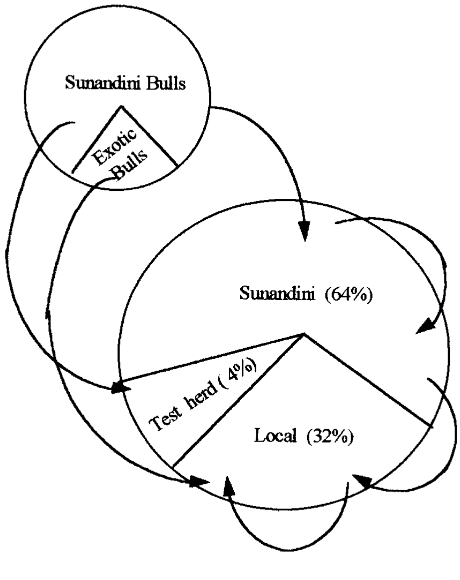

Figure 1. Breeding operations of the State.

2.2 Selection of Sunandini bulls

Forty bulls, which have completed production of the required number of doses, are replaced every year. The young Sunandini bulls required for replacement are produced through:

- Nominated mating of elite cows maintained in the bull mother farms of the KLD Board using proven Sunandini bulls' semen 40%
- Nominated mating of the elite cows identified among the cows belonging to farmers in milk recording area using Sunandini bulls' semen 47%
- MOET of the top elite cows 5%
- Mating of registered zebu cows with imported semen of HF and Jersey breeds 8%

All the young bulls entering the semen production programme are put to progeny testing using around 4% of the total cattle population of the state.The operation of progeny testing programme is explained in figure 2.

3. Data collection

3.1 Bull mother farms and semen production stations

The production and distribution of frozen semen for AI in Kerala is the responsibility of the state owned company, the KLD Board. They have bull mother farms, calf rearing stations, semen production and semen distribution stations for the above purposes. Altogether about 800 animals are maintained at these stations. Information on growth, reproduction, disease aspects and production of the stock are maintained systematically and analysed periodically enabling for genetic selection and productivity and production improvement. Management of information at these centres is fully computerised. Bull mothers are selected based on the most probable production ability, where each cow is given weight for its age at first calving, calving number and compared with its contemporaries through year and season.

3.2. Data from farmers cows

3.2.1 Facilities built in for data collection and compilation

The test herd is spread in an area of about 1 200 km^2, maintained in three agro climatic zones and controlled by 50 artificial insemination centres. The total breedable Sunandini population in the area is about 80 000. All Sunandini cows in the area are permanently identified using metal eartags and registered in the livestock register maintained at the AI centre. Insemination using semen of test bulls and its follow up till calf birth is the responsibility of the AI technician. The female calves born out of test A.I. are identified and followed up at intervals of six months and their heart girth circumference measured and recorded. When such animals calve, their milk yield is recorded on monthly basis morning and evening for 10 consecutive months or till cessation of the lactation. Unemployed youth and workers of the adjacent milk societies are engaged for the above works paying on quantum basis. A supervisor monitors the work of six such milk recorders. The data obtained is fed to the computer. On an average, record of 5 400 female calves are collected annually. These milk recorders also collect the milk yield of about 2 000 first calves. Due to

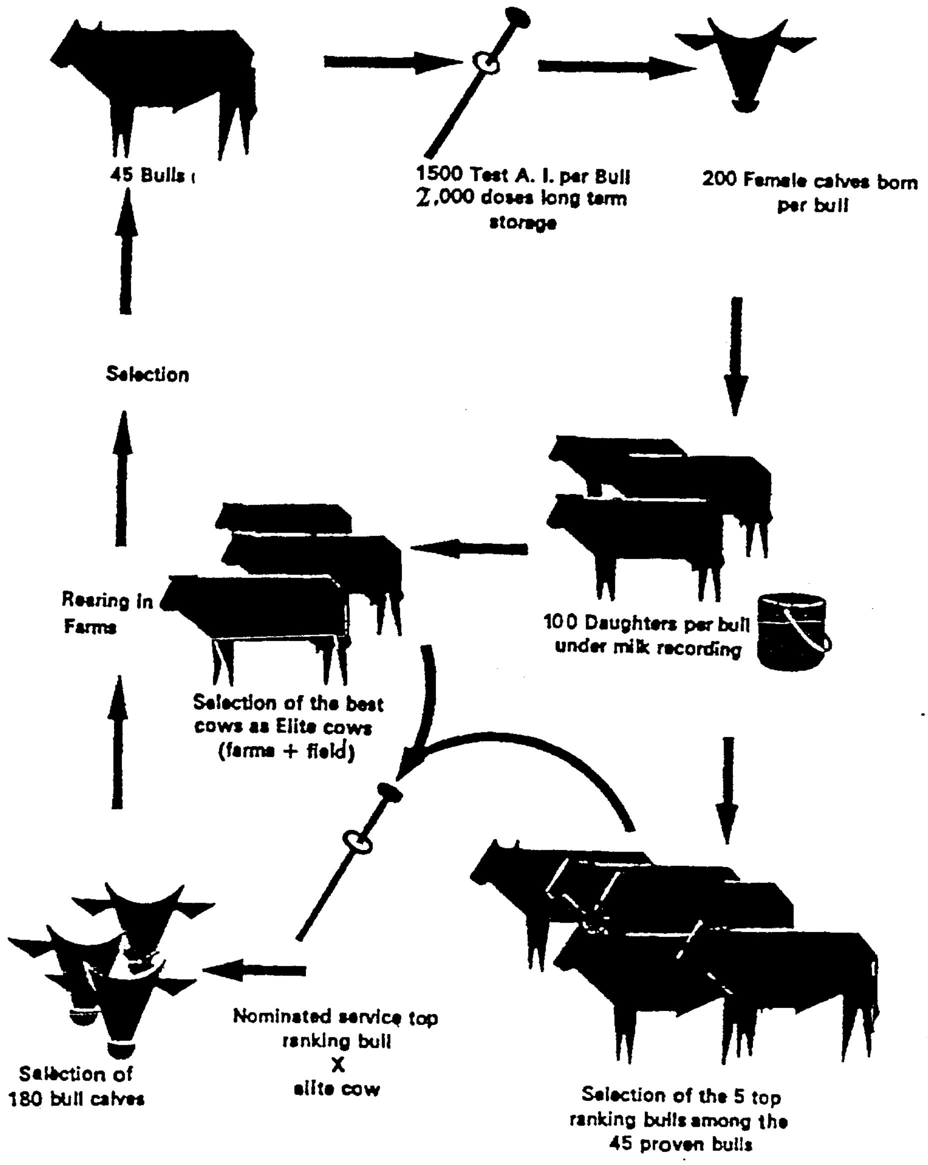

Figure 2. Functional flow chart of progeny testing scheme.

reasons like migration of animals, sale, etc. only 28.3% of the animals identified as calves, are ending up with a completed first standard lactation (Please see table 2).

Table 2. Animals completing first standard lactation out of female calves identified (1984-96)

	Number	%
Total no. of female calves identified	56 922	
No. of cows enrolled for milk recording	21 061	37.01
No. of cows completing first lactation	16 124	28.33

Information on the age at first calving, milk production, feeding and management of the animals born for test mating is collected from the field. This information is used for sire evaluation carried out by the KLD Board, for selection of elite cows in the field and for the planning exercises of the state.

3.2.2 Information on growth

All the female progenies born through test inseminations in the milk recording area are identified using metal ear tags. These calves are followed up on a half yearly interval. In addition to making sure that the animals are available, the average heart-girth circumference are measured and recorded at the time of every visit. The average heart girth circumference of the Sunandini calves recorded during the period 1984-1997 classified according to age group is given in table 3.

From table 3, it can be seen that the average heart girth circumference of the Sunandini female calves in the field increased by 36% during the period from one month of age to 36 months. The rate of increase is faster from three months of age onwards.

Table 3. Average heart girth circumference (cm) of Sunandini females in the field (1984-1997).

Age (days)	Number	Mean	S.D.	% increase
<31	17 673	73.16	5.94	
31-60	31 392	74.65	5.74	2
61-90	10 750	77.36	6.67	6
91-180	13 457	91.7	11.58	25
181-365	46 159	99.39	12.37	36
366-730	78 027	116.79	14.52	60
731-1096	58 576	135.11	14.08	82
>1096	58 309	141.40	12.35	93

On an average, 2 000 animals are registered annually for recording of their first lactation milk yield. The average age at first calving of these cows according to year of calving is given in table 4. It may be seen from table 4 that the age at first calving has gradually reduced from 41.6 months to 39.6 months during the period from 1983 to 1996. Though this is to be considered as a positive development on account of the improvement in the management given to the cows in the field, the age at first calving obtained for the cows belonging to the farmers are far too high in comparison to the average first calving age recorded for Sunandini cows in the bull mother herd maintained by the KLD Board. The analysis of the age at first calving of the cows according to the agro-climatic zones revealed that it is significantly higher in the high land and the lowest average age was noticed for the animals maintained in the coastal region.

An analysis of the milk recording data collected from about 2 000 first calvers annually indicates that there is a steady increase in average lactation yield of the Sunandini cows over the years. The average first standard lactation milk yield of the Sunandini cows classified according to geographic zones and year is given in table 5. The average annual increase is to the tune of 3.72%. The average annual increase registered is 3.41%, 3.89% and 5.1% respectively in the coastal, midlands and highlands. All through the years, mid lands had the highest lactation yield followed in order by coastal regions and highland.

Table 4. Average age at first calving of Sunandini cows according to year of calving.

Year of calving	Count	Mean	S.D.
1983	1 621	41.6	8.1
1984	1 768	40.1	9.1
1985	1 865	40.2	7.8
1986	1 942	41.2	7.7
1987	1 987	41.8	8.8
1988	2 076	41.6	8.9
1989	1 787	40.6	8.6
1990	2 039	40.0	7.4
1991	3 017	40.3	8.5
1992	1 700	40.3	7.9
1993	1 823	40.6	6.5
1994	1 870	40.9	8.2
1995	1 766	39.6	8.4
1996	1 324	39.6	6.8

Table 5. First standard lactation milk yield (kg.) of Sunandini cows in the milk recording programme according to year of calving and agro-climatic zones.

Year	Coastal		Midland		Highland		All	
	Count	Mean	Count	Mean	Count	Mean	Count	Mean
1983	1 214	1 507	195	1 549	212	1 269	1 621	1 480
1984	1 134	1 673	382	1 603	247	1 404	1 763	1 640
1985	1 089	1 724	548	1 646	228	1 456	1 865	1 669
1986	1 124	16 971	606	1 691	212	1 672	1 943	1 691
1987	1 142	1 700	544	1 745	301	1 801	1 987	1 726
1988	1 209	1 687	576	1 804	290	1 843	2 196	1 749
1989	988	1 753	500	1 792	299	1 873	1 988	1 796
1990	1 172	1 803	613	1 741	354	1 854	2 039	1 706
1991	1 822	1 803	753	1 787	441	1 928	3 017	1 833
1992	976	1 823	432	1 893	292	2 073	1 700	1 960
1993	1 114	1 916	386	2 049	323	2 030	1 823	1 985
1994	1 165	1 996	380	2 202	352	2 042	1 897	2 046
1995	1 193	2 138	343	2 171	291	2 075	1 827	2 134
1996	924	2 176	222	2 333	222	2 115	1 368	2 192

Table 6. Average first standard lactation milk yield of Sunandini cows according to the level of feeding. (Period 1995-1996).

	Total digestible nutrients		
D.C.P.	Low	Optimum	High
Low	2 213	2 236	2 252
Medium	2 285	2 308	2 324
High	2 251	2 273	2 290

The increase in milk production as registered among the cows in the milk recording area is also noticed in the overall milk production of the state, which has during the same period registered and average annual increase of 8.3 percent. This increase is a combined effect of the increase in the per animal production of the Sunandini cows as well increase in the number of Sunandini cows.

From 1985 onwards, data on feeding and management practices followed in the milk recording area are collected. An analysis of the above data for the period 1995 & 1996 indicated that maximum yield was obtained when the animals are fed with optimum DCP and high TDN.

The average standard lactation milk yield obtained under different nutrient plains with respect to TDN and DCP are given in table 6.

It is also noticed that the farmers have a tendency to over feed their animals with DCP, whereas the energy levels are found to be below optimum. More than 47% of animals are under fed with respect to TDN.

3.3 Application of milk recording in the field

The data obtained from the field on the milk yield of the Sunandini cows are used mainly for the sire evaluation programme. 40 bulls are put to progeny testing every year and 4-5 bulls out of them are selected as proven and employed in the breeding programme as fathers of next generation bulls. The milk recording data also helps to identify superior cows belonging to farmers. Around 500 elite cows are identified and maintained in the stock and these cows are mated to proven bulls to produce the next generation young calves. As stated earlier, 47% of the young bulls entering into the programme are produced from the elite cows belonging to the farmers. The milk recording data also gives vital information for the planning purpose of the state.

4. Issues connected with milk recording in the field

Dairying continues to be a subsidiary occupation for the majority of the farmers of the country. As such, they do not give much importance for the keeping of records regarding their dairy production programme. The farmers are yet to find a use for the records and this makes the milk recording programme not a welcome one but an imposed hazard. The average farm size in Kerala is to the tune of 1.3 adult animals. This also creates difficulties in expanding the milk recording programme to more areas. To make the milk recording more effective, efficient and farmer friendly, it is necessary that regulatory mechanisms to make milk recording statutory be implemented. The farmers should also get the benefit of the milk recording programme for increasing the productivity of animals. Effective feedback of information supported with extension activities to effectively use it will go a long way in popularising the milk recording programme.

Progeny Testing of Bulls: NGO's Experience in India

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1. Introduction

Animal performance records have been the major tool for guiding the increases in productivity of all species of farm animals in all developed countries. Development of productive animals requires progressive improvements in both the genetic merit for production and in the feeding, management and health care environment in which the animals live and produce. The animal recording practices are thus essential for progress in both of these areas.

There are several organisations in India that are conducting animal improvement programs. However, the animal recording in the field areas is undertaken by very few of them. BAIF is one such organisation (a NGO) which has been endeavouring dairy animal performance recording and progeny testing of bulls. The purpose of this paper is to share its experience with other organisations in the developing countries.

2. Organisation

BAIF is engaged in development programs with the focus on income generation activities and improvement of quality of life of rural population. Crossbreeding of indigenous (zebu) cows of farmers using frozen semen of exotic breed dairy sires (Jersey or Holstein Friesian) has been one of such activities which is spread over about 7 000 villages distributed across 7 states in India. Majority of the cow-owners are small and marginal farmers or landless families which have traditionally adopted crop-livestock integrated farming system. BAIF provides mobile AI services, so that animals are AI bred at the door-step of the farmers.

Cross breeding programme in Ahmednagar district of Maharashtra is the oldest programme initiated in the year 1970. The herd strength of crossbred cows in this area appears to be adjusted to the local resources of the farmers through their experience and hence stable. Consequently, 143 villages from this district were selected to initiate performance recording.

3. Getting started

As a starting point, the records of artificial insemination (A.I. Register), pregnancy diagnosis (P.D. Register) and calvings (Calving Register) were screaned to identify the prospective herds and animals to be included in recording. It was decided to undertake recording of physical measurements of body size of female progeny of known pedigree (known sire and dam). The difficulties posed were :

- Unreliable information of parentage on large numbers and
- Non co-operation of cow owners for ear-tagging/tattooing of their animals.

These problems were sorted out through:
- Checking earlier identification of animals (Tattoo/ear tag if available), verification by the owner and AI centre incharge (who visits the farm frequently) and cross-verifications of age of the progeny in relation to the AI, P.D., calving dates of their dams, followed by tattoo/ear tagging as token of registration in the progeny testing program.
- Creating awareness amongst the farmers for the importance of animal identification and performance evaluation.

4. Selection of herds

Herds were selected on the following criteria :
- Herd should be located in area of high density of crossbreds. (AI Centre area having minimum 400 crossbred cows).
- Herd should have minimum 2 crossbred cows.(Larger herds preferred).
- Herd should not be located in isolation at far off place (viz. Cluster of herds in the close vicinity were selected).
- Animal owners should be willing to get their animals ear-tagged, get their cows AI bred, allow collection of data on the herd and animal performance, and disallow breeding of their animals by any other agency. (Overlapping of breeding activity by different agencies discouraged).
- Animal sale/transfer should be least as assessed from the history of previous years.

5. A.I. breeding

All the crossbred cows were A.I. bred using frozen semen of either pure-bred Holstein Friesian or crossbred (HF X Zebu) bulls. The A.I. services were made available at door-step of farmers. All the A.I. bred cows were followed to check pregnancy.

6. Selection of recorders

On the assumption of 4 to 7 herd-visits per day by a recorder, 10 milk recorders were appointed on permanent basis and another 10 on contract basis. The operational area covered by these recorders included 143 villages.

A training programme was drawn up to orient the manpower for animal performance recording work.

7. Supervision

The operational area was divided in three clusters and the working of the recorders in individual clusters was supervised by trained supervisors.

Further checks and verifications were entrusted to the respective AI Centre in-charge who were in position to visit the farms regularly.

Senior Scientists and Research Officers cross-checked the data through regular visits and EDP validation.

8. Data collection

Data collection was arranged at three levels as shown in table 1.

Data scrutiny, editing, updatation, storage and analysis was arranged centrally at Uruli-kanchan (Pune).

9. Measurement of growth

Measurements of body-size (heart girth, body length, body height and paunch girth) were recorded at birth, 6 months and then at intervals of 6 months up to 24 months and then at calving. Average of 2 measurements each time was considered adequate. The growth measures were essentially introduced to establish frequent contact with the herd owners and also to maintain track of the female progeny from birth through calving and milk production.

10. System of milk recording

Milk yield in pail for 24 hours was recorded at fortnightly intervals through morning and evening milkings. However, considering the cost factor and operational problems, the herds were visited morning and evening milkings on alternate fortnights later on.

Table 1. Data collection arranged at three levels.

Levels	Type of data
Milk Recorder	Herd status, animal growth, feeding practices, milk production.
Supervisors	Random checks on milk data, fat testing, health status.
Centre in-charge	AI, P.D., calving and animal identification.

Each of the milk recorders attended milking at 2 to 4 herds every day for 5 days a week (Direct Recording). After the milking hours, they visited adjoining herds and collected the records through personal enquires with the farmers (Indirect Recording).

Milk samples from cows in 2nd, 5th, and 8th month of their lactation were analysed for estimation of butter fat percentage. The milk samples for butter fat test were gathered by the milk recorders and transmitted to supervisor for analysis.
Data on feeding practices, health and herd management was collected during routine milk-recording schedule.

11. Outcome

The observation and inferences based on the performance recording undertaken during the period from 1988 to 1993 were as follows.

The number of A.I. required per recorded female birth was 8.5. The herd survival rate of female progeny from birth to completion of first lactation was estimated to be 46% and the number of A.I. required to obtain one milk recorded daughter to be 18.4.

The growth measures on the female progeny were the body length, height at withers, chest girth and paunch girth. Analysis of variance indicated that sire differences were significant at 6 months age for all measures, except for paunch girth. The location effects were consistently significant across all the age groups whereas year of birth and feed group effects were significant up to 12 months age.

The mean age at first calving of the crossbred progeny was 32.8±0.7 months and the mean 305 day milk yield 2 863±309 kg. The average milk yield from 1st to 5th lactation ranged from 2 671±60 kg to 2 995±102 kg. The average butter fat percentage varied from 4.07% in 2nd month to 4.16% in the 8th month of lactation.

Various sampling plans (Combination of Morning and Evening Records) were used to estimate the lactation yields. The estimated yields by these plans were compared with Standard Lactation (based on fortnightly morning+evening test records). The recordings based on evening recording alone underestimated the lactational milk yield while those involving only morning milkings overestimated. The means of first lactation estimated by alternate morning and evening recording appeared to give mean lactational yield nearer to standard lactation. When all lactations were considered, AM/PM uncorrected gave estimate comparatively more nearer to standard.

Test Interval, average yield and centering date methods were used to estimate lactation yield from test day records. The average yield method overestimated the yield while centering date method underestimated it. The difference between the methods were highly significant.

Lactation yields were estimated using different intervals of recording i.e. fortnightly, monthly and bimonthly interval. The estimates were obtained using both test interval and regression methods. As the interval of recording increased, the absolute errors also increased. Yields estimated by monthly interval either by test interval or regression method gave similar absolute errors. The absolute errors estimated from bimonthly records were the largest. Based on various results obtained, it was concluded that Test Interval method would be more suitable and convenient for computation of lactation yield.

Regression analyses were carried out to study the effect of the test-day on the test-day yields during 1st to 20th fortnights. It was evident that the test day yields needed to be adjusted during the initial and end phase of lactation. The correction factors for extending the incomplete lactations to 305-day yields were developed, taking into account these regressions.

The estimated yields were subjected to statistical analyses to study the effect of genetic and non-genetic (environmental) factors. The effects of centre-year-season subclasses and parity contributed to most of the explained variation. The effects of exotic blood level and age at first calving were non-significant.

Six different models (using different “herd-production-levels” as independent factors and inclusion/non-inclusion of Age at first calving as a covariate) were tried. The correlations between rankings by different methods ranged from 0.50 to 0.96.

The rank correlation between BLUP values based on 10 daughters had very poor correlation with those of larger progeny groups of 20 and 25. The rank correlations markedly increased when the progeny groups were 15 per sire. The rank correlations of the BLUP values based on progeny groups of 20 and 25 showed consistent improvement. Based on the results so far, it was concluded that more than 25 daughters per bull would be needed to get reliable estimate of progeny test of bulls.

In addition to Mixed Model Solution (MMS) procedure, the bulls were ranked by Contemporary Comparison (CC), Least Square Analysis (LS) and Relative Breeding Value (RBV) estimates. The ranking by LS was very similar to BLUP. The correlation of BLUP with CC were highly significant but of lower magnitude.

The studies showed that the progeny testing of 10 cross-bred bulls per year would require cross-bred population of minimum 20 000 heads of breedable females and testing of a batch of bulls might require minimum 8.5 years period beginning from the date of their birth. The scheme could provide considerable opportunities for identification of superior cows as bull dams.

On the background of the experience gained, it was recommended that further research is required to be undertaken to focus on milk-recording intervals, use of anxillary data (Like feeding practices), grouping of herds for simulating bigger herds, use of entire herd data, correlating early sire proofs with later proofs, and development of suitable area specific correction factors for adjustment of data.

12. Acknowledgement

Author acknowledges the financial assistance received from the Indian Council of Agricultural Research, New Delhi, for undertaking research on field performance recording and progeny testing.

Animal Recording for Livestock Development Experiences of the Swiss Agency for Development and Co-operation and of Interco-operation in India[1]

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1. Summary

The Swiss Agency for Development and Cooperation and Intercooperation support in their collaborative projects of livestock development in India various animal recording activities.

Evolved from the former Indo-Swiss Project, Kerala, the Kerala Livestock Development Board is running since 1977 a successful field progeny testing programme for sire evaluation and breed improvement in a crossbred cattle population. Indo-Swiss Project Andhra Pradesh is supporting the set-up of progeny testing schemes for buffalo and cattle. Through the former Indo-Swiss Goat Development Project in Rajasthan experiences were gained in recording of milk and body growth in goats to establish a selective breed improvement programme for the local Sirohi breed. Performance recording in goats is partly continued by two non-governmental organisations under the Intercooperation NGO Programme Rajasthan. In 1995 a milk recording scheme has been initiated in the Himalayan State of Sikkim to identify potential bull mothers and to select their crossbred male calves for natural service in remote villages.

Links between animal recording and livestock development projects in general, including the role of development agencies and their partner organisations are discussed.

The experiences show feasibility and usefulness of animal performance recording under conditions of small scale livestock holdings. Purpose and institutional environment need to be clearly defined; especially while looking at long-term perspective for assured continuity.

[1]Compiled for the Workshop on Animal Recording for Smallholders in Developing Countries, 20-23rd October, 1997 at Anand, India; this paper is an up-dated version of Groot, B. de; 1996; Experiences on Animal Recording in Bilateral Collaborative Projects for Livestock Development in India; compiled for the 30th Biennial Session of the Committee for Animal Recording (ICAR), 23-28th June, 1996 in Veldhoven, the Netherlands.

2. Introduction

The Swiss Agency for Development and Cooperation (SDC)[1] and Intercooperation (IC)[2] support animal recording activities within the context of their technical collaboration with India for improved livestock production and dairying. Though performance recording activities tend to be relatively small and simple as compared to equivalents in the industrialised world, there is a high degree of pioneering, especially in setting up field performance recording systems. Animal recording can play a significant role in making livestock programmes in developing countries more practical and farmer oriented. Objectives of this paper is to present experiences of SDC, IC and their partner organisations in animal recording activities and to put these experiences in the wider context of livestock development projects.

There are more of such experiences under similar conditions, but documentation appears to be limited and scattered. In India a first attempt to focus on exchange of information regarding animal recording at national level was made in a national workshop in 1993 (Maru, Itty and de Groot); a second workshop is planned for 1998.

3. Livestock sector India

India is endowed with an impressive livestock wealth of cattle, buffaloes, goats, sheep, camels and poultry which in numbers all represent a sizeable portion of the world population. A large part of this livestock is kept under traditional management with relatively low levels of input and low productivity. An increasing demand for animal products has triggered off significant developments in intensification and search for suitable technologies to enhance production. The potential of livestock for economic and social development in rural areas in India is well recognised and has attributed to a range of support programmes largely financed and implemented by local government and occasionally, non-government organisations (NGOs). There is a clear need for more farmer based organisations such as breeders' associations and cooperatives for providing technical inputs and services. Collection and better utilization of farmer based information is likely to play an essential part in such development.

Swiss bilateral assistance in the livestock sector in India started in the early sixties in Kerala with the introduction of crossbreeding and frozen semen technology in cattle. Since then, six more livestock projects were initiated in five other states, while in 1994 the Government of India requested SDC to extend its support for the elaboration of a new national

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[1]Swiss Agency for Development and Cooperation, Ministry of Foreign Affairs, Government of Switzerland.

[2]Intercooperation, Swiss Organization for Development and Cooperation, P.O. Box 6724,3001 Bern, Switzerland is the implementing agency of SDC for livestock projects in India.

livestock policy. At present there are five livestock projects going on. Besides, there are livestock activities as integral components in four IC NGO programme. Over the years an evolution has taken place in the approach to livestock projects; from a limited technical 'crossbreeding' oriented approach to a programme that addresses improvement of the livestock sector as the integral part of any farming system. Policy analysis, farmer orientation, human resource development and institution building are elements which gained importance over the past. SDC continues its present involvement in and support to the livestock sector in India. Thereby, field performance recording and attention to management of information with the necessary human resource development are considered important aspects (SDC, 1995).

4. Animal recording within projects

A schematic overview of animal recording activities under different projects is shown in table 1. Specific experiences of each of the schemes are elaborated in the following sub-headings.

4.1 Kerala Livestock Development Board

For sire evaluation and breed improvement a field recording scheme was started in 1977 by the Kerala Livestock Development Board (KLDB) under the erstwhile Indo-Swiss Project Kerala. Designed as a field progeny testing scheme, crossbred cattle bulls are evaluated based on milk production performance of daughters in farmers' herds. Breeding policy is to improve milk production of the crossbred cattle population in Kerala State, limiting exotic inheritance of mainly Brown Swiss and Jersey to around 50% and establishing a synthetic breed, Sunandini. Over the last 20 years more than 600 bulls have been evaluated, for each of which about 1 500 test inseminations were carried out in order to assure availability of 50 complete first lactation recordings. Annually the best 3% of the first lactation cows are selected as potential bull mothers and continue to be inseminated with semen of top bulls. Suitable bull calves from these elite cows are purchased by KLDB and raised for selection of breeding bulls (KLDB, 1996, Chacko, 1994).

The field milk recording in Kerala is done in herds that mostly consist of 1-2 cows; farm households keep cows as an additional source of income besides horticulture and crops or non-farm activities. This causes significant difficulties in running the field recording system. It attributes to a reduction in the statistically explainable proportion of variation in information and may cause unreliability in tracing of parentage. Other problems are long generation intervals due to late maturity and substandard reproductive performance of crossbred bulls. Nevertheless, there is evidence of significant progress. From 1983 to 1995 the average standard milk yield in first lactation of field recorded animals increased from 1 480 to 2 100 kg (3.42% annually; KLDB, 1996). Though better management and probably

Recording Scheme	Activities	Results
Indo-Swiss Project, Kerala, later on Kerala Livestock Development Board (KLDB)	Milk recording in crossbred cows for progeny testing and purchase of bull calves. Started in 1977. Annual enrolment 2 000-3 000 cows.	Enrolled over a period of 18 years 54 222 cows for recording and completed 36 743 lactations. 613 bulls have been tested, while 951 bull calves were purchased from farmers. Programme provides genetic basis for the cattle breeding programme with an annual production of 2 million doses of semen and over 50% coverage of the cattle population in Kerala State.
Animal Husbandry Department Andhra Pradesh (AHD) supported by Indo-Swiss Project Andhra Pradesh (ISPA)	Milk recording scheme in buffaloes and crossbred cattle, both for progeny testing. Started respectively in 1987 and 1990. Annual enrolment 2 000-2 500 cows.	Enrolled over a period of 8 years 17 235 cows for recording and completed 9 501 lactations. Most of these are records of buffalo dams (8 892). 102 Buffalo and 28 crossbred bulls have been put for testing. The programme is yet to start its evaluation for selection of sires for future breeding bulls.
Indo-Swiss Goat Development Project (ISGP) in partnership with the Animal Husbandry Department Rajasthan.	Recording of milk production in goats and body growth of offspring, with the purpose of selection of superior bucks for natural service. Scheme started in 1988 and lasted till 1993. Annual enrolment 2 000 does with offspring.	Enrolled over a period of 5 years about 5 000 goats in 500 herds. Data available of 4 041 completed lactations. Information was used for purchase of around 200 breeding bucks.
KVK-Vidiya Bhavan Society and BAIF Rajasthan with support of the Intercooperation NGO Programme Rajasthan.	Both NGO's started field recording of milk production and body growth in local goats in 1992. Annual enrolment together 1 500-2 000 does with offspring.	Schemes are running satisfactory and information is regularly processed, but unfortunately no consolidated reports were available at the time of preparation of this paper. Information used by organisations for monitoring of field activities and for interaction with farmer groups on selection of breeding bucks.

Indo-Swiss Project Sikkim (ISPS)	Recording of milk production in crossbred cattle for selection of bull calves to be purchased for rearing as future breeding bulls for distribution to less accessible villages that are not provided AI services. Proposed annual enrolment 500-1 000 cows.	Programmes designed in 1995 and presently in first stage of implementation.

(De Groot, 1996)

Table 1.Overview of animal recording activities and results in different Indo-Swiss projects.

higher levels of feeding have contributed to increased lactation yields as well, Chacko et al (1985) estimated for the Sunandini population an annual genetic gain in lactation yield of about 20 kg.

4.2 Indo-Swiss Project Andhra Pradesh

The local partner organisation in the India-Swiss Project Andhra Pradesh (ISPA), the Department of Animal Husbandry (AHD), Government of Andhra Pradesh started in 1987 a progeny testing scheme for buffaloes in coastal districts of Godaveri and Krishna delta. The aim was to assess milk and fat production potential of buffalo bulls purchased from the Murrah breeding track in North India or raised in AHD farms, in order to identify superior sires for production of the next generation of breeding bulls. So far 8 batches of 10-14 bulls have been put for testing with minimum 2 000 inseminations per bull. Though completed daughter lactations are available for the first 2 batches, their number is small and affects the accuracy of any analysis. More than in cattle, the late maturity in buffaloes is apparent, causing long interval before results are available (AHD-AP, 1996).

In 1990, a second scheme was initiated by AHD for progeny testing of Jersey crossbred bulls in the southern district of Chittoor where cattle keeping is more dominant. As per 1996, test inseminations at the rate of 1 500 per bull are done for the third batch of 10 bulls and recordings of the first series of daughter lactations are getting completed.

Both schemes are implemented in herds with an average of 2-3 cows, concentrated in villages that are identified as progeny testing centres. ISPA support the schemes in conceptual aspects and development of facilities for computerised data processing. In Chittoor, the project is involved in the establishment of a comprehensive district livestock development information system (AHD-NAARM-ISPA, 1997).

4.3 Indo-Swiss Goat Development Project

Following a negative assessment of the potential for introduction of crossbreeding with temperate dairy breeds, the Indo-Swiss Goat Development Project (ISGP) started in 1988 field performance recording of milk production and body growth of the local Sirohi goat breed in central districts of Rajasthan. The upper 25% of the population showed a performance of a similar level at what could realistically be expected from any crossbreeding effort, i.e. milk yields of 300-350 kg in 180 days. Next, a breeding programme was formulated for improvement of the Sirohi breed through selection of breeding bucks from an institutional nucleus herd and field herds, based on standard phenotypic characteristics, milk production of the mother and own body growth. For an annual production of 250-300 herds in 20 villages would be recorded consisting on an average of 8-10 lactating goats per herd. The top producing quarter of the recorded goats are selected as potential buck mothers, with ultimately, 10% of the bucks being used in the recorded herds for production of the next generation of breeding bucks (ISGP, 1993).

Innovative in the ISGP recording scheme, as compared to the other projects, was the degree of computerisation in management of the scheme, flexibility in recruitment of part-time recorders in consultations with farmers and structural feedback to farmers of annual herd performance statements.

The goat performance recording scheme continued till 1993, when Swiss collaboration was concluded. The partner organisation was not in a position to carry on with the programme.

4.4 IC NGO Programme Rajasthan

In association with ISGP goat development activities started in early nineties by two NGOs active in the southern part of Rajasthan. Between 1992 and 1996, both programmes recorded more than 2 000 animals each for milk and body weight. However, an evaluation revealed that the purpose of performance recording by these two NGOs was not entirely clear and understood which led subsequently, to a revision of the NGOs' recording activities (de Groot, Sharma, 1996).

KVK-Vidiya Bhavan Society introduced performance recording in order to evaluate performance of local goats in the southern district of Udaipur and to make a comparison with the introduction of improved Sirohi goats from the former ISGP working area in central Rajasthan. The recording scheme continues mainly as a monitoring tool for other goat related extension activities.

BAIF-Rajasthan started recording with the aim to evolve with local farmer groups an approach for a breeding programme, by which the responsibility for recording and buck selection is given to these groups.

4.5 Indo-Swiss Project Sikkim

Performance recording was introduced in 1995 as a component of the newly formulated breeding programme for improvement of dairy cattle production in this small East Himalayan State. Implementing agency is the Department of Animal Husbandry and Veterinary Services. Aim of the recording scheme is to identify bull mothers at farmer's level for purchase of bull calves that can be reared for herd improvement through natural services. The State has an extensive bull distribution programme to cover villages in remote areas. Artificial insemination is done only in limited areas that have reasonably good logistic access. Frozen semen of good quality crossbred bulls is imported from other parts of India (de Groot, 1995).

4.6 Animal Recording and (Livestock) Development

As development agencies, SDC and IC focus in their livestock projects in India on a wide range of issues; animal breeding is one among others. Improved livestock production and animal productivity shall contribute to the achievement of project objectives like creation of income and employment opportunities. With the smallholders as target population, projects have to deal with the resources available at these farm levels, including livestock. Though there is a large number of breeds in India, more than 80% of India's livestock population are of local, 'non-descript' types. Therefore, improving livestock resources and their management means for the smallholders first of all improvement of their herds. Breeding as the improvement of a particular breed is for many farmers of second priority. Subsequently, purpose of animal recording as part of livestock development projects varies.

One purpose of animal recording arises from the need to know production and performance levels in order to be in a position to plan any livestock development activities. In addition, field recording at farmer's level can be seen in livestock development projects as an extension tool to establish regular contacts with farmers and perhaps, even to explore alternative small scale breeding schemes, e.g. at village herd level. Finally, animal recording is an integral part of any breed improvement programme.

The size of the herd for recording, as well as type and frequency of recording depend then on the purpose. For a situation analysis recordings over a limited period can be sufficient. In the case of extension and for exploration of small scale breeding schemes and interventions, more regular and consequent recording is required, although, one should be aware about its limitations in terms of contributing to a genetic herd improvement. A well organised recording scheme adopted to a representative breeding scheme has been chosen.

The above mentioned points concerning animal recording in livestock development projects lead to different perspectives and ask for an appropriate institutional environment. Project internal set-ups may be sufficient to organise animal recording for study/analysis purpose. For extension services, field level organisations with strong interactions with livestock holders are required; in India, often NGOs do this type of work in a confined area. Organisations with respective know-how and finances are a pre-requisite to take up breed improvement programmes. Further more, such organisations require freedom and flexibility in their operational functioning; that proved to be crucial for running breeding programmes in a sustainable manner. Today, ways and means have to be found in India to better integrate other actors than the Government into breed development activities by promoting e.g. breeders' associations.

4.7 Project related conclusions

The field progeny testing scheme of the KLDB is one of the most acknowledged efforts of breed development in India, though its focus is on the establishment and improvement of a new synthetic breed, Sunandini. Three factors were crucial in implementing this programme: creation of sound technical know-how, setting up of an innovative institutional structure and following clear objectives and schedules under a long-term perspective. Today, there is not only a functional animal recording scheme but its results underline the genetic progress made in this new population in Kerala.

Besides the collaboration with KLDB, the direct contribution from SDC\IC's livestock development projects to the improvement of breeds through animal recording has been limited. As development agencies, SDC and IC don't see breed improvement per se as a direct objective for their activities, but they support livestock organisations to enable them to take up livestock development including implementation of breeding programmes and animal recording systems. In this regard, the beginning of animal recording in the Indo-Swiss Project Sikkim mainly focus on exploring opportunities in establishing an appropriate and lasting institutional environment.

The lack of a strong and dedicated institutional environment, including human as well as financial resources, led to the discontinuation of the goat recording activities by the partner organisation under the ISGP in Rajasthan. The continuation by NGOs in Rajasthan is done, partly with a changed objective. Their impact to breed development in Sirohi goats is small but the NGOs are instrumental in trying out new extension and alternative village based breeding models.

The experience in ISPA from animal recording, especially when looking at data quality and analysis is somehow mixed. Till today, the data is not used in an integrated manner for herd improvement which also indicates unclear objectives and perspectives in the overall breeding programme of the partner organisation. The project clearly detected that breeding activities including animal recording and data management have to be set into new and more adapted and sustainable organisational and institutional structures (ISPA, 1995; AHD-NAARM-ISPA, 1997).

5. Final conclusions

The experiences presented here show feasibility and usefulness of animal performance recording under conditions of small scale livestock holdings in a developing country. Essential is that the purpose of such schemes should be clear in the context of a well defined livestock production improvement programme. Priority and care has to be given to establish an adequate institutional structure for animal recording which have to be in conformation with recording purpose and programme perspectives. In encountering the technical problems more adaptive research and technical training is required. The bias on low expectations from animal recording under less advanced conditions often overlooks the decades of numerous efforts that went into western equivalent used for reference.

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Animal Recording in Smallholder Farming Systems. The Sri Lankan Experience

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1. Background information

1.1 Introduction

The contribution of Livestock Sector to GDP and to the Sectoral GDP in Sri Lanka have been estimated to be 1.2% and 5.6% respectively. The above ratios have remained constant during the past decade. The livestock population of the country has also remained stagnant over the last two decades and it comprises 1.7 million cattle, 0.9 million buffaloes, 0.5 million goats, 8.7 million poultry and about 86 000 pigs and negligible number of sheep and ducks.

Livestock products account for 25% of the total protein intake of the average Sri Lankan. The annual per capita consumption of livestock products are 32.8 ltrs of milk, 1.52 kgs of beef, 1 kg of chicken, 0.07 kgs of pork, 0.15 kgs of mutton, and 47 eggs.

The present policy of government is to promote the development of the livestock sector with a view to creating the opportunities for rural employment as well as to raise the farmers income. Of the total food import bill, nearly 20% goes to import of milk. The government has provided various incentives such as tax exemptions on capital items, tax holidays, provision of state land on long term lease etc. to potential investors to promote livestock development in the island.

The total area of the agricultural land in Sri Lanka has been estimated be around 2 million hectare or about 30% of the total land area. Almost three quarters of the agricultural land comprises 2 million smallholdings. Of the total smallholdings, 60% have farm size of less than 1 ha, and 25% have farm size of 1 to 2 ha. Seventy five percent of the smallholdings are wholly devoted to cropping and the remaining 670 000 are engaged in mixed crop and livestock farming. In total, the farm population is estimated to be in the region of 10 to 11 million with an average house hold size of 5.3 persons. An estimated 3.5 million persons in the island is involved or dependent upon livestock.

1.2 Farming system

Sri Lanka is divided in to three agricultural zones, the dry zone covering 4.1 million hectare. With average rainfall of 875 to 1 875 mm, the intermediate zone covering 0.9 million hectare with a rainfall of 1 875 to 2 500 mm per annum and the wet zone covering 1.4 million hectare with an annual rainfall of over 2 500 mm. The wet zone is the most intensively exploited agricultural area, although the irrigation development is providing considerable resettlement and increased production in the dry zone. Rain fall follows a bimodal pattern with North East Monsoon from November to February and the South West Monsoon from May to September.

Cattle and buffalo keeping is generally distributed through out all the regions of the country. In the hill and mid country and in the Jaffna Peninsula cattle is kept primarily for milk. In the Wet zone cattle and buffalo keeping forms a integral part of paddy production, draft power, weed control and manure as well as milk production. In the dry zone these species are regarded as a source of insurance by smallholders as they provide a store of wealth and access to hard cash by way of disposing the animals and sale of milk. Nearly half of the cattle population is located in the dry zone especially in the districts of Pollonnaruwa, Batticaloa, Mannar, and Amparai.

Six milk production systems have been identified in the island depending on the agro-climatic characteristics in the locations.They are (See table 1):

1. The plantation system where animals are owned by the estate labourers and zero grazing is practised.
2. Home garden system in the mid country & up country where bostaurs animals are kept and zero or limited grazing practised.
3. Coconut Triangle System covering the coconut plantations of the North Western and Western provinces where cattle are tethered and grazed on the pasture under coconut.
4. Low country, mainly southern area comprising mixed home gardens where mainly *Bos indicus* animals are kept on paddy straw and garden residues.
5. Settlement schemes in the dry zone includes mahaweli and other major irrigation schemes.
6. Dry zone extensive system where herds of cattle and buffaloes are grazed on public lands and forests.

Average farm holding in the hill country and mid country is 2 to 5 cow units, predominantly Friesian and Jersey animals with milk production of 2 to 5 litres per day. In the intermediate zone the average size of the cattle unit is 5 to 10 cows, mainly Jersey and zebu crosses with milk production of 5 to 7 litres per day. The type of cattle kept in the dry zone varies from indigenous breeds to zebu and European crosses with an average milk production of 1 to 2 litres per day.

Table 1. Cattle farming system and their characteristics by agro-climatical zones.

Agro-climatical zones	Production emhpasis	Main characteristics of the farming system	
		Herd size, breeds	Keeping, feeding
Hill country zone	Milk	1-3 animals per unit; high share of European breeds (Holstein Friesian, Jersey, Ayrshire) and their crosses.	Intensive Permanent housing, good conditions; Zero grazing, feeding of concentrates
Mid country zone	Milk, meat	2-4 animals per unit. European crossbreds	Semi-Intensive Fairly good housing conditions; mainly stall feeding, tethered grazing and moderate amount of concentrates; limited possibilities for pasture and fodder production on the farm.
Coconut Triangle zone	Meat, Milk	2-10 animals per unit Mainly European x Indian crossbreds or Indigenous Zebu type (Sindhi, Sahiwal)	Semi-extensive Night housing; free grazing in coconut plantations, tethered grazing, stall feeding with little concentrates.
Low country wet zone	Meat, Milk	2-10 animals per unit Mainly Indian breeds (Sindhi, Sahiwal) x Indigenous Zebu type	Semi- extensive Night housing; mainly tethered grazing with stall feeding, no concentrates.
Low country dry zone	Meat	a few up to over 160 animals mostly indigenous Zebu type	Extensive system Night paddock; free grazing system with no concentrates.

1.3 Status of the dairy sector

Dairying is a major component of the livestock industry in Sri Lanka and it is estimated that there are 600 000 milking and breeding animals with an annual milk production of 200 to 250 million litres per annum of which 70 to 75% is coming from neat cattle and the rest is from buffaloes. The dairy industry is based predominantly on smallholder system.

The formal milk collection is about 100 million litres per annum. Milk is collected through various channels and a typical system involves a group of farmers/farmer organizations supplying milk to near by chilling centre owned by milk processing companies direct or through a middle men.

The milk processing industry comprises liquid milk processing plants and powder re-packing plants. The milk processing in the island is mainly dominated by two major processors namely, Milk Industries of Lanka Company Ltd. (MILCO) procuring about 55% of the total annual milk collection and Nestle Lanka Ltd., handling about 40% of the total milk collection in the island. The total installed capacity of these plants is around 700 000 litres per day and the current utilization rate is about 30%.

The formal market for milk products dominated by whole milk powder (WMP) which accounts for about 80% of the total consumption on liquid milk equivalent basis.

Farm gate price of milk is very low in comparison with that of other countries of the region and presently it ranges between Rs. 10.00 and 12.50 per litre. The farm gate prices again vary according to the regions depending on the quality and composition, transport cost etc.

2. Animal breeding programme

2.1 State Livestock Farms

The National Livestock Development Board being the only biggest organization involved in managing and breeding livestock by the state sector, operates 31 livestock farms at present with a total land of 17 200 ha. The main objective of these farms is to supply breeding stock to farmers in the island. Some of these farms are maintained as bull mother farms for production of bulls for artificial insemination and/or natural service programmes. Several programmes have been implemented to maintain elite cattle herds of pure bred Holstein Friesian, Jersey and Sahiwal herds in some of the NLDB farms by continuous selection. Similarly, pure bred buffalo herds of Murrah and Nili Ravi are also maintained by the Board. In addition, a cross breeding programme is also in operation to up grade and maintain crosses of Jersey, Sahiwal and Zebu breeds. The present nucleus stock of Holstein Friesian, Jersey, Sahiwal cattle as well as Murrah and Nili Ravi buffaloes have been imported from Australia, New Zealand, The Netherlands, India and Pakistan and the selected herds of this stock and it's followers have been inseminated with imported progeny tested proven semen. The bull calves of the above elite herd have also been selected and used in Natural and Artificial breeding programme.

2.2 Natural breeding programmes

About a decade back Department of Animal Production and Health had maintained 250 stud centres located through out the country. Several centres were located in the dry zone where the cattle density was high. The required bull calves for these centres were provided by the state farms and the bulls were rotated among the stud centres. The impact of the above centres was negligible.

A programme also was in operation to provide bulls and bull calves as well as necessary technical assistance to farmers through state extension service to establish service centres to potential farmers.This programme was also not so successful, as it's progress was not monitored.

2.3 Artificial insemination programme

Although the artificial insemination for breeding of cattle has been carried out for last 30 years, only 10% of the total breedable cattle population has been covered so far. Two hundred artificial insemination centres located through out the country perform about 100 000 inseminations annually with the assistance of 300 private and government technicians (See table 2). About 45% of the total AIs performed, have been carried out with Holstein Friesian semen, another 30% with Jersey semen and the rest with European or Zebu crosses.

Sri Lanka has been importing superior genetic quality cattle and buffaloes to up grade the elite herds in the bull mother farms. The imported bulls have been used for production of semen for AI programme. Superior bull calves of top bull mothers are selected at the age of one year and brought to a bull calves rearing centre. Physical, physiological and breeding parameters are closely monitored before bulls are used for semen production.

The Deep Frozen semen is collected, stored and distributed through out the country from the Central Semen Processing Centre located at Kundasale. The quality of the semen used in the field is also monitored by the centre. The imported progeny tested semen is used for breeding bull mothers kept in the bull mother farms.

The female calves born out of the AI programme is supported by a heifer calf rearing scheme with a view to producing healthy animals that reach the breedable age within 30 months and also to reduce the mortality. Fifty percent of the cost of feed is subsidized by the Government under the this scheme, if the calf achieves required weight.

Table 2. Government and private technicians (1990-1995).

Year	Number of government technicians	Artificial inseminations	Number of private technicians	Artificial inseminations	Total artificial inseminations
1990	266	32 599	48	14 398	46 997
1991	266	37 217	58	15 573	52 790
1992	218	49 800	57	17 101	66 901
1993	248	56 063	67	17 453	73 516
1994	260	62 881	81	19 414	82 295
1995	248	81 021	67	20 481	101 502
1996	258	85 521	99	22 817	108 338

3. Animal recording

3.1 Large state farms

All the 31 State farms keep the individual animal record as well as the herd record in respect of production as well as reproductive parameters. Presently all the farms are using the software Dairy Champ which is a comprehensive computerized record keeping system for monitoring production, reproduction and health of animals. In addition, a continuous genetic evaluation is also carried out by the genetists of the Department of Animal Production & Health.

3.2 Record keeping

3.2.1 Milk recording

The smallholders having one or two cows very rarely keeps individual production records. Especially for the cattle herds in the dry zone where extensive management system is practised no records are kept. The only record that the farmers keep is the receipt issued by the milk collecting centre for the supply of milk.

In 1980 a pilot milk recording programme was initiated with the assistance of Swedish Government under CIDA artificial Insemination project with the objectives of providing a better extension service and ascertaining the impact of the AI programme. Under this programme both breeding as well as production parameters were recorded and maintained for the farms covered under AI. This programme was closely monitored by field officers visiting the farms regularly. The biggest constraint faced by the programme was movement of animals. Many farmers sold their animals due to limitation of land, inability to feed etc.

3.2.2 Artificial breeding programme

Artificial insemination recording system was initiated in 1980s with the implementation of CIDA artificial insemination project. The whole recording system is centrally computerised with a view to monitoring the performance and the efficiency of the AI programme, and evaluating the performance of bulls, quality of semen and performanceof the technicians. The impact of the programme is also being analysed.

A system has been developed to record the details of herd structureand other parameters and of inseminations carried out using farm card called GVS 51. Over 50 000 farms have been registered through out Sri Lanka for this purpose. Feed backs are provided to farmers giving details of farmer, date of birth of cow, last calving date, AI date with code number of the AI centre, breed, bull number etc.as well as details of follow up actions to be carried out. A copy of the above receipt is sent to the Animal Breeding Head Quarters regularly. In addition, every follow up action taken is communicated to the Animal Breeding Head Quarters immediately in order to monitor whole breeding programme.

In order to make the project attractive to the technicians, an incentive programme is in operation under which technicians are rewarded financially on the basis of results achieved.

4. Past experience in animal recording

Since the colonial period, Sri Lanka has been importing cattle both bos-indicus and bos-taurs. The bulls produced from these cows have been distributed tofarmers. However, neither any records have been kept in this connection nor attempts have been made to evaluate the programme. As a result of the land reform in 1970s the land owners were compelled to sell the high productive cows as well as bulls for slaughter as the available land for dairying became limited. Superior and well grown bulls were sold off by the farmers as they fetched better price from butchers leaving the inferior quality bulls for natural breeding. This resulted in detoriation of quality of animals.

Even though, artificial insemination programme was carried out, no systematic efforts have been made to put in place a genetic improvement programme. Farmers have also not been involved and motivated to keep records.

Convincing small farmers to keep records on the performance of their in a situation where animals are not giving them adequate returns is very difficult. Even though, there were several constraints decade with regards to animal recording, attempts have been made to record milk yield of animals with the purpose to identify high yielding crossbred cows and to inseminate them with progeny tested semen to salvage resulting bull calves and select them for breeding. Unfortunately this programme was off the ground due to the fact that the government could not organize a scheme to purchase bull calves produced under the programme.

However, some progress have been made to keep records of the animals involved in heifer calf rearing scheme initiated in 1993 and so far more than 5 000 heifer calves and their mothers have been covered. It has been observed that proper records in respect of milk production cannot be maintained as a result of suckling habits of the calves.

5. Conclusion

The genetic potential of the Sri Lankan herds in various agro-climatic regions at present is unknown. In addition, due to inadequate record keeping, monitoring of the performance of the herds cannot be done and the genetic evaluation of the bulls produced in these herds also can not be done.

Attempts have been made to carry out selection on subjective basis by giving emphasis on milk production and reproductive characteristics. It is realised that a genetic progress is not possible until a comprehensive scheme for animal recording is in place.

Priority must be given to initiate performance recording of the herds with a view to monitoring production as well as achieving genetic progress in the population. Such a programme could be implemented through the existing AI programme. For this purpose, AI technicians can be requested to collect the relevant information when they are visiting farms.

It is imperative to know the genetic quality of local and crossbred animals in order to achieve genetic improvement of the dairy herds. Sri Lanka Government has also recognised the importance of record keeping to increase the productivity of the animals and it has been decided to seek an international assistance to plan and to implement a long term programme of animal recording and genetic evaluation of animals.

Monitoring Livestock Productivity in Malaysia

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1. Introduction

In many developing countries, a large segment of the population is engaged in several agricultural activities including animal farming. However, in Malaysia, the number of people in animal farming is dwindling for three main reasons. Firstly, rapid urbanisation causes migration of farm workers into the cities seeking better opportunities. This leads to difficulty in getting human resources to manage farms. Secondly, urbanisation also means that land available for cultivation and farming will be very much reduced. It will continue to decline as more buildings and factories are erected. Finally, animal farming particularly ruminant production, has been shown to be labour intensive and does not produce comparable monetary return as compared to other non-agricultural activities. As such ruminant farming tend to become a sunset industry as compared to the successful pig and poultry enterprises.

By and large, the Asian animal agriculture is also characterised by the preponderance of small farms and traditional crop-animal systems (Devendra, 1994). Increasing the productivity, particularly of the ruminant sector is a big challenge which include minimising the cost of feeding by utilising natural resources and application of technological options in livestock production.

This paper briefly highlights the livestock industry and its significance to the Malaysian economy. Particular emphasis is placed on the development of the ruminant sector. This paper also discusses the management input with respect to farm recording and its use in the development of the livestock and poultry industry in Malaysia.

2. Livestock industry in Malaysia

This industry is an important component of the agricultural sector in Malaysia. Its share of the Gross Domestic Products is approximately $US 1.5 Billion. It contributed to 25 and 44% of the 1995 national agricultural and food production, respectively. Animal farming activities are largely centred in Peninsular Malaysia.

Poultry and pig industries are the most developed and important sectors and has contributed to approximately 94% of the total livestock output in 1995. Pork and poultry products are produced in excess and Malaysia exports these products. The ruminant sectors are struggling to improve their production capacities even though their population are much lower than the swine or poultry.Most significantly are the persistent reduction in their population over the years (Table 1).

Even though the output of most livestock products increased gradually over the years (Table 2), the demand particularly for beef and dairy products exceeds their supplies as consumption increased (Table 3).

3. Beef and dairy production in Malaysia

Farming system in Malaysia is generally a smallholder type which is characterised by a low input and output. The cattle population has to treble and their productivity improved through cross-breeding. In a series of the National Development Plans from 1971 to 1990, Malaysia embarked on a massive import of breeding cattle to increase the base population with the objective to achieve self sufficiency or near self sufficiency in beef and dairy products by 1990. This objective was never achieved as evidenced by the consumption rate greater than the production capacity of the local farms (Table 3).

Beef production will be promoted in the integrated sustainable production system with the plantation crops, largely in oil palm plantations and to a lesser extent in the rubber plantation (Harun & Chen 1995). The environmental conditions in the plantations are conducive to beef cattle production as have been demonstarted for sheep (Rosli and Nasir 1997). The potential of this system has been shown in sheep and the approach is convincing as Malaysia has enormous acreage of oil palm plantations. The integration of beef cattle with the oil palm plantation has been adopted in several oil palm plantations, particularly in the southern part of Malaysia.

The dairy industry is mostly a part time activity with only a few large (more that 100 heads) commercial operations. Although traditionally, consumption of dairy products in Malaysia has been relatively low, there is no doubt that a rise in disposable income has altered lifestyles and dietary habits accordingly, and will continue to do so. However, the production of raw milk in Malaysia is still a small contributor to the country’s overall milk requirement. At present, the raw milk production is approximately 5% of the national consumption. The local milk production will be further consolidated towards the creation of more commercial dairy enterprises to supply the local fresh milk market.

Feeding systems are generally based on agricultural by-products which are produced in large amount (Table 4). The strategy to use agro-byproducts would be enhanced by intensive research programmes.

The most popular local source is the oil palm by-products particularly the palm kernel cake, which forms the major energy and protein sources for the dairy and fattening cattle in feedlots. Some of these by-products such as brewer's grain, wheat bran and pollard and soybean meal are produced from the processing of imported resources.

4. Development of the dairy and beef industries

Many countries in the tropics are increasingly importing European breeds of ruminants in their attempts to increase milk and meat production. Malaysia also embarked on an importation programme of several cattle breeds for the purpose of increasing milk production and finding the suitable breeds that can adapt to the environment. In the late 1970's and early 1980's, the dairy breeds imported were Holstein-Friesian, Australian Milking Zebu, Brown Swiss, Ayreshire, Jersey and Shorthorn (Murugaiyah 1982). Later, the Friesian-Sahiwal (50-50) breeds were imported from mostly Australia and New Zealand in an attempt to improved the local milk

Table 1. Livestock population in Malaysia.

Year	Buffaloes	Cattle	Goats	Sheep	Swine
1986	141 938	559 582	258 101	90 359	1 591 529
1990	129 517	614 498	281 759	199 909	2 242 055
1993	110 149	689 288	277 065	244 023	2 334 744
1995	103 027	659 065	228 589	203 624	2 491 139

Source: Dept of Veterinary Services Malaysia (1995)

Table 2. Livestock production in Peninsular Malaysia.

Year	Beef *(MT)*	Mutton *(MT)*	Pork *(MT)*	Poultry meat *('000)*	Milk *(million L)*
1986	12 308	586	141 350	248.8	24.1
1990	12 244	658	197 301	348.5	26.2
1993	13 663	607	231 140	560.7	29.23
1995	15 395	530	246 623	631.4	31.87

Source: Dept of Veterinary Services Malaysia (1995)

Table 3. Production and consumption of beef, milk & milk products.

	Beef			Milk		
	Production *(MT)*	Consumption *(MT)*	Per Capita (kg/year)	Production *(million L)*	Consumption *(million L)*	Per capita *(L/year)*
1991	14 347	63 796	3.38	30.0	837.23	44.4
1992	14 833	65 408	3.38	31.2	801.15	41.42
1993	15 623	70 052	3.53	33.1	738.08	37.18
1994	15 188	77 647	3.81	35.5	545.05	26.78
1995	16 919	85 985	4.12	36.8	875.52	41.70

Source: Dept of Veterinary Services Malaysia (1995) production. The production data were not conclusive and as such the suitability of the dairy breed could not be recommended to improved the dairy cattle production programme.

It appears that a correct collection of production management data is essential before a judgement is made on the genetic potential of a breed of animal. Some records indicated that the reproductive performance of these herds varied enormously between and within herds, which is largely attributed to environmental stress such as high humidity. The reproductive efficiency of pure bred *Bos taurus* breeds and their crosses with more than 50% *Bos taurus* tend to decline. These cows also exhibited long calving interval and poor conception rates. Today, we are still seeking the appropriate beef and dairy cattle breeds. It may appear that the genetic potentials of the cattle were limited by low management input and environmental stress.

5. Animal recording and organisational structure

In modern dairy farming, successful management relies on good record keeping and on information that can be derived from it. With the records, the farm management plays a central role in the management decisions through the interpretation of the recorded information. Farm records are to be utilised routinely for daily management and to solve problems. A quantitative knowledge about a farm provides the basis for understanding where the dairy has been, where it is today and where it is going.

Maintenance of animal data is generally carried out by the Department of Veterinary Services. The most established data are those related to the health and disease control programmes. Report of the livestock production statistics is also produced annually. University Putra Malaysia, Malaysian Agricultural Research Development Institute and farms under the Department of Veterinary Services organise their individual recording system related to animal productivity including the reproductive performances. This is not normally organised at the smallholder system and thus a national standard values are not precisely known.

6. Animal recording at smallholder system

By and large, farmers are ignorant of the importance of maintaining farm data. They are not trained to record and maintain farm data. In addition, farming is generally engaged as a part-time activity, time is a major constraint. Data may be only in the memory of the farmer or scattered in many different spots. For example, a disease outbreak is noticed, but no data on disease incidence or performance have been recorded. Without a correct assessment of the magnitude of the problem, quantitative improvement of heifer health, growth and economics, after intervening actions, cannot be shown to the farmer. However, our main concern has been related to the unavailability of proper breeding data at most farms.

The first step is to train farmer in accurate and complete record keeping. The data must be recorded in a functional way. Some of the important data that the farmers should keep are:

1. Individual animal records of reproductive events, health disorders, condition scores, culling, laboratory reports.
2. Herd events e.g. vaccinations, ectoparasite control, anthelmintic treatment.
3. Breeding records.

7. Record keeping and data storage

Keeping farm data requires skill and organisation so that they can be retrieved easily and used to make sound interpretations and decisions. Manual recording are normally practised. An electronic record keeping system in milk production is not used, even though milking parlour in large farms are automated. The main reason being that the animal numbers may be small and the productivity is low to justify expensive installation of a computerised system.

However, the automatic cow identification systems have been used in an extensive beef cattle farm. The system has greatly assisted animal counting, weighing and monitoring growth.

8. The record of reproductive efficiency of dairy cows

Reproductive efficiency of the dairy cows is considered as the most important information used to compare the suitability of dairy cattle breeds in Malaysia. These data are normally maintained and used in all institutional farms such as those owed by the Malaysian Veterinary Services and the University Putra Malaysia. The records were used as the basis of selecting breeds of temperate dairy cattle to be imported during the expansion of the dairy cattle industry in Malaysia. The reproductive efficiency records are still maintained at most institutional farms and have been used effectively for several purposes. However, it is undeniable that, some of these records have not been regularly updated resulting in some relevant records being missed. Future plan and recommendation on suitability of breeds in our environment are made difficult by unavailability of these records.

The most common records of the reproductive performance are: length of oestrous cycles, calving intervals, service per conception, calving to first oestrus and service period (calving to conception). In a report, the Holstein-Friesian cattle in Malaysia, the calving interval was 496 days, services per conception was 3-6 and age at first calving was 36 months. In the imported Jersey, the interval between the first calving to first oestrus was 68 days. These parameters have been used to compare the suitability of several breeds of dairy cattle in several stations in Malaysia.

Table 4. Local feed production in 1996.

Feed type	Estimated production (MT)
Copra cake	12 000
Rice bran & polishing	50 000
Cassava residue	30 000
Palm kernel cake	1 000 000
Molasses	50 000
Brewers grain	4 0000
Soybean meal	450 000
Wheat bran & pollard	45 000
Fish meal	45 000

Calving to conception interval is one of the major factors affecting the economics of dairying. A cow should be bred and it should conceive within 60-90 days post-partum. In the imported Jersey, the mean days open for the second reproductive period was 288 days with a range of 84-429 days. Most of the cows were repeat breeders and longer intraoestrous period contributed to this extended calving to conception interval.

These records have been cited on many occasions when recommending the purchase of dairy herd either by private enterprise or institution. The pure-bred Jerseys and Friesian, either pure or 50-50 are considered an undesirable breeds in Malaysia with respect to milk production and reproductive efficiency. However, today, farmers are now keen on rearing pure-bred Friesian or Jerseys or Friesian-Sahiwal (75-25) which is contrary to the earlier recommendation. Perhaps, there are isolated cases of successful production system using these breeds and that the farms records from which recommendation were extracted, was not properly managed.

9. Health records

Suitability of breeds was also based on the health records that was maintained in most farms. In the study of Jersey cattle (Murugaiyah 1982), causes of death, number of abortions, dystocia, neonatal and prenatal death were all recorded and compared with those reported for Holstein-Friesian which were also imported at about the same time as the importation of the Jersey.

10. Manual recording of data

Manual data recording and storage has been the main mode of record keeping in most farms particularly in smallholder farms where the average number of animals is 12. Computation of the primary performance indices is uncommon and is only carried out when farm research is conducted by a researcher. Farmers do not usually use recorded data as a tool to management of his animals or farms. Perhaps most farmers are ignorant of the importance of the recorded data in farm management.

Electronic data processing is far more efficient than manual, but many performance figures can be manually computed. Hand calculations take time and herd dependent, and may be impractical for large herds. As there is no accessibility of data in centralised systems, such as Dairy Herd Improvement databases, the use of computers in herd health and herd management services are not practised in Malaysia. This is perhaps far different in North America (Nelson, 1994). The availability of the right data is the key factor in the herd health and management programme. In countries where livestock production is successful, most farm data are routinely computed into performance indices which are used to monitor animal performances.

Manual data processing is, in a large number of farms, the only way to generate adequate information in the form of performance indices that can be used for making decision (Kristula and Uhlinger, 1995). Not all primary performance indices, such as calving interval, age at first calving, etc., are easily calculated manually.This approach lacks flexibility and computational ease as compared to computerised systems.Monthly monitoring is not a regular exercise and is not consistently recorded.Thus, a pattern or trend of a particular record could not be translated effectively.

11. Computer aided technology in animal data recording

The rapid progress of the livestock farming technology today has created a need to devise a method to develop and transfer technology efficiently. One example is the Trop-Dairy. Feed software developed by a research institution to assess cost-benefit ratio and to estimate performance and feed requirement of lactating and dry dairy from a given feed quality. Other software regarding investment analysis, breeding plans, pasture and fodder management, environment modifications and other livestock technologies have been planned.

12. Future of animal recording

The advancement of information technology should make animal recording an easier and essential exercise. All data could be utilised effectively and assessable from any parts of the country. There is a need to establish a unit dedicated to keeping and organising all animal records. The unit must be staffed with efficient and responsible person and using computer as a management tool.

The cost of acquiring relevant technology and updating of data could be constrained by lack of funds. However, the information system is an important source of information for a successful livestock farm operation. Most important is to determine the correct data to be collected before they could be used effectively in a herd management programme.

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Practical experiences in Milk Recording in Indonesia

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1. Introduction

Indonesia is a tropical country that relies on Friesian Holstein dairy cows for its domestic milk production, and since 1979 intensive development efforts have been made to improve the productivity of animals so as to meet the increasing demand for milk. One of the most important policy measures which was taken, in cooperation with the milk processing industry, was to set up an integrated development programme aimed at guaranteeing the market for milk produced by smallholders. Smallholders are dependent on milk production and in the cooperative system, to obtain a legal permit to operate, the milk processing plants must accept locally produced milk. This policy resulted in a significant contribution to domestic milk production increase; however, it has created a problem by increasing inefficiency in farms and cooperative units lproduction resulting in low productivity of the dairy herds.

In order to improve the production and the productivity of dairy animals, it was considered important that accurate and continuous records of various productions and of biological factors should be obtained. It is apparent that such accurate and permanent record keeping is still very weak and does not enter into the daily activities of the farmer in comparison with other animal production farms where intensive extension and training means have been supplied..

In facing the free trade commitments that will be implemented in the year 2005, production efficiency and productivity should receive more serious attention in order to allow smallholder dairy farms to compete with milk producers in other countries. Record keeping becomes a priority for the farmers and cooperatives concerned in respect of improving management orientations . The records would serve as a source of information for the decision makers involved in improving production and productivity of the animals of farmers and of cooperatives. More important will be the improvement of breeding stock that will result in increased domestic milk production which, at present, has reached only 3 000 litres in a lactation.

This paper will present the progress of a recording program at farmers and milk plants levels and in the implementation of record keeping at institutional and national levels. Moreover, the progress of the breed improvement programme over the past two decades is reported both to provide a clear picture of the role and functions of record keeping as a source of information in the decision making process and to improve production through breeding in the Indonesian dairy industry.

The establishment of the dairy industry in Indonesia began during the Dutch colonial time (1891) with the importation of Friesian Holstein bulls from The Netherlands and of Shorthorn from Australia to Pasuruan in East Java. Its development started through crossbreeding with local Ongole and Ongole crosses. After the independence of Indonesia, the development of the dairy industry was rather slow. The national policy at that time was to keep dairy cattle and their crosses in Java. Only a few times were large numbers of dairy cattle imported into Indonesia. Once in 1962 Friesian Holstein cattle were imported from Denmark prior to the Asian Games Festival in Jakarta. Thereafter in 1964, to increase the production of milk, around 1 354 dairy cows were imported from The Netherlands as breeding stock. (Sudono, 1983).

Entering the new order, increased milk consumption was observed due to nutrition awareness of the community for milk that could be relatively easy to obtain in conjunction with the development of milk processing plants. However, all the milk which was being used by the diary industry for processing was imported. The result was that the irregular supply of non-guaranteed quality local milk produced by the farmers under a cooperative scheme could not compete with milk products produced by highly technical processing plants.

Because of the unfavourable condition of the dairy industry and of the problem in facing the increasing dependency upon milk importation, since Pelita III (1979-1983) the Government has made serious commitments to improve milk production within the smallholder farming system as a means for the industry to increase farmers' incomes, employment opportunities in the villages and improve farmers'welfare. The dairy development program is an integrated agro-industrial systems (Soehadji, 1989) it includes a holistic programme comprising:

- Measures to guarantee the marketing of the milk produced by smallholders and large enterprises through the cooperative scheme (GKSI) and milk processing plants (IPS). This was enforced by means of a decree issued by the three competent ministries for milk policy.
- The importation of dairy cows to support the genetic improvement of the dairy herd by means of AI services, training and extension and animal health coverage.
- The assistance to smallholders in the form of credit packages for dairy production through DGLS and village cooperatives units (KUD).

- Maintaining and expanding fresh milk handling capacity by the village cooperative units with respect to potential supply to the existing milk processing industries.
- The strengthening of dairy cooperatives through an institutional approach with a view to developing cost effective and viable production systems over a period of time, and reducing imports of milk powder.
- The setting up of a National Dairy Development Coordinating Team, supported by a Technical Working Group at national policy making level.

The implementation of the above mentioned policies has positively affected the development of the dairy industry. It resulted in 1993 in an increase of 98 000 dairy farmers in 207 village cooperative units (V.C.U.) With a production capacity of 3 88 600 tons , compared to 2 174 dairy farmers in 11 V.C.U. who in 1978 could only produce 3 800 tons of milk.

With the implementation of the Presidential Instruction decree No. 2, 1985, that regulates the importation quota versus the domestic milk production and the absorption of domestic milk supply by processing plants, milk import decreased and domestic milk production increased. The milk ratio of domestic milk production to import which was 1:20 in 1979 came down to 1:2 in 1996. The lowest ratio of 1:0.7 was reported from 1987 till 1989.

Efforts to create and maintain a conducive environment for developing the dairy industry through providing a guaranteed milk market and stable milk price for those dairy farmers members of the cooperative, have induced other problems. Farmers were not motivated to expand their business and did not take into account efficiency aspects and animal productivity (GKSI, 1996). The dairy business is traditionally managed by most farmers; however production efficiency was neglected, including the importance of starting with a proven breeding stock, the implementation of an economically viable feeding system based on meeting the biological requirements of the animals, and the attitude consisting of managing the dairy business as a side business. The lack of professional human resources to cope with various technical problems at village cooperative units further induced the downward trend of production efficiency and to a larger extent, also, it has induced a weak program planning for developing the dairy industry at cooperative level and limited the supply of technical services to farmers i.e. animal health service, feeding management, and the availability of essential inputs.

Entering the free trade era that will be implemented in developing countries in the year 2005, the policy of milk ratio that has been implemented by the Government of Indonesia, to comply with the GATT/WTO commitments, should end and be replaced by a tariff policy. Hence, efficient production and improved productivity, become, among others, two decisive factors in allowing the smallholder dairy production systems to compete with exporting countries, and this should be taken into account (Diwyanto and Setiadi, 1995 and DGLS, 1996). Efficiency and productivity targets would initially be dependent upon a recording system of accurate production factors, regularly and continuously monitored. This is important information in deciding the management policy at cooperatives and farmers levels and also on the policy to improve the genetic quality of animals in order to achieve development goals.

2. Dairy herd improvement policy

The Java island, which is only 6% of the Indonesian territory but is inhabited by almost half of the human population, is the centre of the dairy agribusiness. The three reasons which make the Java island the major dairy agribusiness centre are: (i) its high altitude areas with a climate that is close to that of the temperate dairy cattle habitat; (ii) the fact that the majority of potential milk consumers, and almost all dairy product processing plants are located in Java (Jakarta, Yogyakarta, Bandung etc.). The principle of the dairy herd improvement policy which is being implemented is based on a dairy herd breeding programme and on the utilization of a nucleus breeding center.

3. Dairy herd breeding program

The objectives of the dairy herd breeding program are to increase the genetic make-up of the local dairy herd towards higher grade Holstein crossbred animals through upgrading. A small part of *Taurindicus* that have Zebu (Sahiwal) *and Bos Taurus* dairy types will be maintained. Grading-up is applied through the importation of Friesien Holstein purebred cows, superior proven bulls, and frozen semen as gene sources. From 1972 till 1992, around 125 000 cows have been imported from New Zealand and Australia (Soehadji, 1993). In addition, millions of frozen semen doses of superior bulls have been imported from England, USA, Middle East and Japan. This was followed by the importation of young bulls and proven bulls. The artificial insemination technique has been widely used to increase the dairy population and the genetic quality of animals utilizing Friesian Holstein frozen semen produced at the AI centers in Lembang and Singosari. However, the local and imported bulls from which the frozen semen was produced, have not gone through progeny testing in Indonesia.

In line with the advancement in animal science and technology, Indonesia has also initiated the utilization of embryo transfer technology to increase good quality dairy cows. The first embryo transfer on dairy cows was carried out in West Java with 205 embryos. The results of this will be assessed when the offspring is in production.

4. Nucleus breeding center

To enhance consolidated genetic improvement rate of the dairy population, over Pelita VI (6th Five Year Development Phase), a breeding strategy has been implemented in a pyramidal selection within the dairy foundation stock. The plan was to involve 5% (16 thousand) of the dairy cows with highest milk production record from a total population of 320 000 heads. Ten percent of the best animals of the foundation stock (1 600 heads) are to be used as breeding stock, and 30% (4 800 heads) as multiplication stock, whereas 60% (9 600 heads) are considered as commercial breeding stock. The establishment of the nucleus breeding herd is an effort aimed at collecting and utilizing the gene sources of proven dairy cows in the foundation stock, in particular, those in milk production centres. The development of foundation stock was carried out by applying the super-ovulation and embryo transfer techniques (Soehadji, 1995)

Genetic improvement was applied in an "open nucleus breeding scheme " with the establishment of a hierarchy in the population where the genetic quality of the bulls proceeds from the foundation stock to the breeding stock, from the breeding stock to the commercial stock and allow the reverse flow of genetics of proven dairy cows. This has been the focus of attention to produce locally tested dairy cows in order to reduce the dependency on importing dairy cows for replacement stock. The availability of locally proven dairy cows has the advantage of preventing the reduction of performance due to stress factors against climatic and hot, humid tropical environment as generally was experienced with imported dairy animals. From the total dairy population of 320 000 head and on the assumption that 57.9% are cows used for multiplication over a 3-8 years period, it was calculated that around 11.1% or 35 500 cows are needed as replacement stock annually. From this total number of replacement stock, at least 5 to 10 000 animals are expected to be certified proven animals produced through a selection process (Hardjosoebroto *et al.*, 1997).

In order to achieve the selection progress as expected, evaluation should focus on the genetic or the inherent superiority of the selected animal. Therefore, in the process of obtaining local Holstein breeding stock or Indonesian Holstein type to replace the unproductive ones a complete record of each animal is needed.

5. Implementation of the recording program

The following discussion will focus on the recording scheme that has been implemented at small-holder farmer level as well as at the dairy enterprise. The scheme covers the identification of limiting factors and the solutions to overcome the problems, especially those related to genetic improvement for increased production. The recording scheme needed in managing the whole system at farmer and cooperative levels is also discussed.

The dairy records at dairy farms includes identity records, pedigree, production, reproduction, nutrition and health condition of each individual animal, in general, this has not been done by farmers. Recording was only carried out by a few large dairy enterprises with various methods partially dictated by the importance of the records to the enterprise. Record keeping is often implemented for calculating production and income costs to decide what positive actions are needed to increase production efficiency. Most of the farms also use records of animals to decide on the best breeding program. It is unfortunate that guidance and extension service to farmers on the importance of performance records that has been introduced by the institutions concerned, i.e. village cooperative units, professional organizations and also the universities, gained little success. In an in-depth study carried out over five years by the University Padjadjaran aimed at socializing the recording programme through extension and training of dairy farmers in West Java, indicated that the data could only be analyzed with regard to the production aspect, but was not sufficient for the selection and genetic evaluation purpose (Bandiati *et al.,* 1997). The problem in respect of genetic evaluation of dairy cattle, that is related to limited availability of data, was also observed in a study conducted by the Provincial Livestock Services of West Java in collaboration with the Research Institute for Animal Production, Ciawi-Bogor. The effort was to identify and select breeding cows as replacement stock for the dairy population in West Java. The study could only provide information on milk production based on one sampling of individual cows, without any data on pedigree, lactation period, length of lactation, age/period of production, and other important information to evaluate the dairy cattle. Obviously that the data available is still far from being sufficient to confidently select the genetic quality of cows being evaluated (Diwyanto *et al.,* 1996).

A recording scheme to support the breeding programme of dairy cattle in Indonesia was initiated in 1986/1987 as a joint effort between the Directorate General for Livestock Services and JICA (Japan International Cooperation Agency - ATA. 233) it was actually a progeny testing exercise. The programme was divided into two phases in three villages in West Java and nine villages in East Java. The first phase of the progeny test was implemented with three dairy bulls introduced from Japan and involves 1500 selected cows with an average production capacity of over 3 600 litres per lactation. The second phase was conducted with more cattle involving five bulls introduced from Japan and 3 500 cows.

In the attempt to evaluate milk production, recording was carried out twice a day in the morning and in the late afternoon. To predict the production potential of dairy cows a performance test was carried out using the Most Probable Producing Ability (MPPA) which include : identity of the animal and of the owner, animal pedigree, mating and calf birth, selected information production aspects (including lactation period, total milk production and milk production per lactation), animal growth, nutrition and health (Soehadji, 1989).

It is apparent that at the initial stage the collaboration efforts between Indonesia and JICA could only indicate the productivity and health of the bulls offspring, and no data is available for the contemporary local bulls. Therefore, the progeny tests could only be done on the Japanese bulls, but not to evaluate the superiority of the local dairy bull (Padmadinata, 1994). Further, the government policy to identify the proven bulls to be used for AI purposes could not be implemented either. This is due to the many problems encountered in implementing conventional selection at farmer level, since the identity of the animals was not known and no milk production, reproduction, nutrition and health recordswere available. This condition imposes limitations on carrying out performance tests in village breeding centres and progeny testing at breeding and AI centres (Soehadji, 1989).

A progeny test is currently being conducted to evaluate the local dairy bulls and imported proven bulls, aimed at improving the genetic make-up through AI and provide a significant contribution towards increased milk production of local dairy cows. The Research Institute for Animal Production will evaluate, both on the dairy farms and at the BPT-HMT of Baturaden in central Java, the superiority of bulls which have been used for AI from among those which have a sufficient offspring for progeny testing.. BPT-HMT Baturaden is a breeding unit under the DGLS that produce breeding stock. With the availability of well organized, regular and continuous records at BPT-HMT Baturaden and at dairy farms, it is hoped that progeny tests could be carried out so as to include various genetic parameters (heritability, repeatability, genetic correlation) of importance for selection. The availability of records at dairy farms would no doubt serve as a basis for further selection.

The development of correction factors is also considered necessary for a better assessment of milk production in relation to the physiological condition of local cattle population. The inadequacies of of the correction factors of the Dairy Herd Improvement Association (DHIA), US, that has been developed in the 1960 and used so far as standard factors of milk production variation, has shown that the duration of lactation of dairy cows at the farms were not normally distributed over the 305 days lactation period but rather skewed (Anggraeni, 1995). Standardized milk production records using correction factors that are more suitable for local dairy cattle will in turn increase the accuracy of selection of dairy cows and bulls.

6. Problems in the implementation of recording scheme

Assessment of the recording scheme being implemented at farmer level under the supervision of extension officers, village cooperative unit, association, researchers, and university personnel; and also at dairy farm enterprises indicate the existence of various limitation i.e. :

- The farmers limited experience and knowledge of the benefit of recording, hence their low awareness and participation in doing recording.
- Most of the dairy farms operate on a small scale.
- Lack of farmers understanding of the dairy herd improvement program.
- The high influence of trading activities on cattle evolution in the provinces.
- Insufficient facilities for data collection and analysis.
- Limited role of the associations in collection of data and in the coordination of recording scheme improvement schemes.
- Unclear organizational structure and responsibility in carrying out the implementation of breed improvement schemes.
- Limited number of recording personnel.
- No incentive for the farmers who implement milk recording.

7. Development of future recording systems

The evaluation and identification of the various supporting factors and limitation of recording systems would apparently provide invaluable inputs to be considered in establishing the future of record keeping that involve the various parties and organizations concerned. The implementation of an informative and effective management structure involving all parties concerned in a national network is expected to result in a better and well planned operational recording scheme with the objective to support the goals and aims of a national breeding programme geared to increase the number and genetic quality of Indonesian dairy cows.

In order for them to play an active role in record keeping and as actors of the production process the dairy farmers require intensive guidance, extension service, a flow of information and training to keep the records and increase the awareness of the advantage of recording activities . Better attention being given by the government, by the association (PPSKI/AHI) and the cooperatives in variousrespects will further motivate the farmers to maintain records of their animals. This can be done through :

- providing an incentive to the farmers that are already keeping records;
- translating into economic merits the genetic improvement results of keeping good selected breeding stock, such as the increased income from additional sale of milk if farmers raise proven cows; and
- applying an attractive guaranteed price for the milk produced by good breeding cows , etc.

Recording personnel need to be prepared in sufficient number, with good knowledge and experience in doing the job. Establishing a bridge between farmers and the record organization to quarantee the accuracy and completeness of the data will be of advantage. It appears also that the coverage area should be optimal so as to enable the recording people to carry out their duties and responsibility. An attractive incentive might be paid to the recording personnel from the self-supporting fund of the cooperative, that does no burden to the farmers, to increase product processing by the cooperative.

Providing adequate facilities will stimulate the collection of comprehensive information on biological and technical aspects. This will enable ascertaining that all the essential data needed are being collected, including both biological data of the animals at farm level and technico-operational data at national level. The various facilities needed include a high-speed computer with a program to store and formulate available data on management and also breeding aspects. Various examples of available computer programs include the Dairy Champ program package, US-Holstein, LKV, Super Kuhe and others that could be implemented by the consultants or the managers toget advice towards optimal production efficiency (Bandiati *et al.,* 1997). Another problems with regard to the identification of individual animals at farm level with the high mutation rate of animals due to active market opportunities, could be minimized by using the International Identification

Program (IIP). With this package program, complete data input of each animal identity could be entered, for easy finding of the animal location, ownership, and movement to other locations.

For a uniform data entry by the recorders, that will ease the transfer of information results of laboratory analysis and interpretation of results, a guidebook needs to be prepared. Uniferm data entry should not be worked out at regional level but well at the national level.

The organizations and government agencies which have the privilege of being part of the improvement process of the exisiting dairy herd but who are still facing limitations in carrying out their jobs or functions, should strengthen their role. Some of the organizations and agencies which are expected to have, in connection with animal recording, a significant contribution to genetic improvement are mentioned hereafter and their role is summarily described.

KBTN (Komisi Bibit Ternak Nasional – The National Livestock Breed Commission)using data as complete and accurate as possible, the organization makes recommendations as regards the certification of the breeds that have to pass a genetic quality test.

PIDT (Pusat Informasi Data Ternak – National Livestock Information Centre) could strengthen its role in the fields of data collection and analysis utilisation of information for decision making purposes, in providing information to those in need, as well as of brochures, guidelines and genetic information.

PIDTD (Pusat Informasi Data Ternak Daerah – Regional livestock Information Center) carries out various activities in relation to data collection at regional level which include : inventory, identification and registration of male and female animals, recording the production of cows, of their offspring and the selection steps ; data analysis providing information on the result of analysis/recording and recommends better feeding practices and management.

The establishment of a network of breeding expertise (universities, research institutes, a private companies and professionals) involved as collaborators of the govenment in organizing improved breeding. This organization would give neutral advice in its field of competence. For instance, by providing advice to the government on positive and negative impacts of the policies being enforced in the livestock breed improvement program. The Indonesian Holstein Association (AHI) that is under the PPSKI (Persatuan Peternak Sapi dan Kerbau Indonesia – The Indonesian Cattle and Buffalo Farmers Association), as dairy breeding organization in Indonesia, is expected to take a more active part in carrying out its function.

The dairy breeding program could be fully operational in respect of selection and mating of dairy animals, if all organizations/government and non-government agencies that are competent collaborate and, in line with their special function, implement essential recording means including statistical data, population structure, dynamics, dairy herd technical coefficient apart from techino-operational data at farmer level, cooperative and national organizations.

8. Final remarks

In Indonesia dairy cattle recording is not properly implemented, because farmers and other parties concerned still do not realize its importance. Efforts to set up a recording scheme that is consistent and accurate could only be implemented under sustainable projects. Large scale farmers are applying recording systems that could be considered well organize; however, available data is not used in the best possible way. In contrast, small scale farmers that are more numerous, practically do not keep any records of their animals for better management nor for genetic improvement.

The rapid random mutation and replacement of animals are not based on their breeding value. The sale of animals does not take into account the whole situation, hence, animals for replacement do not carry any pedigree information and their origin is also unknown.

The GKSI (Gabungan Koperasi Susu Indonesia - Indonesian Milk Cooperative Alliance) and the Indonesian Holstein Association (IHA) makes continuous efforts to implement a recording scheme in Indonesia. Farmers are expected to participate actively in the scheme by collecting and providing data for subsequent analysis by the associations. The data is intended to be utilized to improve the genetic quality of dairy herds. The Livestock Service officers could in fact play a significant role motivator and, in particular, by supplying essential farm inputs.

In carrying out recording of dairy cattle that includesa production factors and biological aspects, the priority need is towards better and focused and\or rehabilitation and organization of a recording scheme. This is considered important, in order for the organization to fully operate in providing good and accurate information to improve the production efficiency and genetic make-up towards increaseing dairy production through breeding. Many limitations exist which include the lack of human resources in the field of recording, limited budget, insufficient facilities, and the still inactive role of organizations/government institutions that have the authority to carry out recording.

In planning a recording program for successful implementation in the future, there is a need to cover the limitations that exist at each organization, implementing unit or institution level through an informative and effective communication network between the recording parties from at farmers level, as major source of data, to the level of thed organizations/institutions concerned at national scale.

Entering the globalization era, information flow between countries has no border, and the establishment of a network across countries in the world would speed up breed improvement efforts, in particular, for those that are relatively new in the implementation of dairy cattle technology. Indonesia as a tropical country that started to actively adopt the importation of dairy Holstein cattle over the last two decades, supports the convening of an international meeting like this one in order to learn from experience and through the exchange of information on many positive results and on limitations in developing dairy production in respective countries, especially through recording systems or programmes. Countries that adopt current available technology, in general the developing countries, could learn and assess the various challenges and at the same token, opportunities that could be advantageous to enhance dairy industry development . In contrast, the countries of origin of the technology in question that are already developed are expected to provide the solutions to overcome the problems faced by the countries that adopt advanced technology.

The outcome of this workshop is expected to provide useful inputs and suggestions/recommendations to improve the recording program in each participating country. The results could be further implemented in a realistic form such as by establishing a worldwide network between countries for the development and management of dairy cattle and other livestock species.

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Animal Recording in the Philippines

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1. Introduction

The Philippines is an agricultural country with the agricultural sector contributing a significant portion in the economy absorbing about 49.7% of the labour force as of 1995 and 20 to 22% to Gross Domestic Product (GDP). Within the framework of the agricultural sector, the livestock and poultry sub-sectors play a significant role in the development of agriculture sustaining growth in this sector for the last several years. This pattern of growth is expected to be sustained and expanded in the coming years as demand for livestock and poultry products is expected to accelerate as may be brought about by the rapid increase in human population which is now estimated to be about 68.5 million with 2.3% annual growth rate.

The present situation of Philippine animal industry is characterized by a well-developed poultry and swine sectors and least developed ruminant sector. The most distinctive feature of the poultry and swine sectors why well developed is the fact that majority of the production comes from the medium to large commercial farms rather than the small subsistence farms. It also reflects fragility owing to the fact that a large percentage of its inputs are import dependent. On the other hand, the ruminant sector particularly the cattle, carabao and goat have been sluggish which suffered from eroded quality of breeding base resulted from relatively high extraction rate and low level of productivity. Specifically for water buffaloes, productivity parameters are expressed in different manner as majority of the animals are owned by farmers which are primarily used for work in a crop-dominant farming system.

While the livestock and poultry sectors play a significant role in the agricultural industries of the country, it is imperative that animal recording which is one of the important component of the general management for optimum production of the herd must be given attention. For an efficient operation to attain optimum production, systematic and accurate recording of day-to-day events of an animal is very important and the performance recording of an individual is usually associated with selection for genetic improvement. Recording is an aggregate information of an individual or group of animals which is necessary pre-requisite to effective decision making in breeding policy. Proper recording and record keeping practices will enable the farmer or the manager of the farm to use inputs and management skills effectively and economically. In most of the developing countries production figures on individual animals are usually available for only a small proportion of the total population and there is no systematic recording at all. The lack if not absence of reliable records from which performance efficiency and constraints could be monitored and evaluated is a serious problem to be taken into consideration. This paper tends to describe the status of the animal industry, the recording and animal identification systems in our country. Also, the standardized recording system adopted for use in buffalo is herein presented.

2. The Philippine animal industries

Majority of the Philippine livestock and poultry industries are in the hands of the smallholder who hold from 90.6 to 99.7% of the ruminant, 80.1% in swine and 56.7% of poultry (Table 1). The commercial raisers, however, while they have lower percentage of the animal population are highly efficient and some large corporations have full integrated system in their operations.

Table 1. Inventory of animals by species and by farm size, 1996, in the Philippines.

Species	Smallholder		Commercial		Total
	(‘ 000 hd)	%	(‘000 hd)	%	
Cabarbao	2 835.2	99.7	5.8	0.3	2 841.1
Cattle	1 929.0	90.6	199.4	9.4	2 128.4
Hog	7 238.9	80.1	1 786.9	19.9	9 025.9
Goat	2 834.5	99.6	10.6	0.4	2 845.1
Duck	8.335.1	77.6	2 107.2	22.4	9 442.3
Chicken	65 674.6	56.7	50 106.0	43.3	114 781.5

P=Preliminary estimate
Source: Bureau of Agricultural Statistics (BAS), 1996 as cited by Nazareno and Cruz, 1996.

3. Inventory and population

During the past few years, estimate of the total animal production in the Philippines clearly indicate that poultry and swine industries dominate the sector (Table 2). A review of these annual animal trend shows a steady pattern of growth for these two commodities while those of cattle and water buffalo were rather erratic. The large ruminants had negative population growth from 1982 to 1992 at an annual average of -2.2% and 0.22% for cattle and water buffalo, respectively. In the years proceeding thereafter, ruminant population bounced to positive growth.

Inventory of various animal species during the recent years (1992-1996) indicate robust development with an average annual growth rate of 9.3% for chicken, 5.4% among small ruminants, 5.2% cattle, 3.0% for hogs and 2.5% in carabaos (Table 2).

Table 2. Inventory of livestock and poultry by species in the period 1992-1996. ('000 000 heads).

Species	Year 1992	1993	1994	1995	1996P	Average Annual Growth, %
Carabao	2.57	2.57	2.55	2.70	2.84	2.5
Cattle	1.73	1.91	1.93	2.02	2.12	5.2
Hog	8.02	7.95	8.22	8.94	9.02	3.0
Goat	2.30	2.56	2.63	2.82	2.84	5.4
Duck	8.33	8.70	8.18	9.11	9.44	3.7
Chicken	81.52	87.15	93.10	96.21	115.78	9.3

P= Preliminary estimate Source: Bureau of Agricultural Statistics (BAS), 1996 as cited by Nazareno and Cruz, 1996.

4. Production

The total volume of production from the industry in 1995 was 2 657.7 metric tons valued at US$ 4.4 billion (Tables 3 and 4). Pork and chicken meat constitute 81.3% of the total meat production, with pork being the largest contributor equivalent to 50.3% of the total local meat supply. This results from the fact that chicken meat and pork remain to be the least expensive meat in the local market today and thus the consumer demand for these two commodities are the highest. In turn, the sector responds by increasing inventories. The value of animal products during the period 1992 to 1995 is presented in table 4.

Meat supply from ruminants also showed positive annual growth rate that ranged from about 1.4% in buffalo meat to a high of 8.4% in beef. This large increase in availability of beef can be associated with the influx of considerable number of reasonably priced feeder stocks from foreign sources in the last few years. This live animal importation increased from only 12 674 hd in 1991 to 188 348 hd in 1995 (Table 6).

Growth rate in goat meat production was also significant during the last five years. Aside from some quantities for export, the local consumers have already developed the taste for chevon.

The only commodity that has stagnant in production is the dairy sector. Slow rate of development manifested during the last decade is readily explained by the liberalized importation of highly subsidized milk from foreign sources depressing private sector initiatives for dairy development.

Table 3. Volume of livestock and poultry production, 1992-1995, in the Philippines ('000 metric tons).

Species	Year 1992	1993	1994	1995	Average annual growth
Livestock	1 407.5	1 471.5	1 539.4	1 614.9	4.6
Carabao	108.6	108.3	108.6	103.9	1.4
Cattle	166.9	181.7	195.5	213.0	8.4
Hog	1 056.9	1 101.5	1 152.6	1 213.1	4.7
Goat	59.6	65.5	68.5	70.7	5.9
Dairy	15.4	14.3	13.9	14.0	3.0
Poultry	908.3	961.7	991.0	1 042.8	4.7
Meat	690.9	720.3	753.4	795.1	4.7
Chicken	651.9	678.7	709.4	747.8	4.6
Duck	30.0	41.6	44.0	47.3	6.6
Eggs	217.2	241.3	237.5	247.5	4.5
Chicken	180.5	202.1	196.0	199.9	3.6
Duck	36.7	39.2	41.5	47.6	9.9

Source: Bureau of Agricultural Statistics (BAS), 1996 as cited by Nazareno and Cruz, 1996.

Table 4. Value of Animal Product, 1992-1995, in the Philippines, (US$ Million).

Item	Year 1992	1993	1994	1995
Livestock	1 986.1	1 968.8	2 223.7	2 566.2
Carabao	117.1	121.8	142.2	123.2
Cattle	237.0	253.3	149.1	330.3
Hog	1 555.7	1 506.1	1 842.9	2 013.9
Goat	72.5	83.9	85.8	94.9
Dairy	3.7	3.5	3.5	3.9
Poultry	1 712.2	1 772.8	1 946.7	1 863.5
Meat	1 365.3	1 397.2	1 487.7	1 390.4
Chicken	1 290.3	1 320.0	1 487.7	1 390.4
Duck	75.0	77.2	81.8	91.2
Eggs	346.8	375.4	377.0	381.6
Chicken	298.5	321.9	320.3	311.8
Duck	48.3	53.5	56.7	69.8
Total	3 698.4	3 741.7	4 170.5	4 429.7

Source of base data: Bureau of Agricultural Statistics (BAS), 1996.
US $ = Phil peso 26.3 as cited by Nazareno and Cruz, 1996.

Many of the private commercial farms from where the bulk of the local milk production were derived have either shut down operation or decided to trim down their herd size.

5. Importation

Breeder stocks requirements of the poultry and swine industries are generally augmented through importation from US and European sources. Magnitude of importation of breeding stocks of cattle and buffalo during 1994 and 1995 was initiated by the government and represent genetically superior stocks (Table 5).

Table 5. Importation of breeder stocks, 1992-1995, in the Philippines.

Species	1992	1993	1994	1995
Poultry	1 024 535	1 295 952	982 006	2 037 117
Swine	1 746	5 016	6 340	2 452
Cattle	4 000	3 340	2 104	2 568
Buffalo	-	-	690	398
Goat	-	40	-	-

Source : Foreign Trade Statistics, Bureau of Animal Industry; DA; Philippine Carabao Center, DA as cited by Nazareno and Cruz, 1996.

Table 6. Importation of feeder stocks, frozen bovine meat and processed meat products, 1991-1995, in the Philippines.

Year	Feeder stock (hd)	Bovine meat (Metric tons)	Bovine meat Value FOB US$'000	Processed meat (Metric tons)
1991	12 674	11 000	19 000	94.2
1992	33 362	14 395	23 433	206.2
1993	74 672	17 895	28 920	1 848.2
1994	109 486	36 968	46 998	3 483.9
1995	188 348	44 189	57 322	2 853.3
1996	49 967*			

* Partial data, Jan. - June only.
Source: Department of Agriculture, 1996; National Statistics Office (NSO) as cited by Nazareno and Cruz, 1996.

In general terms, the local animal industry's level of production is not adequate to meet the local requirements. For this reason, the Philippines continues to be a net importer of animal and animal products. While the swine and poultry subsectors are at a level to be able to meet the current local demands, there remains a gap between the domestic requirements and the local supply from beef cattle and carabaos sectors. These deficiencies are largely met by importation of live feeder stocks, beef and processed meat products (Table 6).

One major contribution to the supply of beef is buffalo meat, the importation of which has seen remarkable increases in 1994 and on. The volume and value of the various importations are shown in table 6 and such has an impact on the local meat processing industry, an agro-industry sector that grew from merely 26 processors to 64 in 1995. It has, to some extent, lessened the pressure on the local buffalo population from where buffalo meat, widely used in processing owing to its inherent properties and reasonable price, are derived.

The local dairy industry, on the other hand, can only produce less than one percent of the local requirements. Therefore, 99% are met by importation of milk and dairy products (Table 7), mostly coming from Australia, New Zealand and Europe.

Table 7. Local milk production, milk importation and total milk supply, 1990-1995, in the Philippines.

Year	Local Production (M Kg)	Importation (Liquid Milk Equivalent) LME		Total Milk Supply (M Kg) LME
		Volume (M Kg)	Value (US$)	
1990	19.1	1 650.3	266.5	1 669.4
1991	18.9	1 566.8	221.6	1 585.7
1992	15.4	1 625.0	264.7	1 640.4
1993	14.3	1 598.3	270.8	1 612.7
1994	13.9	1 893.5	330.0	1 907.4
1995	14.0	2 197.0	438.0	2 211.0

Source : National Dairy Authority, 1996 as cited by Nazareno and Cruz, 1996.

6. Philippine animal recording

Animal recording and keeping it in proper order is an important component in management. This aspect of management should be over-emphasized as generally Filipino farmer finds it difficult to keep his records religiously. The animal recording process in our country has been done primarily by government agencies/farms, research centers and institutions/universities. However, utilization in most of these recorded data have not been properly recognized and evaluated.

Recording may varied in many forms. However, under Philippine farmers setting having one or two head of animals, if in case he is doing recording, one simple way that he sometimes sorted to record important data and or events that need to attend to is to jot down information in calendars. Still another would be to keep simple diary. The advantages of these methods is simplicity. Their main disadvantage stem from the fact that they would be incomplete and may easily get lost. But generally, under smallholder level of production, no if not few animal recording is being done.

One may argue that if an enterprise is small and or if animal is less there is no need of written records. Transactions are few and infrequent and or in the other way a farmer is familiar with the one or two head of his animals, easier for him to remember and can be committed to memory. The disadvantages however outweight the advantages. Memory recall is never accurate. This case practically happens in smallhold farmers.

In an organized commercial farms proper recording is always practiced. An objective recording system is adopted suited to their production schemes. Recently, they are now diverted to use computerized programs as part of their record keeping system and for easy analysis of data.

7. Standardized recording system of Philippine Carabao Center

7.1 Records and recording system

Animal performance are properly recorded and analyzed to accurately ascertain the genetic worth of buffaloes, whether of swamp or riverine type. Minimum data to be collected are as follows:

A. Bulls

1) Institution
   - monthly body weight and structural traits (HG, BL, WHT);
   - semen characteristics;
   - semen production (Frozen Semen & Extended Liquid Semen) and disposal.

2) Outside of the center
   - conception rate;
   - calf drop/crop.

A minimum of 25 progenies per bull is required to assess his potential forgrowth and milk.

B. Heifer/Cows

- body weights;
- estrus variables;
- breeding data i.e. breeding date, bull’s genotype, rebreeding date;
- parturition date/calf drop/crop.

C. Progenies

- birth weight and monthly body weight and structural traits (institutional herd) up to 24 months of age;
- birth weight and quarterly weights (village born offsprings) for 24 months.

D. Dams

- daily milk yield;
- weekly milk fat and monthly analysis thereafter;
- lactation length.

E. Other Data for Consideration

- herd health program;
- animal disposal;
- etc.

7.2 Animal identification of the Philippine Carabao Center

The most common methods of identification are hide brands, ear marks and tattoos. Our law requires animals like cattle and carabaos to be branded. Aside from the three methods, some animal husbandry men use eartags and horn brands.

An identification schemes implemented in each agencies were designed. At Philippine Carabao Centers alone, at least two identification of ear tags and or ear notch and skin/horn branding. Minimum information included in this scheme were: date and year of birth, genotype, location of the center where this animal belongs, and sex of the progeny.

8. Constraints to animal recording

Despite the advantage that animal recording might contribute to livestock improvement, it has not received much attention from farmers, researchers and extension workers. The implications are obvious. Lack of knowledge and awareness about the importance of records, organizational problems, inadequate budget for operation are the constraints to animal recording.

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Livestock Production Situation in Vietnam and Development Orientation

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1. Present conditions

Vietnam has long been known as an agricultural country. Recently its population which is more than 76 millions, about 80 percent is living in the rural area and their living depends on agriculture production. Livestock is closely integrated with crops production; it has an important role in the overall agriculture production system and plays various functions, namely:

- Significant contribution to the agricultural GDP (about 27%)
- Employment of about half of the rural population
- Important role in integrated crops production
- Improvement of the annual income of farmers.

Traditionally, Vietnamese farmers are agricultural producers, cattle and buffaloes being kept as a source of power for farm work. Cattle and buffaloes utilize agricultural by-products and provide remunerative employment.

A similar situation is found in neighbouring Asian countries. The country can be divided into seven agro-ecological zones, each with different economic potential and environmental condition, i.e.:

Ecological Zone	Area (%)	Human Population (%)
1) The Northern Mountains and Uplands	32.0	17.4
2) Red River Delta	3.6	19.4
3) North Central Coast	15.4	13.9
4) South Central Coast	13.5	10.4
5) Highland	16.5	4.6
6) North East of Southland	7.0	12.5
7) Mekong River Delta	12.0	21.8
Total Vietnam	100.0	100.0

In 1995 the total area of agricultural land was about 7.3 million hectares. Of this approximately 4.2 million hectares were for rice production. There were about 0.3 million hectares for grass production and almost 0.3 million hectares for surface water acquaculture.

The forest area comprises some 9.6 million hectares, of which 8.8 million hectares were natural forest and almost 0.8 million hectares forest plantation.

Uncropped land resources amounted to about 14.2 million hectares. This included some 9 million hectares of upper land and rangeland, the remainder being grassland used for grazing ruminants.

Basic grain production has increased rapidly during the last five years. In 1995 grain production was 27 million tons of rice equivalent. This comprised some 24 million tons of rice. In 1995 about 2 million tons of rice were exported and the average grain production per capita was 365 kg.

In 1994 the agricultural production output value was about 35.4% of GDP, industrial production represented 26.6% and trade and services 38% of GDP respectively. In 1995 livestock production as a proportion of agricultural output value amounted to some 25% of the total.

2. Livestock production situation

The changes in livestock populations from 1990 to 1995 are shown in table 1.

The average annual increase rate of the individual populations species from 1990 to 1995 has been as follows:

Species	Annual increase %
Pigs	4.96
Cattle	2.84
Buffaloes	0.73
Chicken	5.15
Ducks	5.25
Goats	6.47
Dairy Cows	8.23

Table 1. Livestock populations statistics 1990-1995 ('000 heads).

Year	Buffalo	Cattle		Pig	Chicken	Duck	Goat
		Total	Dairy				
1990	2 854.1	3 120.8	11.0	12 260.5	80 184.0	23 636.4	372.3
1991	2 855.6	3 151.0	12.1	12 183.2	80 578.2	24 680.5	312.4
1192	2 883.4	3 193.8	13.1	13 881.7	89 704.9	28 170.7	312.3
1993	2 960.8	3 353.0	15.0	14 873.9	95 081.2	31 312.3	353.2
1994	2 971.1	3 466.7	16.5	15 569.4	99 627.1	23 041.2	427.8
1995	2 963.1	3 638.7	18.7	16 307.4	107 958.4	32 045.6	550.5

The most significant rates of population increase for most species have been achieved between 1993 and 1995, the period in which basic grain production advanced to yield a significant surplus above human food requirements in the country.

3. Livestock production statistics

Livestock production statistics in terms of animal live weight for the years 1990 to 1995 are shown in Table 2. The main livestock product is meat, of which 73.5% is produced by pigs, 15.0% by cattle and buffaloes and 11.5% by poultry.

Table 2. Livestock production in terms of live weight (1,000 tons) 1990-1995.

		Live weight (1,000 tons) in which							
		Pork		Poultry meat		Beef		Eggs	Milk
Year	Total	Total	%	Total	%	Total	%	(1,000)	(Tons)
1990	1 007.9	729.0	72.3	167.8	16.6	111.9	11.1	1 869 400	9 300
1991	1 015.2	715.5	70.4	146.3	14.4	123.4	12.1	2 016 960	9 352
1992	1 078.8	797.1	73.8	154.4	14.3	127.3	11.8	2 269 086	13 043
1993	1 171.5	878.3	75.0	169.8	14.5	123.2	10.5	2 346 940	15 073
1994	1 235.9	937.7	75.8	186.4	15.0	111.8	9.0	2 672 108	16 234
1995	1 322.1	1 006.9	76.1	197.1	15.0	118.0	8.9	2 825 025	20 925

The average annual rates of livestock production increase for 1990-1995 were as follows:

Pork production	7.26%
Poultry meat production	3.48%
Beef production	1.10%
Egg production	10.00%
Milk production	25.00%

Livestock production per capita per year.
The per capita availability of livestock products in 1995 is summarized hereafter:

	kg	%
Average per capita production of		
Animal live weight	17.75	100
of which:		
Pigs	13.51	76
Poultry	2.64	15
Cattle and buffaloes	1.58	9
Average egg consumption per capita	38 eggs	
Average milk production per capita	280 ml	

In Vietnam, the consumption of livestock products per capita is still very low.

4. Cattle production

The local cattle population has traditionally been maintained to provide draft power for agriculture therefore, the productivity in terms of meat is relatively low. The herd structure in many areas includes thirty to forty five percent of draft male animals and female cattle are also used as a source of draft power. With tractor mechanization the demand for draft power has started to change, so that changes in herd structure and productivity can be expected as mechanization proceeds. Current annual beef production is estimated at 118 000 tons (including buffalo meat) and annual commercial milk production at 27 000 tons.

4. 1. Natural distribution of cattle population

The distribution of the cattle population is given in table 3.

Table 3. Distribution of the cattle population in Vietnam

Ecological zone	Cattle population %
Northern Vietnam	
North Mountains and Upperland	18.7
Red River Delta	8.7
North Central Coast	22.5
Southern Vietnam	
South Central Coast	23.0
Highland	10.7
North East of Southern land	11.9
Mekong River Delta	4.5
Total Vietnam	**100.0**

Some 45.5% of the cattle population is concentrated in the Central Coast Provinces. These areas have traditionally provided replacement of draft animals to the Mekong and Red River Delta areas. About 54.5% of the cattle population is distributed among the other five ecological zones where cattle provide a major source of draft power. The Highland zone, despite its large grazing areas suited to ruminant production, has only 10.7% of the cattle population.

4.2. Structure of cattle breeds

Eighty five percent of the cattle population are local Yellow cattle. The breed is characterized by a small body size with mature males weighing from 230 to 250 kg and females 180 to 200 kg. The dwarf breeds also show a low slaughter performance, when measured on conventional basis, so that the total carcasses may be only 40 to 44.2% of live weight.

Zebu and crossbred zebu cattle represent some 14.5% of cattle population, mainly crosses of Red Sandhi with local Yellow cattle.

About 0.5% of the cattle population are dairy animals mainly crossbred animals of the Holstein/ Friesian type.

The current livestock extension sub-component of the Agricultural Rehabilitation Project, supported by World Bank funding (Credit VN 2561), assists in livestock crossbreeding through artificial insemination and natural service in 23 project provinces throughout Vietnam. The project funding totals $ 7.7 million US (World Bank) and $ 2.3 million US (Vietnam Government). National and provincial artificial insemination courses are funded to train eight hundred field extensionists in AI technique and to transmit priority extension messages on improved animal health, animal nutrition and management. The programme includes supplying of inputs to establish an efficient and effective livestock extension service to assist farmers in raising productivity and profitability of cattle production.

4.2.1. Productivity of the dairy cattle population

Two major Government farms in Moc Chau and Lam Dong imported Holstein/Friesian cattle from about 1970 onwards. These animals produce an average yield of 3 000 to 3 500 litres in a 305 day lactation.

Crossbred dairy animals between local improved Red Sindhi/Local Yellow cattle and Holstein/Friesian are reared by individual farmers. Their first and second generation crosses (F_1 and F_2) produce milk yields of 2 500 litres in a 300-day lactation. These types of dairy animals are mostly found in the peri-urban areas of Hanoi, Ho Chi Minh City and North East of Southern land.

Lai Sind crossbred dairy cattle are found in the suburban areas of Hanoi and Ho Chi Minh City with average milk yields of 1 500 to 1 600 litres per lactation.

4.3. The structure and size of cattle herds

Some forty five per cent of the cattle herd provide draft power in the smallholder agricultural sector. Most cattle are kept by smallholders who have only one or two animals. Animals are traditionally housed at the farm. In cultivated areas they are grazed on field boundaries and on river bank retention funds. Locally cut grass is also carried to feed stock on the small holding. Weed grass and forage by-products stovers are used from field crops and these include maize together with rice straw. There is some cultivation of forage grass, such as mapier. *(Pennisetum purpureum)*, which is cut and carried to stock. In the Central Coast and Highland areas some leading farmers keep from 50 to 100 cattle in larger herds which are grazed on rangeland areas. Dairy farms normally keep a small number of cows, (usually less than ten animals), though there are a few larger holdings with 50 to 100 cows in the region of Ho Chi Minh City.

4.4. Cattle nutrition and feeding system

Semi-intensive feeding system is only applied to dairy cattle and extensive feeding system is most common in traditional cattle production. Total pasture land in Vietnam is only about 3 200 00 ha. Pasture production is frequently limited by prevailing conditions such as poor soil quality, steep sloping land, inadequate rainfall or lack of irrigation. Main feed sources in most cattle systems are agricultural by-products. The lack of forage during the dry season is a common problem. In the northern provinces, during the winter months, poor forage growth due to cool temperatures combined with dry weather leads to forage scarcity. Rice straw is the most common forage reserve for these times of shortage.

4.5. Infrastructure facilities for cattle husbandry and cattle breeding

Artificial insemination and breeding services include the following facilities: Bavi Frozen Semen Centre, in the Hatay Province; national cattle breeding stations, and provincial breeding centres.

The provincial A.I. and district A.I. stations include: the cattle breeding farms; the Red Sindhi breeding farm; Brahman, Sahiwal breeding farm, and Zebu crossbreeding farm (Bavi)

In general, poor infrastructure and insufficiency of public and private investments are also constrains to livestock and cattle production in Vietnam.

5. Buffalo production

The buffalo population is about 2.9 million and the distribution of buffaloes is shown in table 4.

Table 4. Distribution of the buffalo population in Vietnam

Ecological Zone	Cattle population%
Northern Vietnam	
North Mountains and Upperlands	51.80
Red River delta	8.60
North Central Coast	22.00
Southern Vietnam	
South Central Coast	4.60
Highland	1.58
North East of Southern land	6.38
Mekong River Delta	4.96
Total Vietnam	100.00

More than 50 percent of the buffalo population is located in the Northern Mountains and Upperland. The local swamp buffalo are mainly used for draft purposes and for breeding. Traditional buffaloes feeding in Vietnam depends mainly on grazing and on agricultural by-products. Dry rice straw is the most common forage reserve for ruminants all through the year.

6. Livestock feed resource

Table 5 shows the planted areas, productivity and yields of some feed grains and feed crops.

The estimates of maize production and utilization in 1995 were as follows:

		% of total
Total soya bean production	127600 tons	100.0
Of which:	18000 tons for seed	14.2
	90000 tons for human consumption	70.5
	10000 tons for export	7.8
	9600 tons for animal feed	7.5

Corn crop prices fluctuate between harvest and other times of the year due to the lack of adequate processing and storage facilities to keep the crop. This results in depressed prices at harvest time and so stimulates export. Table 6 shows the planted areas, productivity and yield of peanut and sorghum.

The estimates of soya bean production and utilization in 1995 were as follows:

		% of total
Total soya bean production	127600 tons	100.0
Of which:	18000 tons for seed	14.2
	90000 tons for human consumption	70.5
	10000 tons for export	7.8
	9600 tons for animal feed	7.5

Soya beans in Vietnam are mainly used to produce curd, soya milk and soya sauces for human consumption. Productivity of the soya bean crop is still quite low.

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Table 7 shows the estimated total utilization of animal feed for livestock production in 1995.

Table 5. Planted areas, productivity and yields of maize, sweet potato and cassava during the year 1990-1995.

Year	Maize			Sweet potato			Cassava		
	Area 1 000 ha.	Prod. 100 kg/ha.	Yield 1 000 tons	Area 1 000 ha.	Prod. 100kg/ ha.	Yield 1,000 tons.	Area 1,000 ha.	Prod. 100 kg/ha.	Yield 1 000 tons
1990	431.8	15.5	671.0	321.1	60.1	1 929.0	256.8	88.60	2 275.8
1991	447.6	15.0	672.0	356.1	60.0	2 137.3	273.2	89.8	2 454.9
1992	478.0	15.6	747.9	404.9	64.0	2 593.0	283.3	90.4	2 567.9
1993	496.5	17.7	882.2	387.1	62.1	2 404.8	278.0	88.1	2 450.0
1994	535.3	18.6	1001.0	343.7	61.8	2 125.7	279.4	86.9	2 430.0
1995	550.1	19.5	1200.0	385.7	62.0	2 350.7	281.2	87.0	2 496.5

Table. 6 Planted areas, productivity and yields of soya beans and peanuts 1990-1995.

	Soya Beans			Peanuts		
Year	Area 1,000 ha.	Production 100 kg/ha.	Yield 1,000 tons	Area 1,000 ha.	Production 100 kg/ha.	Yield 1,000 tons
1990	110.0	7.9	86.6	201.4	10.6	213.1
1991	101.1	7.9	80.0	210.9	11.1	234.8
1992	97.3	8.2	80.0	217.3	10.4	226.7
1993	120.1	8.7	105.7	217.2	11.9	259.3
1994	131.9	9.4	124.2	246.6	12.1	300.6
1995	133.0	9.6	127.6	247.0	12.5	308.2

Table 7. Estimated Animal Feed use for Livestock Production in 1995.

Animal Type	Feed production 1 000 tons	Average feed conversion/kg bodyweight gain	Feed used for livestock production 1 000 tons
Pigs	1 006.918	5.0	5 034 590
Poultry	197.0	3.0	591.0
Beef Cattle			60.0
Dairy Cattle	20.0	0.5 per kg milk	10.0
Total			5 695 590

Table 8. Estimated production and utilization of commercial mixed concentrate feeds in 1995.

Production	Total animal feed (1 000 tones)
State enterprises and individual organizations in Vietnam	200.0
Joint Venture or 100% investment from overseas	450.0
Small private producers	300.0
Mix at farms	150.0
Total	1100.0

Animal feed sources for livestock and poultry production in Vietnam include the use of the following main ingredients: rice bran, broken rice, cassava, sweet potato, maize, groundnut and soya beans and soya cakes.

Table 8 shows the estimated production of commercial animal feeds used for livestock production in 1995.

The ratio between commercial concentrate mixed feeds to total animal feed use is 19.7%. In developed countries with intensive livestock industries the ratio could be as high as 70%.

Table 9 provides details of the value of exported animal products.

Table 9. Animal product export values 1988-1991 and estimates 1992-1995.

Animal products	Value of exported animal products (1 000 000.0 US$)				
	1988	1989	1990	1991	Estimate 1992-1995
Combined totals	4.5	9.0	16.0	25.0	10-15

- The value of animal products exported annually is still low.
- There are more than 20 organizations, many operated by provincial governments, for animal product processing with a total production of about 60 000 to 80 000 tons per year mainly of frozen products.
- Many of the organizations are not operating and this is a major financial constraint on provincial economics.

7. Evaluation of livestock production in Vietnam

In the five years 1990-1995, animal production in Vietnam increased rapidly to produce more meat, eggs and milk. This has met the demand for local consumption and provided a great social benefit.

However, animal productivity is still low and the quality of animal products is poor. In pork, for instance, there is an insufficient proportion of lean meat and too much fat. Average per capita meat production is still low.

Basic technical equipment and infrastructure for animal production and animal health are still limited and investment is dispersed. A government decree (or law) on animal health, animal breeds management and animal feed management has been issued, but there is still no quality control system to administer these aspects.

Animal product processing facilities are limited in number, sometimes not well equipped and processing technology is often poor.

Animal production is changing from subsistence to commercial systems, but it faces problems in marketing and trading of the production. Local demand is still low and fluctuates. Export demand is constrained by price and quality problems, which limit access to market. Some 90% of dairy products and 80% of high quality beef for the tourist market are imported.

Limited research capacity and extension service facilities are a constraint to the transfer of new technology to farmers.

The Vietnam Government invites and strongly welcomes all organizations and individuals either national or from overseas to invest or participate in joint ventures for animal production. However, the number of such investments is still small.

8. The orientation of livestock production development from 1996 - 2000

Objectives

- To develop all forms of animal production, but concentrate on animals that meet local and export demand. More attention to pig, poultry, beef and dairy production is required . Other animal species , such as buffalo, goat rabbit and bees are likely to develop according to the resources available in the different ecological regions and to the requirements of the market.
- To expand animal husbandry by using extensive feeding systems to improve animal productivity and quality so as to get more commercial products. At the same time improve the exploitation of traditional feeding systems in rural areas.
- Improve the investments in basic infrastructure, techniques of animal breeding, feeding and in animal health. Simultaneously upgrade the processing industry and establish the requirements for the management of quality regulation on animal feeding, animal breeding, veterinary products and meat quality.
- To meet the demand for meat, eggs and milk in accordance with the requirements of the market.

Aims

To improve the average animal production per capita per year to achieve by the year 2000 the following availability:

• Carcass meat	18 kg (equivalent to 30 kg livestock)
• Eggs	62 - 70
• Milk	0.8 - 1 litre.

The main production parameters

Serial No.	Animal breeds	Index		Plan Objectives	
				1996	2000
1.	Pig population (head)	1 000 000	16.5	17.5	20.0
	- Slaughtered pigs (head)	1 000 000	13.6	14.0	16.8
	- Pig live weight prod.(tons)	1 000	10500	11800	16400
2.	Poultry population (head)	1 000 000	142.0	180.0	300.0
	- Chicken population (head)	1 000 000	109.0	140.0	200.0
	- Duck population (head)	1 000 000	33.0	40.0	60.0
	- Poultry meat (tons)	1 000	210.0	270.0	450.0
	- Poultry eggs	Billion	2.9	3.5	5.0
3.	Cattle & buffalo population	1 000 000	6.5	6.75	7.7
	- Buffalo population	1 000 000	2.9	3.0	3.3
	- Cattle population	1 000 000	3.6	3.75	4.4
	- Dairy cows	1 000	20	25	63
	Milk production (tons)	1 000	21	30	60
	Cattle live weight prod. (tons)	1 000	125	150	250
4.	Goat Production (head)	1 000	470	530	840
	- Dairy goat (head)	1 000	3.0	4.0	7.0
5.	Honey bee	Hives	200	250	500

Solutions

Nutrition is the key to increased animal productivity. In view of increased annual demand for animal products (meat, milk and eggs), there is an increasing need for large quantities of good animal feed. Feed ingredients production is still limited and this affects animal production. In the coming years importation of feed ingredients to meet the demand for development of livestock and poultry production will be essential.

- Encouragement for investments to build a fish meal plant to produce high quality fish meal are required.
- It will be necessary to import feed ingredients, especially corn and extracted soya bean meal, where local production cannot meet the demand.
- To encourage the investment on equipment and technology for animal feed processing, storage of ingredients and specialized transportation of animal feeds.
- To improve policy on tax, loan or credit for the production or importation of feed ingredients.
- To help dairy farmers to produce good quality grass varieties such as kingrass or legumes and make better use of crop residues such as molasses and urea, feed blocks and other feed stuffs.

9. Animal breeding program

There are many livestock and poultry breeds in Vietnam. Many of the exotic breeds are well adapted to agro-climatic conditions of the country. They have contributed substantially to increasing animal production, by three to four times in the last ten years. However, there are some limitations e.g.: the exotic breeds were imported some 15 - 20 years ago and, at that time, the feeding and management systems were still very poor.

In order to upgrade animal breeding programs in the next few years the Government is requested to invest funds for the importation of good quality breeding animals. Commercial organizations or individuals in Vietnam and overseas should be encouraged to import livestock and poultry breeds.

The investments on animal breeds and on establish breeding systems for pig and poultry production should be increased. As regards cattle and buffalo breeding systems, more attention should be paid to dairy breeding and high quality beef breeds.

9.1 Animal health

- A veterinary service network and a vaccination plan for the control of common animal diseases should be established.
- To improve animal health and reduce the mortality rate.

9.2 The proposed policy

- It should encourage organizations or individuals to develop animal production without limitation on the size of herds and the number of animals.
- The Government, as a matter of priority, should exempt from taxes and fees for five years, the organizations and individuals who establish an animal husbandry farm in the mountainous areas.
- The Government should offer credit grants and loans at a low rate of interest to farmers involved in animal production, namely:
- For pig and poultry production the interest rate should be 0.6% per month for a period of 6 months.
- For dairy production, farmers should be entitled to borrow money over a period of 60 months. During the first 36 months there should be no interest and for the last 24 months the rate should be 0.6% per month.
- For beef production, the duration of loan should be 36 months, there should be no interest during the first 24 months and the rate of 0.6% should apply during the last 12 months.
- To use one part of the slaughter tax in the commune for building the veterinary net work and organize disease security for farmer in order to help them to overcome the adverse situation (e.g. Animal losses due to diseases). To provide every commune with one technician with vaccine and drugs for disease prevention and control.
- As regards importing of milk powder, the Government should consider the following points:
- Imports of milk powder should only be permitted when the fresh milk produced by local farmers can be purchased by milk processing organizations at a suitable price, remunerative to local dairy farmers.
- To utilize the tax on imported milk powder to support dairy development e.g.: through dairy breeding programs and for local farmers to purchase dairy cattle.
- The Government should consider increasing investments in research activities on animal husbandry.
- To pay more attention and give more support to animal extension and to the transfer of new animal technologies to the farmers in the villages and communes.

There is a need to encourage organizations or individuals, from Vietnam or from overseas, to invest in animal production, feed ingredient processing and animal product processing. There are, in particular, needs for investments in ruminants production (dairy production and beef); pig breeding (hybrid pigs from GGP, GP and PS stock); and in breeding hybrid poultry birds.

Other encouragements to the farmer could include low interest loans or credit for dairy cattle breeding, sow breeding, pork production, beef production and apiculture and on exempting animal breeders from taxes

9.3 Extension network and extension services

The expansion of extension which can deliver messages to apply new production technologies profitably can help the farmer to increase farm income.

9.4 Animal recording experiences in Vietnam

In Vietnam more than 80% of the population is in the agriculture production sector, smallholders livestock production plays an important role in their income but animal recording implementation in small farms is limited. However, we have some animal recording systems which are described hereafter.

10. State annual animal recording (on 1st October)

The statics data on animal production will be reported every year on 1st October by the villages, districts and provinces to State level. They cover the following parameters.

Animal population

- Cattle Population: local cattle population; crossbred cattle population, and dairy cattle population
- Buffalo population: Swamp Buffalo population; Revine Buffalo population, and Crossbred Buffalo population
- Small ruminant animals population: Goats, Sheep
- Local small ruminant animals population: crossbred small ruminant animals population and Dairy Small ruminant animals population.

Animal production (Meat)

- Total live weight of cattle.
- Total live weight of buffalo.
- Total live weight of small ruminant.
- Total milk production.

Off-take rate

This recording system is very well organized and is working perfectly under the State regulations. All the personnel working for this system are employees and their monthly salary is paid by the state government or the local authorities.

10.1 Annual, monthly and daily animal recording data from state farms

All the state farms in Vietnam have the duty to produce breeding stock and to supply breeding services to the provincial breeding farms and to individual farmers. State dairy farms are mostly keeping Holstein Friesian cattle and other pure breeds. These farms carry out an annual, monthly and daily recording system including animal population, animal production parameters, animal breeding traits, animal reproductive parameters, off take rate.

The dairy record of state farms includes identity records, pedigree, production, reproduction, nutrition, body condition and health status of each individual cow.

All the state farms keep both herd records as well as individual record by means of computer programs. However, sometimes data analysis and feedback information are still facing difficulties due to insufficient of experience of personnel and to the lack of operating funds.

10.2 Animal recording in smallholder farmers

In Vietnam, the livestock extension project funded by the World Bank to improve cattle production has been implemented as from 1995. The objective of this project mainly focuses on enhancing farmers' income from cattle production by introducing an artificial breeding service on local cattle using, to this effect, the frozen semen of Zebu. At the same time, new feeding and management techniques were also demonstrated and transferred to the farmers.

The whole recording system has been implemented to record herd structure and other parameters of the farm as well as details in respect of inseminations carried out with the use of a project fund. In total, 27 provinces throughout the country, with over 300 000 farms, were covered by this project. The project was most welcome by all the farmers in the project area.

All the AI recording parameters have been collected and analysed at regular intervals. Achievements have been made in the fields of animal breeding, feeding and management techniques. Crossbreeding of cattle resulted in improving production and the total income of the farmers involved in this project.

10.3 Milk recording for leading farmers (Dairy production project /National dairy development project 1991-1995)

Within the framework of the dairy development project, animal recording was introduced to farmers who raise cattle and goats for dairy production, through organizing relevant training programmes.

Animal recording has been introduced to farmers who raise cattle and goats for dairy production under the dairy development project by organising the training programmes for farmers:

- Dairy production technique for smallholders
- Dairy farmers cross visits
- Demonstration on feeding and management of dairy animal
- Milk production management and recording
- External and internal control of parasites in dairy animals.
- Free training for farmers, free AI. service and free vaccination against common diseases.
- In this period with the help and under the guidance of the extension worker at village and district level recording sheets were available to the leading dairy farmers.

- Under this programme breeding and production parameters were recorded and kept on the farm and village level.
- Recording dairy production was going on well when the project was being implemented under government funds.

However, when the project came to an end there were some constraints to pursue the implementation of animal recording. The reasons for this are given hereafter:

- Farmers' awareness of the benefit which would derive from animal recording was still limited.
- Dairy development projects were few and their financing limited.
- Facilities for data collection and analyses were not sufficient.
- The feed back to farmers was limited.
- Labour at farm level was not sufficient.

11. Future plan

- In Vietnam, animal recording among smallholders is not well developed due to the fact that farmers and the leaders concerned still do not realise its importance also from the economic standpoint. So, first of all, this limitation must be overcome.
- A national recording system should be established with proper funding for operations and a positive feed back mechanism.
- Vietnam should apply the suitable animal recording methods for low and average production systems.

Dairy Cattle Development in China

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1. Introduction

Production Performance Testing System (PPTS) is the basis of dairy cattle improvement. At the present time, a complete PPTS has not been set up yet in China. Milk production is recorded by the workers and farmers themselves including weighing, sample collection and testing milk composition. The poor data reliability resulted in low selection efficiency and slowed down the rate of improvement. It is absolutely necessary to establish PPTS urgently and to work out a long term implementation policy.

2. Targets

The following targets have been set for the year 2000 and thereafter for the dairy herds involved in the Dairy Herd Improvement Programme for Chinese Holstein (DHIPCH):

- Production performance data should be accurate and equitable as a result of PPTS implementation.
- The present animal population involved in the program, i.e: 35 000 Holstein should be increased to 5 000 in five years.
- The bulls used must be progeny tested and have positive breeding values; they must have a registration certificate issued by the China Dairy Cattle Association and use a permission certificate issued by the Ministry of Agriculture in China.
- Ten superior bulls should be selected and milk production of the 50 000 cows involved in the program should be increased by 250 kg per cow within 5 years (1996-2000).

3. Dairy Herd Improvement Program (DHIP)

3.1 Milk production performance test

Equipment and Methods. All equipment and methods used in PPTS must meet the standards defined by the National Dairy Herd Improvement Committee (NDHIC) and equipment accuracy must be tested according to their quality standards. Any equipment that does not comply with the standards is not allowed to be used in the recording system.

Testing day and Testing Interval. Testing is carried out once every month and includes three or two times milking according to the practice of the dairy farms. Testing interval should be not more than 33 days or not less than 26 days. The first testing day must take place six days after calving.

Milk Man (person in charge of testing). The testing day is selected by the person in charge of testing. This person should not inform the farm of his/her arrival more than twelve hours before the testing is carried out. This person should not be the working staff of the farm and should not have any economic relationship with the farm.
Milk weighing and sample collection. Milk weighing, sample collection and recording for every animal must be conducted according to the stipulated procedure and by people holding the required training certificate.
Cooperation of the Dairy Farm. The members (or the dairy farms) of the NDHIC must support and coordinate the work of the people in charge of testing. Everywhere management practices must be the same and should be a constant practice . The milk man must send a special report if any particular behaviour is observed happening on the farm.
Cows to be tested. All milking cows of the NDHIC member have to be tested.
Abnormal record. When a cow is sick or injured, or in heat and its milk production is going down to a certain degree compared with that obtained on that of the day before the testing day, a special note must be made on the record. The abnormal record will be adjusted at the data processing centre of NDHIC.
Abortion, premature delivery, calving before drying off and lactation before calving. Normal calving includes at least 250 days pregnancy and excludes those with a lower duration, which must be recorded as abnormal. If abortion takes place in the middle of the lactation, when the number of pregnancy days is less than 152, the current lactating record can be continued. If calving happens before drying off, the new lactating record begins from calving day and previous record ends one day before new calving. If a cow produces milk before calving, that production should not be included in the new record.
Lost testing day record. If a testing day record is lost accidentally (e.g. a record of weighing or sample is lost), the reason must be noted and lost data should be estimated by special methods at the data processing centre (DPC).
Testing milk composition (Fat, protein). All samples must be tested in a laboratory recognized by NDHIC or in the laboratory of the local DHIC.
Processing of the testing day record. All testing day records including milk composition must be submitted to the data processing centre within one week. And the information should be returned to the farmer after processing and analysis.

3.1 Type classification

- Adopt the linear classification.
- Linear classification score and global figure must be included in the progeny test result of the bulls.
- On mature cows involved in DHIP information on linear classification must be available.

- The implementation of linear classification must be carried out in accordance with the Practice Scheme of Linear Classification for Chinese Holstein (PSLCCH).

3.3 Genetic evaluation of dairy cattle

- Genetic Evaluation is carried out by DPC appointed by the China Dairy Cattle Association.
- BLUP is used for breeding value evaluation of dairy cattle
- All data used must be standardized.

3.4 Progeny test for bulls

Progeny tests must be conducted strictly according to both the progeny test regulation for Chinese Holstein Bull and to the and Progeny Test Management Regulation for Chinese Breeding Holstein Bulls. The proven bull, after having been progeny tested should comply with the condition stipulated in the Breeding Animal Management Regulation issued by the State Council of the People's Republic of China. Frozen semen produced by these bulls can by used extensively only after receiving the Breeding Bull Certificate issued by the Provincial Animal Husbandry Department.

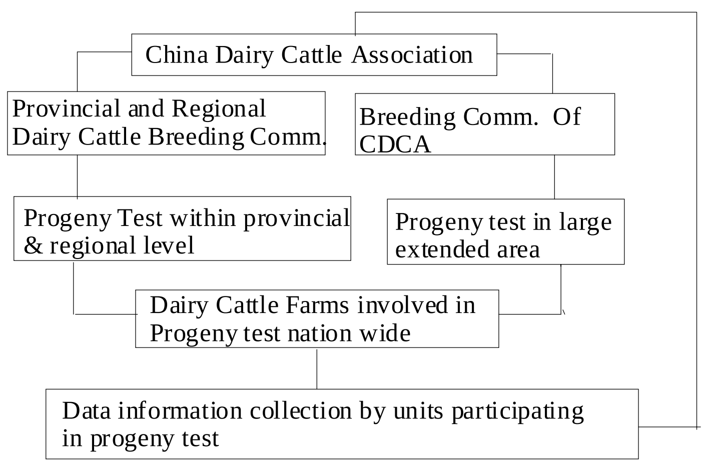
3.5 Breed registration

Breed registration should be carried out according to the Registration Method for Chinese Holstein issued by the Ministry of Agriculture. All animals which meet the standards of the breed are allowed to be registered.

3.6 Blood typing

Blood Typing (BT) is an important method to determine the parentage of an animal. The following animal, need to be blood typed
- The proven bull itself and its parents.
- Progeny born from embryo transfer both the and donor and the sire.

Figure 1. Progeny test regulation for Chinese Holstein bulls-Organisational structure.



3.7 Breeding system for Chinese Holstein

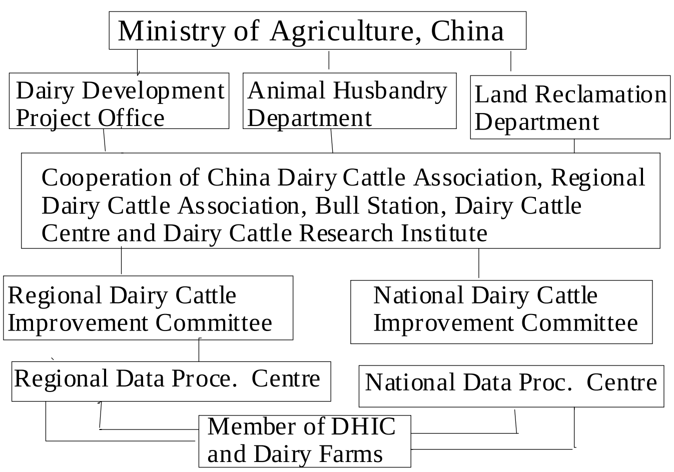
The main objectives of the breeding system are to complete breeding measures concerning selection and utilization of bulls with the aim of selectingtop quality bullsby progeny testing. Breeding efficiency is influenced by the main following factors, i.e. size of the population, size of the active breeding herds (AB-herds involved in progeny testing), percentage of tested females in active breeding herds, annual number of tested bulls, number of daughters of each tested bull, number of positive proven bulls versusu all participants in progeny testing, percentage of positive proven bulls among the sires.

The total Holstein cow population in China was 800 000 in 1995 but only 35 000 are in the ABH category. At the present time, only milk production and butter fat can be tested, protein will be included later on. The size of ABH. will be enlarged in the future. The following table shows the calculation of the different population.

Factors	Size of active breeding herd involved (population)		
	35 000	60 000	120 000
% tested female	40	40	35
Number of proven bulls/year	35	50	70
Number of daughters of each proven bull	80	96	120
Number of young bulls/year	70	110	155
% of positive proven bulls	50	50	50
Number of young bulls used as sires	4	4	4
% positive proven bulls of the sire	11.4	8.0	5.7
Generation interval (year)	4.92	4.92	5.70

3.8 Structure of dairy herd improvement program for Chinese Holstein

Figure 2. Structure of dairy herd improvement program for Chinese Holstein



- **Age**. Not more than 18 months, weight at birth : 38 kg, semen quality: qualification of National Standard for Bovine Frozen Semen.
- **Pedigree bulls** must have a clear pedigree for 3 generations.
- **Sire**. Name & registration number and progeny test information: imported animal or semen should have complete ID including registration number and Name of the country of origin, ear tag number. Country abbreviation: America-USA, Canada-CAN, Japan-JPN, German-DEU, Netherlands-NLD, Denmark-DNK. Daughter number, herds, daughter first lactation average production,fat %
- **Dam**. Number and milk production and fat % of total and of 305 day lactation. Qualification: at least 7 000 kg milk production for the first lactation at least 9 000 kg milk for the highest lactation, fat % at least 3.6% or fat kg at least 324 kg.

The following particulars of the progeny should be noted i.e. born from Embryo Transfer (ET), Red Factor Carrier (RF), Inbreeding Coefficient (F). Left and right side photo should be available.

AI statistics for progeny tested bulls should include, the name of the farm, quality of semen, identification of the artificially inseminated female, date and number of pregnancies, fertility note (%), other information as may be appropriate.

Statistics on sons and daughters of progeny tested bull: in addition to the name of the farm, the following information should be available on the status of the progeny, number of males and females, average birth weight of males and females, abnormal hair colour, namely difficulty in calving, genetic diseases, other information.

Daughters production performance of the progeny tested bull: the information should include: identification of daughters, identification of sires, date of birth, birth weight, weight at six months, weight at twelve months, date of calving, production during the whole laction: Kg of milk per day, fat %, protein % and Kg of milk over 305 days.

4. Registration rules

4.1 Preface

The registration of Chinese Holstein is actually the basis for ensuring the quality of the breed and of the breeding process.The record of information should be kept in an accurate and comprehensive manner. Initially, the pedigree provides basic information; subsequently as animals grow up, other information such as milk production, kilogrammes of fat, fat percentage of every lactation and type classification should be recorded.

4.2 Requirement and conditions for registration

- The parents of the animal must be registered.
- The Holstein blood proportion of the animal must be at least 87.5%.
- Imported animals must be registered.

4.3 Encouragement and rewards

The herds and breeders who meet the following conditions may receive an award from the Ministry of Agriculture and from the China Dairy Cattle Association (CDCA).

- The health condition of the herd must be good and should be evidentiated by a veterinary certificate.
- The performance tests must comply with the regulations.
- The average production of the herd should be higher than the provincial or regional level and all females should be registered animals.
- Average conformation score must reach at least 75 points.
- The farm must be a member of the Local Dairy Cattle Association and of the CDCA.
- The breeders must have made an outstanding contribution to registration activities.

4.4 Gold Medal Cow

- Milk production: total milk production of all lactation must amount to more than 50 000 kg, Annual average milk production should be at least 8 500 kg, butter fat percentage should be at least 3.6% or the quantity of butter fat should be more than 300 kg.
- The conformation score should account for more than 85 points.

4.5 Gold Medal Bull

Production performance should comply within following requirements:
- at least 20 daughters must have completed the first lactation;
- production performance test must be recognized by CDCA;
- daughters' average fat percentage should be at least 3.6% or average quantity of fat should be at least 310 kg;
- daughters' average milk production should be at least 8 000 kg.

Note: adult equivalent correction factor: Lactation Correction Factor

1^{st}	13 514
2^{nd}	11 765
3^{rd}	10 870
4^{th}	10 417
5^{th}	10 000

Conformation classification. At least 20 daughters should have been granted the Type Classification score in accordance with linear classification tests.

Body Score should reach the following standards:

Proportions in %	Body Score (Points)
>75%	76
50-75%	77
25-50%	78
< 25%	79

If the animals meet the above standards they can receive awards from the Ministry of Agriculture of China.

Contents of registration record. Initial information. Farm number and name, place of birth: province (region or city) county and name of the farm, Colour patern (left, right and head) or photo, sex, date of birth, year\month\date of application for registration, age at the time of application, blood typing, if twins (yes or no, if positive, indicate sex of the other twin), pedigree (3 generations, including blood typing of the parents and of maternal grand farther), if ET, if frozen or imported embryo, freezing date, transfer date, number of the recipients (farm or person) of the application: address, zip code, telephone.

Additional information on the animal to be added at a later date:
- Production performance of the cow including date of calving, lactation number, age at calving, actual number of days, days of milking, actual milk production and fat percentage, milk fat in production, kg and fat percentage in 305 days, conformation score (including date of classification), record for calves including sex, number and sire.
- Information on bulls must have progeny test results, first lactation performance of their daughters including year, number of daughters, actual average number of days of the milking periods, actual average milk production, average milk production in 305 days, average fat percentage, distribution of daughters (number of provinces and herds), average body score, ETAM, ETAF%, ETAT and body score of the bull.

4.7 Registration fee and price of registered animal

- Generally speaking, the price of registered animals should be 10 per cent higher than that of non-registered animals.
- Transactions of registered animal must go through the Local (Provincial, Regional or City) Dairy Cattle Association (LDCA) and a reasonable transaction fee should be paid.
- Registration fee

Registration fee should be paid to the Local Dairy Cattle Association including the cost of registration certificate according to the following scale: (RMB Yuan/head).

Age at application	Member of LDCA & CDCA	With registration for membership	Without registration for membership
3-6 months	5	7	10
18 months	17	20	22
more 18months	20	22	15

Note: 1 US$ = 8.3 RMB Yuan

Experiences in Dairy Recording with Smallholder Producers in the Ethiopian Highlands

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1. Introduction

Ethiopia is one of the developing countries whose economies are almost entirely dependent on agriculture. Crop and livestock production are generally the mainstay of the people.

Livestock plays a major role in the Ethiopian agriculture as a direct source of food (meat, milk, eggs and blood), as a raw material for leather and carpet industries, as crop production inputs (draft power, manjure) and contributes heavily to the country's export earnings. Its contributions to the agriculture GDP is about 35% (Jahnke 1982).

Although the country is endowed with a huge resource of livestock population, the contribution that this resource makes to the national income and export earnings is proportionally very low. This is mainly due to the low productivity of the cattle caused by poor husbandry, management practices, prevalence of diseases and malnutrition.

2. Livestock population and distribution

Given its diversified to prographic and climatic condition, the huge livestock population size and the different types of animals which have evolved over time and adopted to the ecological conditions of their habitat to some extent having been influenced by production systems of their owners make Ethiopia a center of diversity for animal genetic resources. Ethiopia's livestock population is the largest of any country in Africa: cattle,sheep and goats ranks first, second and third, respectively, in the continent. That is 15%, 12% and 7%, 43% of the cattle, sheep, goats and equines, respectively, are found in Ethiopia.

Although this is true in general terms, the actual size of the statistics available is inconsistent and does not provide information for future planning for development work. Today the data quoted are estimates, obtained from various sources and therefore lack consistency (Table 1).

Table 1. Estimate of Ethiopia's livestock population.

Livestock type	Population ('0000)					
	FAO 1995	CSA 1995	World Bank 1984	IBRD 1976	Rank in Africa	% share in Africa
Cattle	29 825	29 825	27 000	29 000	1st	15%
Sheep	21 700	11 615	24 000	6 400	2nd	12%
Goats	16 700	9 611	18 000	7 000	3rd	8%
Equine	8 580	3 938	-	-	-	44%
Camel	1 000	248	1 000	-	-	0.5%
Poultry	54 000	54 000	-	-	-	-

The distribution of livestock varies among different ecological zones of agricultural systems. In Ethiopia, livestock are important component in both the highland mixed farming system and lowland (pastoral) system of productions. About 79% of the cattle, 75% of the sheep flock, 30% of the goat population, and most of the equines and poultry are found in the highlands. In the lowland areas (pastoral zone) 12-15% of the human population, 70% of the goat population, 100% of the camel and 25% of the cattle are found. In the pastoral zone area lievestock are the basis of the economy providing virtually all the food and the very means of their existence.

3. Livestock production system and productivity

There are three major livestock production systems zones in Ethiopia, the crop-livestock mixed (highland) system, the pastoral (lowlands) system, and the perennial/livestock (humid) production system.

In the mixed cereal/livestock farming system farmers keep cattle for draft, meat and milk probably in the order of importance. Manure is an important by-product that is increasingly being used to substitute the fastly depleting fuelwood supply. In this production system sheep are perhaps the major source of meat supply. In the drier and semihumid pastoral areas cattle, including camel, are kept mainly for milk; goats increase both in number and importance as the major suppliers of meat and to a lesser extent of milk. In the more humid mixed perennial crop/livestock systems, livestock are more likely to be of much more importance in producing meat, milk and manure (for fertilization) than providing draft power. In this zone of the country (coffee, enset and chat growing area) hoe culture is the dominant form of cultivation.

Ethiopia's livestock productivity is very low compared to African standards (Table 2). Total herd offtake is estimated at 8% for cattle, and 26-28% for small ruminants. High mortality rate, estimated at 20%, occurs. Heifers do not reach maturity unitl 4 years of age, and they have long calving interval (24 months).

Table 2. Ethiopia's livestock productivity estimates for the year 1995.

	Ethiopia	Afria	% share of Ethiopia
1. Milk and milk by products			
Number of milking cows ('000)	-	-	-
Yield in kg/animal	209	450	46
Milk production ('000 MT)	738	15 779	4.7
Cheese (all kinds) ('000 MT)	4 600	509 964	0.9
Butter ('000 MT)	10 350	179 470	-
2. Meat Production			
a) Beef and veal production			
No. Slaughtered ('000)	2 200	260 894	0.8
Carcass wt. kg/animal	105	135	78
Total production	230	3445	6.7
b) Mutton and Lambs			
No. Slaughtered ('000)	7 912	70 674	11.2
Carcass wt. kg/animal	10	13	83.3
Total production ('000 MT)	78	945	8.3
c) Goat meat production			
No. Slaughtered ('000)	7 834	56 294	14
Carcasses wt. kg/animal	9	12	75
Total milk production ('000 MT)	62	662	9

4. Systems of milk production in Ethiopia

It has long been recognized that the Ethiopian highlands, which cover about 40% of the total land area of the country, possess a high potential for dairy development. Amare (1978) has identified three major agro-ecological zones: the high potential cereal/livestock zone; the low potential cereal /livestock zone, and the high potential horticulture/livestock zone. In all these zones cattle play a significant role as source of draft power, milk, meat and manure.

The major source of milk production in Ethiopia is the cow, although small quantities of milk are also obtained from goats and camels in some areas, particularly the pastoral areas.

Until recently four major milk production systems existed (MOA, 1984) namely: traditional smallholder, dairy cooperatives, state dairy farms and private small and medium-sized dairy farms around towns and cities. But based on the current economic policy of the country, state dairy farms are being changed to private onwership. Presently only the three production systems are functional.

The traditional sector predominates and produces over 97% of milk from indigenous cattle breeds. In this system the milk is produced mainly for the household requirements of the farming community, although in many cases it can be an important source of cash income when sold either fresh or as processed products like butter and cheese. The other three production systems are concentrated in the central highland plateaus, and milk and milk products in these systems are produced on a commercial basis. This commercial sector is now growing. The cattle used in this sector are purebred exotic breeds or their crosses with indigenous breeds, the most common being Friesian crossed with indigenous breeds (Abay *et al*. 1989).

The potential for increasing milk production in the country lies within these commercial production systems that are found in the central highland plateaus in which crossbred and purebred exotic dairy breeds can be used. This is because of the low productivity of the indigenous breeds, owing to their inherent low genetic potential for milk production and the poor traditional management systems that lead to inadequate nutrition, particularly during the dry season (IAR 1976, Abay *et al*. 1989).

5. Genetic improvement and dairy recording

In Ethiopia dairy development is mainly based on the use of purebreds (exotic) and crossbreds (*Bos Taurus* x *Bos indicus*) cattle. The purebred European dairy breed predominately used are the Friesian and Jersey in and around major urban centers. Under smallholder production system crossbreds (*Bos taurus* x *Bos indicus*) are mainly used. The conventional breed improvement scheme focuses on selection among the purebred and crossing between the indigenous and exotic breeds. The crossbred cattle are produced on big state farms using artificial insemination (AI), natural service or both.

6. Breed improvement programme

At the research and higher learning institutions the breeding programme are aimed at upgradingthe indigenous by crossing up to a 75% exotic blood level, or at 62.5%, or maintain at 50% level, or selection among the indigenous breeds. The regional extension service provides AI service to the smallholder periurban producers.

IAR, in its earlier breeding works, has evaluated three local breeds (Horro, Boran and Barka) for their dairy characteristics under improved management conditions. The results indicated that the milk yield of the indigenous breeds were very low for an economic level for a dairying activity (IAR 1976). Consequently, a cattle crossbreeding experiment was launched in 1974.

The overall objective of the study was to combine the high milk yield and good dairying trait of the exotic breeds with the tolerant and resistant characteristics to endemic diseases of the indigenous breeds, by means of which to find out what combination of these exotic and indigenous breeds would best be adopted to the various environmental and climatic conditions of the country (Wiener, 1972). In this study, production performance (birth weight monthly weight and milk yields), reproductive performance (age at first calving, number of services, calving interval), as well as health data are recorded for all the animals. The institute has further developed a comprehensive recording scheme to record the data on individual cows production, growth rate, reproduction and health performance.

7. The status of dairy recording in Ethiopia

Over the last three to four decades there has been interest to initiate and develop a national dairy recording scheme at smallholder production level. However, this has not materialized, so far for various reasons, the primary ones being lack of a central institution to coordinate efforts at a national level and lack of dairy breeding policy. This does not mean that there is no dairy recording system in the country. Some dairy records are available in the country, but are limited to research institutions, university dairy farms, state dairy farm and to very few private dairy farms. The format and contents of the records kept at these institutions are not uniform and variable to allow comparison in a meaningful way and the information contained is in most cases either incorrect or incomplete and often not up-to-date.

The Ministry of Agriculture in 1988 commissioned consultants from FINNIDA to study and recommend milk recording requirements of the National Artificial Insemination Centre (NAIC). However, the implementation of the recording scheme at the national level and the utilization of the data for future bull selection need further consideration.

At present only a minor fraction of the whole dairy cow population in the country is included in any kind of organized milk recording scheme in Ethiopia. In all state dairy farms, and a few private dairy farms the types of dairy breeds recorded are pure Friesians, Jersey, or graded Friesians, numbering less than <5000 heads; while at the higher learning and research institutions a few indigenous breeds and their crosses with Friesians and Jerseys are recorded. The animal breeds are identified by ear tags and in some cases by earnotches.

There is no national milk recording scheme in the country to date. The various institutions involved in dairy improvement schemes use different recording formats (Alemu, 1992).

8. Constraints to dairy recording Ethiopia

The Ethiopian dairy industry is lagging behind, because the industry did not get the necessary support in terms of policies and interventions to build it. Previous attmepts to develop standardized national dairy recording have failed due to the following reasons.

• Lack of responsible body for dairy research and development.

- Lack of national dairy breeding and development policy.
- Inadequate resources like finance, trained manpower, equipment and facilities for the analysis.
- Limited data processing facilities and weak feedback mechanism to farmers.
- Weak linkages between extension staff recording schemes and the farmer.
- High illiteracy rate most of the smallholder farmers do not read and write.

Therefore, the aspect of dairy improvement has not received sufficient recording attention in terms of institutional setting for proper implementation of dairy recording under smallholder production system.

The constraints to sustainable increase in cattle genetic improvement in terms of milk yield have been identified and can be classifed broadly into bio-technical, socio-economic and institutional factors. The biotechnical constraints include inadequate feed supplies, poor nutrition, unimproved genotypes, reproductive wastage, high morbidity and mortality rate. The socio-economic and institutional constraints are related to inadequate input arrangements, access to credit, poor marketing organization, poor infrastructure, absence of pricing policies, land tenure policies as well as inadequate health policies.

9. Smallholder dairy recording pilot project

Objectives: to develop, test and validate standardized dairy recording scheme for improved milk production in smallholder system.

Target group: commercially oriented 120 smallholder dairy producers at three sites in the highland of Ethiopia.

9.1 Project implementation

The project is coordinated by multi disciplinary team from 6 institutions. The major activities are:

- Develop standardized uniform dairy recording format.
- Recruit and train frontline extension staff about the importance of record keeping, characteristics of records, types of records and importance of feedback mechanisms.
- Train project farmers on importance of record keeping and how to fill out standardized format.
- Visit farmers regularly.
- Collect data.

9.2 Project coordination

The project is being coordinated by a project leader at the coordination office where the following tasks are done:

- Keeping data bank.
- Data collection.
- Entry of data.

• Processing and summarizing the data.
• Providing feedback to farmers.

9.3 Institutional linkages

• Workshop/seminars, field visits.
• Joint research programmes development on milk recording.
• Feedback summary preparation.

9.4 Expected output

• Frontline and extension staff are trained on importance of record keeping project.
• Farmers are sensitized, introduced to standardized dairy recording format.
• Strengthened and enhanced extention service and feedback to dairy farmers mechanism is in place.
• Dairy data from farmers available are for analysis.

10. Future programme

10.1 Need for national recording and improvement

In Ethiopia, with its growing human population, the food needs are rising. The country's population which is currently is estimated at about 55 million, is expected to reach 140 million by the year 2020. To meet at least the basic food requirement of the country, the animal agriculture (milk and meat) will have to grow at 4.3% per year.

10.2 Ethiopia's dairy research strategy

In Ethiopia smallholder milk producers are increasingly becoming important. To be self-sufficient in milk, the dairy production system dictates that appropriate provision be made for high yielding genotypes, improved standard of dairy management, efficient disease control, better health care, increased accessibility to credit and more renumerative marketing arrangements for milk and milk production. There is no doubt that such incentives will raise the performance of smallholder producer substantially. However, this will greatly depend on efficient recording, analysing the recorded data and feedback mechanism.

According to the Ethiopian Government policy the following commodities have been give high priority, and the research is being undertaken at federal and regional research centres.
• Dairy cattle.
• Beef cattle.
• Small ruminants (sheep and goats).
• Camel.
• Poultry.

Each commodity research will be undertaken by a multi-disciplinary team, and the programme will be coordinated by a commodity leader based at a commodity centre. The research will be undertaken at federal and regional research centres.

11. Recommendations

- In order for Ethiopia to utilize the recorded data for national genetic improvement, breeding programmes, training and policy purposes, there is a need for national data recording centre with regional and local recording centres working under it.
- Ethiopia should have an appropriate milk recording policy for the promotion and development of an efficient and sustainable dairy recording schemes.
- Dairy recording policy should focus on improvement of the feeding and management as well as the genetic improvement of the animal.
- Realistic, simple and standardized dairy recording format should be developed by all producers.
- Central data management systems should be in place to improve data analysis and feed back mechanism.

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Dairy Recording in Kenya

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1. Background information

1.1 Livestock production sector

Livestock production is an important sector in the economy of Kenya. The sector contributes to approximately 10% of the gross domestic product (GDP), over 30% of the farm-gate value of commodities produced in the agricultural sector, and employs over 50% of the agricultural labour force (Muthee, 1996). The sector is charged with the responsibility of ensuring that the country is self-sufficient in livestock products. Most Livestock production activities are undertaken in three agro-ecological zones; i.e. the humid and subhumid high potential areas where mixed farming is practised with dairying, pigs and poultry; the medium potential areas where beef cattle and small ruminants are reared, and the low potential areas where nomadic pastoralism is practised. The estimated total population of dairy cattle, sheep, goats, beef cattle are 3 075 200, 781 900, 10 070 700, 9 861 300, respectively (KARI/ODA report, 1996; MoALDM, 1994). The total annual milk yield, which includes production from cattle, goats and camels, is approximately 2.5 billion litres (MoALDM, 1994) of which 70% is produced by the dairy cattle.

1.2 The dairy industry in Kenya

Kenya has approximately 13 million head of cattle, of which about 3 million (MoALDM, 1994) are of dairy types: the exotic breeds and their crosses (indigenous x exotic). These cattle are kept under different production systems. The distribution of dairy cattle by provinces which, to some extent relates to the country's agro-ecological zones is given in Table 1. The farming systems range from subsistence agriculture and pastoralism to large and small scale commercial farming and ranching. The objectives of cattle husbandry also vary from traditional emphasis on numbers to high productivity per animal or unit of land and high income levels.

Most of the commercial dairy farms are located in the medium and high potential areas (sub-humid, humid and afro-alpine zones) which receive about 900 mm or more of rainfall annually. Due to the high increase in human population, most farms have been subdivided and it is now estimated that about 80% of the farms in these zones are small scale. On these farms, livestock competes with crops, both staple and cash for the limited land. Thus, the rapid population growth and expectation of a high living standard, both in terms of adequate food supply and high income level, require efficient utilization of the cattle resources. Currently, it is estimated that milk yield per cow per lactation is around 1 000-2 000 kg. (MoALDM, 1994; Owango *et al.*, 1996). However, milk yields as high as 6 000 kg or more per lactation have been reported from well managed farms (DRSK, pers. comm., 1996). The low levels of milk production in many smallholder farms is attributable largely to poor feeding and management of the herds. Improvement of these two factors is, therefore, fundamental to achieving sustainable increases in milk production. It would also facilitate correct assessment of the extent to which genetic potential is limiting in the herds.

Table 1. Grade cattle population by provinces ('000) (1990-93).

Province	1991	1992	1993	1994
Rift Valley	1 665.69	1 585.23	1 665.88	1 752.60
Western	114.54	112.48	101.32	105.30
Nyanza	131.25	138.15	150.12	144.95
Central	929.67	838.92	808.86	808.30
Eastern	281.15	292.59	273.58	311.80
Coast	31.18	33.35	45.54	68.44
N/Eastern	0.34	-	0.15	-
Nairobi	11.38	14.06	13.84	13.70
TOTAL	3 165.20	3 014.78	3 059.29	3 205.09

Source: Livestock Production Department Annual Reports

The Kenya Co-operative Creameries (KCC), which currently operates 11 large scale milk plants countrywide, is the major market outlet for milk from smallholder farms. There are also about 46 small scale milk plants which buy, pack and sell milk to local consumers. These have emerged recently following the liberization of the dairy industry in 1992.

2. Role of breeding societies related organizations

The breed societies/associations in Kenya were established mainly to safeguard the purity of their breeds, to conduct the herdbook and promote the general interest of the breeders . These societies have achieved their objectives through collecting and recording ancestry for all animals in the breed, and providing forums for breed promotion for members by holding field-days, demonstrations, conferences etc.

2.1 Breed societies/ associations

Several societies/associations exist in Kenya. These include: Friesian, Ayrshire, Guernsey, Jersey, Sahiwal and Boran. The Zebu cattle Breeders have no society though the genotype is predominant. All the breed societies maintain records of registered animals through the Kenya Stud Book Register. They also formulate rules for the Livestock registrations for their respective breeds. In essence the breed societies have, therefore, a major contribution to make in the development of commercial livestock breeding and production.

2.2 Related organizations

2.2.1 Kenya Stud Book (KSB)

The KSB was started in 1920 with the main objective of registering livestock and maintaining pedigree herd registers and a grading up scheme for all breeds of livestock. The registers are useful and are fundamental for commercial livestock breeding, improvement and production. The data are also referred to when selling, buying and exporting breeding stock.

2.2.2 Central Artificial Insemination (CAIS)

The CAIS was established in 1946 as a semen production and distribution unit. The station is pivotal to livestock improvement by availing to farmers disease free semen from top quality bulls. The station also supplies all the semen needed in the implementation of the Contract Mating Scheme (local recruitment of bulls) and Progeny Testing Scheme (genetic evaluation of A.I. bulls). There is great reliance of the CAIS on livestock registration data and dairy records while delivering livestock breeding services.

2.2.3 Kenya National Artificial Insemination Services (KNAIS)

The artificial insemination (A.I) services in Kenya were started in 1935 with the main objective of controlling breeding diseases and improving cattle through upgrading the local cattle with exotic. The KNAIS was established in 1966 and re-organized in 1969. The main functions of KNAIS include the administration of actual A.I. services with a livestock breeding function of organizing and controlling the use of semen for both Progeny Testing and Contract Mating Schemes. In essence an effective A.I. service is a pre-requisite to an efficient livestock breeding programme.

2.2.4 Livestock Recording Centre (LRC)

The LRC was set-up in 1974 as a joint venture between the Governments of Kenya and Germany. The centre operated a Livestock Breeding Project until 1982. The main activities of the centre are to plan and execute the Progeny Testing and Contract Mating Schemes; perform butter fat testing for milk samples from officially recorded cows; collate the milk production data, and estimate the breeding value for A.I. bulls.

3. Development of milk recording in Kenya

The history of milk recording in Kenya has been closely linked to the establishment of breeds' societies and the subsequent dairy herd development. The first official milk recording scheme was started voluntarily by commercial dairy farmers in East Africa in 1949 (Mosi, 1984). The scheme, which was then known as East Africa Milk Recording Service (EAMRS), covered the whole region though more active in Kenya. Its operations were confined to the large scale farms which dominated the dairy industry then. The main objective of the scheme was to generate data for herd improvement and management, research, training and planning.

The EAMRS faced serious operational problems in the post-independence period, leading to its collapse in 1970. However, in Kenya, a new scheme named Kenya Milk Records (KMR), was set up in the same year to provide milk recording service (Mosi, 1984). The KMR retained the original objectives of the EAMRS even though it was clear that commercial dairy farming was shifting rapidly from large scale to smallholder systems.

The recording system practised by the two schemes was one in which milk yields of individual cows were recorded daily on official milk sheets by farmers and then submitted to the central office weekly. Official recorders visited the farms at bi-monthly intervals in order to take milk samples for butterfat test and also check whether the recording rules were followed. The feedbacks to farmers from the two schemes were: lactation certificates for lactations of at least 180 days, herd and breed averages and butterfat test results.

In the 1980's, KMR experienced serious financial and management problems, leading to its dissolution in 1994. The present recording scheme, the Dairy Recording Service of Kenya (DRSK), was set up by livestock farmers as a substitute.The main objectives of the DRSK were was to revitalise the National Milk Recording Scheme through the provide an efficient milk recording service; it was anticipated that this would consequently increase the number of farmers and herds participating in milk recording. A major challenge to this new scheme is to adopt a more flexible recording system for the smallholder farms which now dominate the dairy industry.

4. Performance of the milk recording schemes

The EAMRS recorded about 500 cows in 16 herds during its initial operational year (1949/50). Its peak performance was in 1957 when about 7 907 cows in 192 farms were recorded. As shown in table 2, KMR achieved its peak performance in 1990 with 22 696 cows recorded in 292 herds (Njoroge, 1990; KMR, 1990). The current scheme (DRSK) had recorded about 10 492 cows in 120 herds by June, 1996 since its inception in 1994 (J. N. Mwangi pers. comm., 1996). Both the table and DRSK figures give simple averages of about 56-89 cows per herd, indicating that it is still more active in the medium and large scale farms than in the small scale farms.

Thus as demonstrated in table 2 recent achievements of the KMR include an annual recording of approximately 20 000 cows, about 300 herds composed of Friesians, Ayrshire, Guernseys, Jerseys, Sahiwals. The KMR also assisted in the establishment of regional testing laboratories which analyzed 10 000 milk samples and, also in the recruitment Artificial Insemination (A.I) bulls and in progeny testing of bulls.

Table 2. Performance of Kenya milk records (1980 - 1990).

Recording year	Total no. of cows recorded	No. of herds participating	Average no. of cows per herd
1980	9 778	153	64
1981	10 544	160	56
1982	12 368	188	77
1983	14 400	174	83
1984	15 840	177	89
1985	17 667	203	87
1986	19 742	224	88
1987	21 138	242	83
1988	21 746	271	80
1989	22 040	292	75
1990	22 696	292	75

Source: Kenya Milk Records, Annual Reports, 1980-1990

According to MOALDM (1994), about 45% (1.35 million) of the commercial dairy herd, estimated at around 3 million, are cows. Based on a mean calving interval of about 456 days or 15 months (Owango *et al.*, 1996), the average calving rate is around 80%. Thus, in a year about 1 080 600 cows should be in various stages of lactation and, therefore, recordable. Though less precise, these estimates show that the DRSK currently covers only 0.98% (less than 1%) of the country's dairy cows population. In certain developed dairying countries like Israel over 50% of the cows are covered by the recording scheme. Thus, the main task of DRSK is now to develop a suitable recording system to enable it expand its services easily to cover most of the 1.1 million recordable cows, the majority of which are with the small scale farmers.

5. Specific constraints to smallholder dairy recording

Several constraints limiting the operations of smallholder dairy recording were identified, prioritized by researchers, extensionists and farmers. These constraints are listed below in order of priority:

- Lack of awareness of the importance of records at farmer and extension level.
- Inadequate personnel.
- Inadequate operational funds.
- Inadequate data processing and analysis facilities.
- Poor communication infrastructure e.g. telephones.
- Inadequate transport for field work (recruitment and extension).
- Lack of proper identification methods of the animals.
- Inadequate information on feeding and management at the farm level.

- Inadequate labour at farm level - e.g. for feeding and recording.
- Inadequate market incentives for products and animals.
- Loss of records as a result of sale and transfers of farms and animals.
- High costs of recording.

6. Strategies towards improved dairy recording

It is apparent that despite the importance of recording on smallholder farms, little has been done to develop suitable recording systems that can generate objective data for use in herd breeding, improved nutrition and management to sustain increased milk production. In 1996, it was realized that solutions to some of the constraints listed could be realized through the conduct of research involving the farmer, the extensionist and the researcher. Thus a pilot research project on the "Development, Testing and Validation of a Standardized Dairy Recording Scheme for Improved Milk Production in Smallholder Systems in Kenya" is being implemented with the assistance of the Cattle Research Network of the International Livestock Research Institute (ILRI). The study is collaborative and involves four institutions thus the Kenya Agricultural Research Institute (KARI), the Ministry of Agriculture Livestock Development and Marketing, the Dairy Recording System of Kenya (DRSK) and the University of Nairobi (UoN). The short and long term objectives of this research project is to develop and test a simplified dairy recording system and to validate and transfer the technology to the smallholder dairy producers in Kenya and other countries in Eastern and Southern Africa.

The project is collecting data from 120 smallholder farmers within two Divisions located in the Rift Valley Province. The data being collected includes production,reproduction, growth characteristics, health care and herd management; feedbacks are routinely provided to the farmer on the same. Preliminary reports have indicated improved farmer perception towards the simplified recording format. It is hoped that the project will be extended in the second phase in which the validated recording format will be transferred to other smallholder farmers in different localities within Kenya.

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Case Study on Cattle Recording Systems in Egypt

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1. Introduction

In Egypt livestock production contributes about 30% of the total value of agricultural production. It contributes considerable share the food of animal protein, represents an important source of cash income to farmers, offers opportunities for employment and provides manure and draft power to crop production. Livestock and poultry numbers for Egypt in 1995 are summarized in table 1.

Annual rates of growth for livestock are 1.7%, 1.4%, 3.4% and 1.3% for buffalo cattle, sheep and goats respectively as reported by MALR in 1989.

The regional distribution of livestock in Egypt in 1995 is presented in table 2.

Mature cows and buffaloes represent 43% and 49% of the total cattle and buffaloes populations respectively. The higher percentage of mature buffaloes confirms the recognition by small farmers of the buffalo as the major dairy animal. About two thirds of domestic milk is produced by buffalo. Cattle and buffaloes produce about 99% of the total milk. They, also, produce 70% of the domestic red meat production. The balance is produced by sheep and goats with a very minor contribution from camels. Production and supply of livestock and poultry are shown in table 3.

Table1. Livestock and poultry populations.

	Number (million)
Cattle	3.2
Buffaloes	3.0
Sheep & Goats	7.3
Poultry	
Broilers[1]	211.0
Layers[1]	12.5
Traditional rural sector	82.0

Source : Animal Production Sector, Ministry of Agriculture, and Land Reclamation (MALR) 1996
[1]Commercial farms, the rural poultry sector is not included.

Table 2. Regional distribution of livestock in Egypt 1995.

Region	Cattle	Buffalo	Sheep & goat
West North, Coastal Governorates[1]	106	60	1 041
Welta (North Egypt) Governorates[2]	1 748	1 653	2 126
Sinai Governorat[3]	2	39	378
Upper Egypt Governorates (South of Cairo)[4]	1 370	1 266	3 808
Total	3 226	3 018	7 352

Source : Animal Production Sector, MALR, 1995.

[1]Alexandria, Matruh and E1 Noubaria

[2]Governorates (12) between the two main branches of the Nile, Cairo is included

[3]North Sinai and South Sinai.

[4]Governorates (11) along the Nile South of Cairo, in addition to New Valley Governorate as included.

Table 3. Recent (1995) and projected (2020) demand and local production of livestock and poultry products.

	Red meat		Milk & dairy products		Poultry meat		Egg	
	1995	2020	1995	2020	1995	2020	1995	2020
Demand	675	985	2 550	3	276	405	4 000	5 900
Local Production	425	653	2 400	740	276	405	4 000	5 900
Gap	250	332	150	3740	--	--	--	--
Self sufficient (%)	63	66	94	--	100	100	100	100
				100				

Source: Sharafeldin, M.A., 1993. Assumptions: Human population 60 million in 1995 & 88 in 2020, fixed per capita consumption of 11.25 kg red meat, 42.5 kg milk, 4.6 kg poultry meat and 67 eggs.

Table 4. Relative contribution of animal products to total value of animal production.

Commodity	% of total value
Red meat	44.5
Milk & dairy product	28.3
Wool	0.6
Honey	0.6
Manure	4.8
Poultry meat	16.4
Table eggs	4.8
Total	100

Source : Agricultural Economic Sector, MALR, 1994.

The relative contribution to the total values of animal production is given in table 4.

Over 90% of the cattle and buffalo populations are kept in small farms of 5<animals. Purebred cattle (only 4% of the female cattle population) are kept in large specialized dairy farms. Native cattle of exotic origin (Baladi) are relatively small animals and low milk producers. Milk production (Table 5) and body weight of buffaloes are higher. Buffalo milk is more in demand than cow's milk due to its white color, higher fat content and desired taste. Beef is produced mainly by cattle. Buffalo is the major veal producer. Some commercial feedlots use imported bulls for fattening.

2. The animal feed situation

The animal feed situation in Egypt (from 1989 to 1992) could be described as reported in table 6.

3. Animal protein in the Egyptian diet

Table 7 shows annual per capita consumption of animal feeds, while table 8 shows comparable protein and energy estimates.

Table 5. Some productive traits of the Egyptian livestock.

Animal Type	Lactation yield (kg)	Calving interval (days)	Yield of milk/year(kg)
Baladi cows	638	388	600
Crossbred cows	1 339	410	1 192
Buffaloes	1 246	416	1 093

Source : Nigm, A., Soliman I., Hamed M. And Abdel-Aziz A., 1986. 7th conference of the Egyptian Society of Animal Production.

4. Livestock production systems in Egypt

4.1 Traditional cattle and buffalo farms

Traditional livestock is an integrated part of the crop/livestock system in the country. Farms of five feddans (feddan=4 200m^2) or less contain about 90% of Egypt's cattle and buffaloes. Three types of herds are commonly differentiated according their composition: Cattle herds, buffalo herd and mixed herds which comprise both cattle and buffalo and represent about 60% of total number. There exist an obvious tendency of farmers to keep buffalo as their main dairy animals. Livestock may not provide the best option of investment for small farmer, but both cattle and buffalo are kept at no or little financial losses under current farming conditions. Field surveys showed that farmers also keep small ruminants (less than 5 heads) and poultry in flocks of about 15 birds. Egyptian clover (*Trifolium alexandrinum*) is the main source of livestock feeding in winter, maize and sorghum provide green fodder in summer. Buffaloes and cows in milk

Table 6. Estimated feed balance for livestock in Egypt, 1992, million tones.

	Amount	TDN	DCP
Requirements:			
Concentrates	10.0	5.5	1.2
Fodder	35.5	3.5	0.7
Roughage	10.7	3.8	0.9
Poultry	5.3	3.9	0.9
Total		**16.7**	**2.8**
Production:			
Concentrates	4.0	2.2	0.5
Fodder	78.7	7.9	1.6
Roughage	6.5	2.3	--
Poultry	4.0	3.0	0.7
Total		**15.5**	**2.8**
Deficit/surplus:			
Concentrates	-6.0	-3.3	-0.7
Fodder	-43.0	4.4	0.9
Roughage	-6.5	-1.5	--
Poultry	-1.3	-0.9	-0.2
Total		**-1.3**	**0.0**

Source : Animal Production Institute, The Feed Gap, 1989.

Table 7. Annual per capita consumption of animal feeds in Egypt, 1995.

	Weight (kg)
Red meat	11.3
Milk & dairy products	43.0
Poultry meat	5.2
Fish	5.8
Eggs	3.3

Source: Sharafeldin, M.A. 1993. Impact of Economic Reforms on Livestock and Poultry Production in Egypt. Agriculture Policy Conference, Cairo.

Table 8. Per capita consumption of protein and energy from animal sources in the human food in Egypt.

	Protein			Energy		
	Total	From animal sources		Total	From animal sources	
Year	gm/d	gm/d	% of total	Kcal/d	Kcal/d	% of total
1970	64.9	9.5	15	2 442	170	7
1990	84.9	15.3	18	3 309	257	8
1995	91.1	16.0	18	3 750	300	8

Source: Sharafeldin, M.A. 1993. Impact of Economic Reforms on Livestock and Poultry Production in Egypt. Agriculture Policy Conference, Cairo. Production in Egypt. Agriculture Policy Conference, Cairo.

may receive limited amounts of grains or concentrate mixtures. Females are bred naturally, the delivery of A.I.services and the rate of adoption of this service by farmers are still low. Animals are kept in small enclosures connected to the family house. Cattle may be used as draft animals, but buffaloes are seldom used. Livestock depend mainly on labour of women. Animals are milked and milk to middlemen at a low price. Usually, simple products are made (butter, gee and cottage cheese). Live animals are sold alive either when cash is needed or when they are culled. Buffalo male calves are sold for slaughter at a very young age to save their dams' milk.

4.2 Commercial dairy farms

The total number of dairy farms in the country, with 50 heads or more, is 386 farms. Pure bred cows (mainly Holstein or Friesians and a few Jersey and Brown Swiss) are kept mainly under an intensive production system for milk production. The farms are equipped with milking parlours, cooling tanks. A.I. with imported semen is used. Most farms keep records and some use computerized systems for performance recording and farm management. The average herd size is between 200 and 500 heads. Farms are operated by skilled labour and experienced management staff. Some large companies have their feed mills and dairy processing plants. Another type of commercial farms, relatively smaller, is located at the outskirts of big cities. Buffaloes in milk are purchased and put under a very intensive system of feeding to produce high-fat milk. Immediately after drying off, buffaloes are sold for slaughter.

4.3 Feedlots

Three different systems could be identified in the feedlot operations:

1. Young native bulls are bought at an average body weight of 180 kg and fed on rice straw and concentrates till they reach 350 kg. Meat produced has the highest price due to the consumers' preference for native cattle (Baladi) meat.

2. Young buffalo bulls are bought at 200 kg and fed on rice straw and concentrate till they reach 450 kg. This system is supported by soft loans under the National Veal Project.
3. Feeder bulls are imported from Ireland at an average weight of 350 kg and fed on concentrate to reach 500 kg in a five months period.

5. Sheep and goat farms

Sheep and goat production is a main occupation for people living in the semiarid coastal zone of the western desert in Egypt. Almost all flocks are mixed of sheep and goats. Barki sheep and Barki goats are the dominant breeds in this area. Flocks of fewer than 50 head of goats and 50-200 heads of sheep are most frequent. Most flocks are looked after by family members and hired shepherds. Over the past decade the number of small ruminants tended to increase particularly goats with the existing governmental policy encouraging exportation of live animals to the neighbouring Arab countries. Along the Nile and in the Delta (the northern part of Egypt which comprises 60% of the total cultivated area) sheep and goats are integrated in the crop/livestock system. Traditional small flocks represent over 90% of the sheep and goat populations. Flocks from individual holdings (usually <5 heads) are frequently pooled and assigned to a hired shepherd for grazing. The dominating breed of sheep in this area is the Ossimi which is a local white coated fat-tailed sheep. Sheep are kept mainly for meat production and they are seldom milked. Wool production is low in quantity and quality. The local breed of goats is small, black and the coat is covered with smooth short hair. Goats have mothering ability and they are frequently milked by farmers. The “Nubian” breed of goat is a favourable breed that has as relatively higher milk production, heavier weight and high fertility.

6. Support services

6.1 Animal health

Local Veterinary Departments in the Governorates are directly connected with the Central Authority for Veterinary Service (GAVS) with the MALR in Cairo. In most villages there are units that perform disease control, treatment and deal with infertility problems. However, assessment of the needed veterinary manpower showed a shortage at the village level. Facilities for clinical, post-partum or carcass examination are reasonable, but treatment of sick animals and supply of biological products are insufficient in many areas. The veterinary sector is currently undergoing a large scale project for privatizations.

6.2 Insurance

Insurance is provided to farmers through an autonomous organization within the MALR. The Artificial Insemination services are carried out by the veterinary departments in the governorates. The proportion of inseminated animals is still small. There are three major A.I. centers in Egypt that produce frozen semen from Friesian and buffalo bulls. There are plans to privatize A.I. service and to provide credit to operators and benefiting farmers. Technical and veterinary extension services are delivered to farmers in villages through representatives of Livestock Departments in governorates. Responsibilities are promotion of new technologies, implementation of technical packages and milk recording systems.

6.3 Credit

Access to credit for the small farmers is offered by the village banks which belong to the principal Bank for Development to establish commercial farms, and to purchase livestock, poultry, equipment and feedstuffs from abroad.

7. Animal recording activities in Egypt

Animal recording including aspects of performance, fertility, growth, feeding and health is practiced in state, research and commercial dairy farms. These recording activities are performed primarily using conventional paper records farm management. Some commercial dairy farms own computerized recording systems for performance recording and farms management. No national breeding programs are implimented in Egypt, due to lack of animals' identification system and to the absence of networking farmers, A.I. centers and functional breeding organizations. Genetic improvement is practical only in large commercial dairy farms by importing quality frozen semen from abroad.

In 1989, the Animal production Department, Faculty of Agriculture, Cairo University started a research project financed by IDRC of Canada to establish a "Pilot Cattle Information System in Egypt". The research project recorded and analysed data on animals of small, medium and large farms, based on once a month visit to each farm (official 24-hour milk recording system, ICAR A4 method). Extension workers of Animal Production Sector, MALR acted as recorders and university staff and post graduate students acted as their supervisor. Monthly reports were issued by the project and sent to the farmers within 4-5 days. As the work expanded, funds were obtained from some local and international development agencies in order to offer incentives for Villages Extensions Workers (VEW's) for extra duties.

To promote enrollment of small farmers the project, with support from development agencies, offered a package of technical services including quality feeds, veterinary services, pregnancy diagnosis, treatment of simple infertility problems, simple milk processing equipment, milking machines beside the technical advice given by the milk recorders on feeding and management of the herd. Services were offered at cost recovery basis. The research project was terminated in November 1994. The project was transferred by Cairo University into a self financed community service centre "Centre for Studies on Dairy Cattle Information Systems" to participate in offering: milk recording, training on dairy management and extension and establishing cattle data base at the national level.

The center is equipped with facilities for data entry, analysis, storing and reporting. In 1996 with the help of FAO, the centre was provided with computer laboratory equipped with proper software covering the needs for data entry, validation and reporting. Standard dairy data inputs (herd basic information, individual information on milk production, reproductive performance, health status, feeding and progeny performance) and output records (herd summary, individual information on cows based on input data and attention list to farmers to improve farm management) were designed. The reports are printed in Arabic. Training.

Village extension workers on data collection, milk sampling and dairy extension as well as programmers and data entry personnel is one of the center's major task. The project activities covered the areas of Giza, Fayoum, South Tahreer and West of Nubaria. Up to October 1997 about 4 604 heads are enrolled.

Table 9 depicts the number of enrolled herds and animals along with the number of available animals in the governorates. Other achievements included the enhancement of effective technologies utilization by farmers, and the establishing good contacts with several local and international agencies. Beside the physical achievements of the project, it succeeded in drawing public interest in milk recording. The project succeeded in combining scattered efforts of some government agencies and farmer's and geared them towards a nucleus for national dairy recording program.

Table 9. Number of females over 2 years, number of enrolled herds animals.

Governorate	No. of animals over 2 years	No. of enrolled herds	No. of enrolled animals
Giza	84 871	46	2 332
Fayoum	127 071	54	937
El-Behera	345 433	178	807
Menofiya	197 984	80	345
Qalubiah	60 862	6	183
Total	816 221	364	4 604

In 1996 a Technical Cooperation Program (TCP) project started between MALR and FAO to plan a National Dairy Herd Improvement System (DHIS) with the following objectives:

1. To increase the productive efficiency of milk producers of all categories.
2. To provide the indispensable production recording system on many farms so that a progeny testing program for cattle and especially buffaloes can be executed within Egypt.

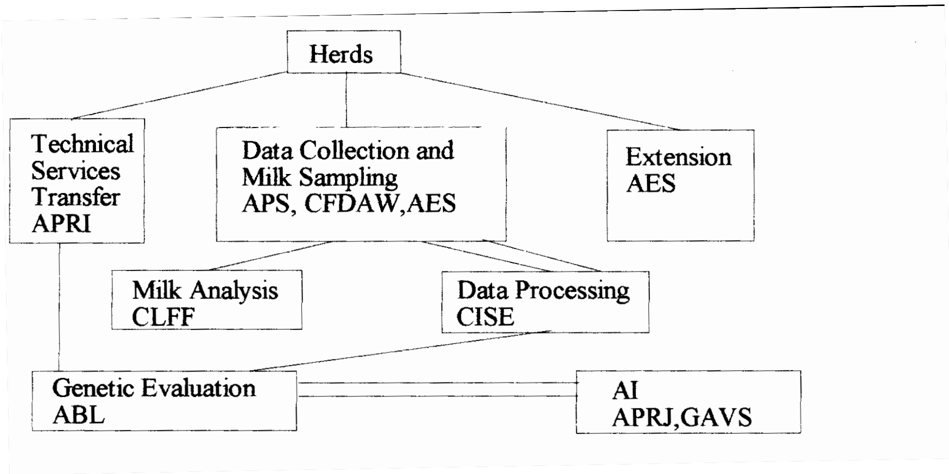
3. To provide reliable information on dairy cattle and buffalo productivity on all types of farms for planning and development agencies to base their projections.
4. To identify specific health and management problems of dairy cattle and buffaloes on all types of farms for solution by animal health and extension agencies.

The preliminary calculations estimated the total cost of recording as £.E. 52.0 ($1=£.E. 3.38) for cow/year in commercial herds (15 L.E. for recording and data & samples transportation, 15 L.E. for cost of data analysis, 18 L.E. for milk analysis and 4.8 as 10% administration cost). The annual cost in only L.E. 33 in small herds with no milk analysis. The total numbers proposed to be enrolled in years 1998, 1999 and 2000 are 12 800, 22 300 and 31 800 heads, respectively.

8. Recommendations

A system for functions and institutions for developing National Dairy Herd Improvement Programme (NHIP) in Egypt based on official institution and organizations is proposed. Cattle and buffalo breeders' organizations and Farmer's cooperatives should be encouraged to take over gradually the direction and administration of all activities and especially the functions of data collection and milk sampling and the

Figure 1. Proposed functions and participating institutions of National DHIP in Egypt.



ABL - Animal Breeding Laboratory, Ain Shams University; APRI - Animal Production Research Institute; APS - Animal Production Sector; CISE - Cattle Information System; CLFF - Central Fund for Developing Animal Wealth, Central Laboratory for Food and Feed; FSDP - Food Sector Development Program; and GAVS - General Authority for Veterinary Services.

transport of these from the farm to the appropriate data center and milk laboratory. The following figure depicts the functions and institutions for developing the NHIP in Egypt.

9. Acknowledgments

The author wishes to acknowledge the staff of the Cattle Information System (CISE), Dr. Ali Nigm (Director), Dr. Ahmed Abdel-Aziz, (Consultant), Dr. Rabie Sadek and Dr. Ashraf Barkawy (Team members) for the information they provided to prepare this manuscript.

Animal Recording Schemes in Senegal

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1. Introduction

The history animal recording activities in Senegal dates back to the 1940s when the first livestock research station was established for the genetic improvement of the local Gobra Zebu breed. A second breeding station was established in the 1960s in the southern part of the country with the objective to improve the trypanotolerant Ndama cattle and Djiallonke sheep. Most of the work on animal performance recording was done using nucleus herds reared on station. A second type of recording schemes were launched in the 1980s with the view to generating information on animal performance, management systems and environmental characteristics. The majors objectives were to investigate the relationship between animal productivity and a number of factors of variation under village conditions, to generate a data and information base that could be used by planners for design of development projects and programmes, and to characterise indigenous breeds. This paper describes major animal recording programmes that were or are being implemented in Senegal with a focus on their objectives, organisational structure, constraints faced and future directions.

2. General background of the livestock sector in Senegal

The livestock industry in Senegal comprises cattle, sheep, goats, equidae, poultry and swine. With the exception of commercial poultry and intensive dairy farming, the herds and flocks are made up of indigenous breeds and their crosses. The ruminant population in Senegal is estimated at 2.5 millions cattle, and 5.9 millions sheep and goats. Main characteristics of livestock production systems found in Senegal are determined by climatic conditions and to what extent capital and land are used in the production process (extensive vs. intensive production systems). With respect to these criteria livestock production systems can be grouped in four major classes.

2.1 The pastoral production system

It is found in the drier northern semi-arid areas where the average annual rainfall ranges between 200 and 400 mm. It is extensive in nature. Because of the scarcity of food and water, this system makes extensive use of land resources through transhumance to feed and water animals. Fulani pastoralist secure their living mainly through milk consumption and cash generation from small ruminants and cattle offtake. The Gobra zebu breed and Sahelian type of small ruminants are reared in this system. The pastoral production system is the major supplier of slaughter animals to meet national demand of cattle and small ruminant meat.

2.2 The mixed crop-livestock production system in semi-arid areas

In more humid parts of semi-arid areas where rainfall is sufficient for successful cropping land is used both for cropping and for animal production purposes. There is a synergetic association between crop and livestock activities. The use of draught animal power from cattle and equine for cropping and transport is a common practice and crop residues constitute valuable feed inputs to the livestock sector. Multipurpose cattle are reared on an extensive land use basis for milk, meat, power and manure production. Animal genetic resources are made up of zebu types of cattle (Gobra Zebu) and Sahelian types of sheep and goats. A stabilised cross between zebu and Ndama cattle (*Bos taurus*), the Diakoré breed, is found in intermediate areas between Zebu and Ndama zones. Average cattle herd size is 39±21 with a minimum of 6 and a maximum of 119 head of cattle (Faye, 1993).

2.3 The mixed crop-livestock production systems in sub-humid areas

These areas are infested with tsetse flies that transmit trypanosomiasis. As a result, trypanotolerant Ndama cattle (*Bos taurus*) and Djiallonke sheep and goats are main animal genetic resources found in these areas. Ndama cattle are multipurpose animals that produce meat, milk, power and manure for the restoration of soil fertility. High population pressure has caused extensive land clearing in this areas with a reduction of trypanosomiasis risk. Therefore the population of more susceptible breeds and species such as equidae has increased dramatically in recent years. Pasture and cropping lands are still more abundant in the sub-humid zones. Average cattle herd size is 65 animals with a minimum of 15 and a maximum of 225 animals. Animals graze natural pastures during the day and they are tethered at night in crop fields for the deposition of manure. Feed supplementation with concentrate is applied on a limited scale. However, crop residues such as groundnut hay are fed to cattle during the dry season.

2.4 Intensive and semi-intensive production systems

These include commercial poultry, cattle and sheep fattening systems and dairy farming systems that have expanded remarkably lately in peri-urban areas where market opportunities have attracted investment in these sectors. These management systems make limited use of land resources, they are capital intensive and they are mainly based on purchased feed inputs (forage and concentrates).

3. Organisation and description of animal recording programmes

A number of animal recording programmes have been implemented in the past in different ecological zones. A common feature of the animal recording activities is that they are all of them carried out by the Senegalese Institute for Agricultural Research (ISRA) with sometime the collaboration of the department of Livestock of the ministry of agriculture. Both on-station and on-farm animal recording activities are conducted with various objectives pursued.

4. On-station animal recording schemes

On-station livestock recording programmes were based on the establishment of nucleus herds and/or flocks reared for breeding purposes. The objective of these programmes was to produce breeding stocks (cattle, sheep) to be introduced into villages for the genetic improvement of local breeds. Two main livestock research stations were established in the semi-arid zone at Dahra in 1938 for Gobra Zebu and Sahelian sheep and goats breeds, and in the subhumid zone at Kolda in 1969 for the genetic improvement of trypanotolerant Ndama cattle and Djiallonke sheep. On both of these stations mass selection for beef purposes was applied on the offspring of about 250 breeding females naturally mated to selected bulls. Male offspring were tested and ranked on the basis of their body weight growth performances. Production data including reproduction, mortality, live weight and milk production as well as linear measurements were recorded.

5. On-farm animal recording programmes

Since the early 1980's comprehensive livestock systems research programmes were implemented in various locations in the country using the farming systems approach to agricultural research. This included diagnostic, design and experimentation components of the systems approach with the view to coming up with appropriate solutions to constraints facing the livestock industry. On-farm livestock performance recording schemes were integral components of these research activities. They aimed at the evaluation of the productivity of cattle, sheep and goats under village management systems and under various resource base and disease situations, and marketing opportunities for livestock products.

5.1 On-farm Ndama cattle performance recording

Because of their trypanotolerance, Ndama cattle constitute a unique animal genetic resource which forms the basis of large ruminant agriculture in many parts of West Africa where trypanosomiasis is endemic. Multipurpose Ndama cattle are kept in the mixed crop-livestock farming system at Kolda as supplier of food (milk), cash through offtake for meat, power for cropping and transport, and manure for the restoration of soil fertility. The Ndama contribute therefore a great deal to the income and welfare of millions of farmers in mixed crop-livestock production systems in West Africa. Research efforts have been directed toward a better knowledge on the production characteristics of these genetic material through cattle herd monitoring schemes. Two major on-farm Ndama cattle recording programmes were (programme 1) or are being (programme 2) implemented in Senegal.

5.1.1 Programme 1

A herd monitoring scheme was conducted between 1988 to 1993 with a view to assessing the relative importance health, nutrition and management factors that constrain the productivity of Ndama cattle kept under traditional husbandry systems. The ultimate aim was to develop strategies to make better use of this genetic resource to meet the growing demand for animal products in West Africa. This study took place in the Casamance region of southern Senegal to investigate causes of variation of Ndama cattle productivity and the stability of the trypanotolerance trait under village management systems.

A total of 531 village Ndama cattle were continuously monitored. Animals were individually tagged on both ears. At the start of the programme each animal's age and the number of calving of each adult female was estimated by farmers. Animals were managed under traditional village conditions and therefore were subjected to natural tsetse challenge. Monitoring of tsetse flies population distribution and seasonal variation was set up to determine trypanosomiasis risk. Data recording included also blood and faecal sampling for the determination of internal and blood parasites. Animals were weighed each month using an electronic scale (Barlo, Australia) and milk offtake for human consumption was measured using a graduated tube by technicians during monthly routine visits in herds. Information on herd dynamics including date of birth, mortality and animal transactions (purchases, sales, exchanges and transfers) were routinely collected during monthly herd visits.

5.1.2 Programme 2

A second on-farm performance recording for Ndama cattle programme deals with the evaluation of the productivity of this breed in two levels of management systems (low and medium input systems). The low input system consists of the extensive livestock management system with limited purchased inputs. With the medium input systems farmers combine improved habitat, health care and better feeding for selected cows during the dry season for milk and manure production or for fattening.

About fifteen hundred head of village Ndama cattle, in 15 herds at 8 villages are visited weekly. Animal identification combines ear-tagging and iron branding. Farmers are enthusiastic to iron brand their animals because this acts as a deterrent to thieves. Data collected include birth, death, exits, milk yield and diseases. The intensity of the monitoring scheme i.e. the number of variables recorded and the frequency or recording varies with the management system. More information are recorded with the intensified management system oriented to milk production. For the intensified management system, animals are routinely weighed. Milk offtake for human consumption is measured each week by enumerators based in villages using graduated tubes. Enumerators record also events related to herd dynamics (birth, death, sales) that occur between two visits. Surveys are also conducted to collect information regarding the quantity of food supplement given to animals and all other inputs (food, drugs, labour) and output prices (live animals, milk, rental of draught animals).

This programme includes also a breeding component for the genetic improvement of Ndama cattle using open nucleus breeding systems. In 1992 an open nucleus breeding system with screening of breeding females for replacement for the genetic improvement of Ndama cattle was initiated in Senegal. Screening of outstanding females was based on-the-spot measurement of their performance. Decision regarding selection of cows is based on both information provided by the animal owner regarding the performance of its cow and measurement by technicians of milk produced during two consecutive days.

During the first screening operation 326 herds totalling 5 387 lactating breeding females were visited. Three hundred and sixty seven animals were identified as outstanding cows by farmers in terms of milk production. Measurement of milk yield of these cows and subsequent correction with respect to factors of variation of daily milk yield led to the selection of 50 cows to be introduced on-station for mating and for more stringent performance recording.

5.2 On-farm small ruminant performance recording

A comprehensive monitoring scheme has been implemented for cattle, sheep and goats through a joint ISRA/EMVT programme since 1983. This programme, "Productivité et Pathologie des Petits Ruminants, PPR" was designed as a tool for a multidisciplinary evaluation of traditional livestock production systems. The objectives were to evaluate the productivity of small ruminants and cattle breeds under different management systems and to investigate the effects of various factors such as breed, disease, and management system on productivity.

This programme dealt mainly with sheep and goats; however, the method and the software developed are applicable to cattle, equine and swine. For instance this system has been used for an extensive breed characterisation programme that involved about 800 village cattle in the Sine Saloum region between 1983 to 1990.

Sheep and goats recording took place in three sites and a total of about 8 000 head were involved in 1992. Data on herd/flock dynamics, health (faecal and blood sampling, clinical signs), management systems, live weight, milk production are routinely recorded.

Information generated with this programme was used for the selection of animals that were going to be used for the implementation of an on-station research programme designed to investigate the resistance of Djiallonke sheep to endo- parasites.

6. Information support systems used in animal recording

Animal recording systems described previously combine a number of devices (field sheets, cards, books, computer programmes) for data storage and management. Field sheets are filled by enumerators and they thoroughly checked for errors before data entry. Examples of field sheets are inventory, individual identification and transfer sheets. Data base management programs such as DBASE or common spreadsheets are commonly used for data storage and management. On-farm animal performance recording programmes use also softwares such as IDEAS which was developed by ILCA, now ILRI. The most comprehensive and well documented programme developed for animal recording in Senegal is PANURGE (Faugère and Faugère, 1993). This programme is designed to manage data on herd dynamic, individual animals characteristics (live weight, body condition, castration, ownership etc.) animal health and management systems. In addition preliminary simple data analyses can be performed with the possibility to transfer the data into ASCII files for further elaborate analyses.

7. Achievements

On-station animal recording programmes for the genetic improvement of indigenous cattle and sheep breeds have been operated for many years. On-farm livestock performance evaluation have also been implemented for a number of years for the characterisation of local breeds. As a result a great deal of experience has been gained by scientists and technicians regarding recording procedures and data storage and analysis.

Infrastructures (fenced pasture lands, facilities) available in many livestock research stations combined with results obtained regarding the characterisation of local breeds and the experience gained in conducting on-farm animal recording programmes in a number of ecological zones and for different species and breeds could form the basis for the development of sound programmes of genetic evaluation of animals.

8. Funding of animal recording activities

The majority of animal recording programmes described here are state-funded with the support of external donors. Where the main objectives of the animal recording activities are research oriented, farmers do not see the immediate benefits. In such situation it is necessary to give incentives to farmers so that they accept to participate in the programme because they incur some costs for participating in terms at least of their time used. It is a common practice to provide free health care and some supplement to secure the continued participation of farmers. When it comes to animal recording programmes for the genetic evaluation of breeds, work in

Senegal shows that farmers could contribute to the cost of the operation, but this needs to be done in a progressive way. When farmers are convinced of the potential benefits they could gain then it would be easier to make them support a part of the animal recording costs.

9. Constraints

Lack of infrastructure or well trained technicians and scientists do not pose any major problem at present in Senegal to run genetic evaluation programmes. The most critical issue facing these programmes is stable funding. Genetic improvement is slow and expensive and therefore decision makers must be convinced of the efficiency and impact of breeding programmes so that they can commit resources for these programmes on a sustained basis.

Animal recording activities should involve producers who benefit from them through their efficient organisations if these programmes are to be successful and sustainable. Producer organisations currently existing in Senegal do not include genetic evaluation programmes in their agenda and this constitutes a major constraint for the stability of animal recording programmes developed by research institutions. Indeed, new agricultural policies are oriented towards less state intervention and government owned institutes have suffered serious budget cuts that adversely impacted the stability of animal recording programmes.

The design of efficient genetic evaluation programmes in Senegal will have to address two issues. First, the heterogeneity of management systems found in villages is likely to introduce a bias in the genetic evaluation because of the increased environmental variability. Second, there is a need to develop proper correction factors for traits measured on-farm under different circumstances. The analysis of data and synthesis of information generated through various animal recording programmes could be used to compute correction factors.

10. Future programmes for animal recording and genetic evaluation of animals

An open nucleus breeding system has been established since 1992 in Southern Senegal for the genetic improvement of Ndama cattle for milk and for more resistance to trypanosomiasis. The programme went through some problems because lack of funding. However preliminary results in terms of organisational achievements are encouraging. Screening procedures to identify replacement breeding females needs to be improved and the establishment of a milk recording system is planned in certain areas. Improvements of health and feeding management during the dry season has caused a dairy industry to evolve in areas around cities. Farmers running these enterprises are getting organised to get feed and veterinary supplies and to market their milk. Because of the complex nature of this programme and many constraints faced, it is imperative that scientists, extension workers and farmers be brought to work together if a more effective open nucleus breeding programme is to be established in the future.

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Dairy Herd Improvement Services in Zimbabwe: Past Present and Future

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1. Introduction

1.1 Current status of the zimbabwe dairy sector

More than 200 million litres of milk are produced per year in Zimbabwe (Central Statistical Office, 1996). The dairy industry is dominated by large scale producers who own over 95% of the commercial dairy herd and supply close to 100% of the intake of processors. There are, however, only about 340 large scale producers, compared to several thousands of small holders.

1.2 Government support services to the dairy industry

Government renders support services to the dairy industry, most of which fall within the Ministry of Lands and Agriculture. Dairy Services, a branch of the Department of Research and Specialist Services, is responsible for statutory, advisory and management services, while research institutions within the same department carry out production research. The Department of Agriculture, Technical and Extension Services provides on-farm advice to farmers, mainly the smallholders, while the Department of Veterinary Services is responsible for monitoring and controlling diseases such as contagious abortion.

The Dairy Development Programme (DDP) was set up by the government in 1983 and charged with the responsibility of spearheading smallholder milk production. The programme pays special emphasis and attention to communal, resettled and small scale dairy producers. This is in pursuit of government's goal of increasing income and contributing towards an improved standard of living for rural communities. A DDP project consists of a group of participating farmers from the communal areas and small scale farming sector. Each project has a resident officer, who co-ordinates dairy development activities and provides dairy extension services in his area.

1.3 Information support systems

The Zimbabwe Herd Book (ZHB) is a statutory body established in 1981 as the sole registering authority of all pedigree livestock (excluding thoroughbred horses). It is an association of 25 breed societies who constitute its members, and the main objectives are to encourage and improve the breeding of purebred farm livestock through, among other means, the promotion of performance recording.

1.4. Current status of milk recording

About 28% of Zimbabwe's dairy producers are members of the milk recording scheme. In addition, three DDP projects are also performance recorded under the group recording option. Milk recording services in Zimbabwe have come a long way and the herd improvement services currently available to Zimbabwean dairy farmers are among the best in the world.

2. Historical background

Official milk recording in Zimbabwe started in 1932, but attemts to organise recording had been started as early as 1929. At that time, only a handful of herds participated in the milk recording scheme, which only involved collection and manual compilation of basic production records. As the Zimbabwe dairy industry became larger and more sophisticated with time, the milk recording scheme also grew gradually in size and became more refined. In 1992, Zimbabwe was granted full membership of the International Committee for Animal Recording (ICAR) to become the second Sub-Saharan African country, after South Africa, belonging to the organisation. The register system of milk recording which was used at that time, is described below.

3. Registered milk recording system

For more than half a century, the milk recording scheme was run by Dairy Services. Participating herd owners were charged a nominal fee and virtually all costs of delivering the milk recording service were borne by the government. Each member of the milk recording scheme was required to keep daily and cumulative lactation milk yield records of individual cows. Milk recorders employed by Dairy Services would visit each participating herd at bi-monthly intervals. During their twenty-four hour stay on the farm, the milk recorders would carry out the following testing procedures:

1. Check farmer's milk yield records and measuring devices.
2. Record milk yield and collect a proportionate milk sample for each milking cow at every milking.
3. Determine butterfat content of each cow's composite milk sample using the Gerber method.
4. Summarise completed lactation records and dispatch them to the Central Milk Records Office.
5. Staff at the Central Milk Records Office would process incoming records as follows:

- Verify information recorded by the farmer.
- Calculate weighted average lactation butterfat content and other parameters e.g. calving interval, age at calving.
- Prepare records for electronic processing.

All the records would then be entered into a computer and at the end of the year, herd averages would be computed for milk yield, butterfat yield and per cent, calving age, days dry, and calving interval.

4. Constraints

The register system involves analysing individual cow and herd performance records retrospectively and as such is of limited value as a herd management tool. Consequently, participation of Zimbabwean herds in the register scheme remained consistently low (Table 1), despite the low cost of the service.

Table 1. Details of herds participated in the register scheme.

Year	Total no. of dairy herds	No. of herds under recording	Participation %
1983	516	104	20.2
1984	524	105	20.0
1985	531	95	17.9
1986	552	101	18.3
1987	556	104	18.7
1988	511	103	20.2
1989	521	102	19.6
1990	508	99	19.5
1991	479	92	19.2
1992	442	86	19.5
1993	412	84	20.4
1994	410	98	23.9

Besides failing to rise to the expectations of herd owners, the milk recording service deteriorated badly in the mid-80s to early 90s, mainly due to inadequate capital and financial support by the government. The scheme could also not cater for smallholder producers, who had now become a force to reckon with in the national dairy industry.

5. Recent developments

The year 1993 saw the implementation of the Canadian International Development Agency (CIDA) funded Zimbabwe Dairy Cattle Improvement Project (ZDCIP), which was a milestone in the history of milk recording in Zimbabwe. A major component of the ZDCIP was the upgrading of the antiquated register system of milk recording to a state-of-the-art statement method. The Zimbabwe Dairy Herd Improvement Association (ZDHIA) was set up in the same year to run the new herd improvement services.

A ZDHIA council, consisting of representatives of all stakeholders in the dairy industry such as the government, producers, processors, ZHB etc. was formally consistuted to direct the management of ZDHIA.

ZDHIA and government (Dairy Services) made an undertaking to operate in a 'joint' venture in administering the new milk recording services. Members of the milk recording scheme began paying substantial fees which were, however, subsidised by dairy industry levies and government's contribution. The proportion of user fees to total costs has been increasing gradually, in a bid to eventually phase out levies and operate on a purely commercial basis. Government's financial provision is also dwindling markedly and is likely to be phased out in the near future. ZDHIA changed its name on 1 July 1997 to the Zimbabwe Dairy Services Association (ZDSA), to reflect the wide range of services that it was now rendering.

6. Main features of the new milk recording scheme

The new milk recording programme was adapted from the Canadian system and was set up by the then British Columbia Dairy Herd Improvement Services. Essentially, the statement system provides a valuable management tool in the form of regular reports containing comprehensive and progressive profiles of each cow's performance. In addition, information on overall herd performance is provided.

Participating members have two options to choose from, namely fully supervised and owner sampler. Fully supervised herds receive ten visits per year from ZDSA milk recorders who carry out all the on-farm testing procedures and dispatch milk samples and accompanying information to the ZDSA central offices. Owner sampler herd owners, on the other hand, do their own testing and transportation of samples to ZDSA central offices.

Small holder farmers participate in group recording, which is a modified form of the owner sampler option. Owner sampler herds are tested every month, with milk recorders visiting them four times a year to check the accuracy of recording devices and do positive identification of animals.

7. On-farm testing procedures

7.1 Fully supervised and owner sampler option

Each participating member is required to keep the following basic records on the farm:
1. Animal identification and pedigree details
2. Event dates(births, calvings, disposals etc.)
3. Breeding details
4. Auxilliary trait information e.g milking speed, calving ease.

On test day, before the first milking, the milk recorder or herd owner extracts from the farm records, all events occurring, and, identification and pedigree details of all cows joining the herd, since the last test. This information is recorded on specially designed input forms.

During each milking, proportionate milk samples are collected and milk yield recorded for each cow. The milk samples are preserved in bronopol pills. After testing, the milk samples and input forms are dispatched to ZDSA central Office by courier.

7.2 Group recording

Each member participating in group recording is required to own a hang scale. Members are encouraged to keep basic on-farm information such as parentage details, event dates etc. On test day, each member in the group weighs and records the milk yield of each cow at every milking. Samples are collected from each cow's milk after physical agitation. All the relevant information and milk samples are delivered to the resident DDP officer, who will check and record all the test day details onto the group's input forms and dispatch them and the samples to the ZDSA central office.

Currently there are three small holder groups (DDP projects) participating in this option, with a total of 129 cows.

7.3 Laboratory testing

At the central laboratory, milk samples are tested for butterfat, lactose and total solids using a Bentley 2000 infra red milk analyser. Somatic cell counts are determined by a Bentley Somacounter.

7.4 Data processing

Information on the input forms is entered into the computer as soon as it reaches the data processing centre. Lab results are transferred electronically from the lab to the data processing centre. Electronic processing of the records then ensues, leading to the production of herd management reports.

The reports are sent to the herd owner within ten days after test day. Farmers thus get timely feedback on their herd and individual cow performance, enabling them to make accurate management decisions.

7.5 Genetic evaluation

Genetic evaluation of dairy cattle in Zimbabwe started in 1986. The National Association of Dairy Farmers (NADF) funded the establishment of the genetic evaluation programme, with technical assistance being provided by the Netherlands Royal Cattle Syndicate (NRS). The genetic evaluation programme was handed over to Dairy Services in 1988, who were responsible for the running of the scheme until the setting up of ZDHIA.

Data collected under the register milk recording scheme were used to compute sire predicated differences (PDs) and Cow Genetic Indices (CGIs) using the BLUP sire model methodology.

The change in the system of milk recording in 1994 saw the introduction of the animal model procedure of genetic evaluation, as part of the ZDCIP. The first animal model genetic evaluations were undertaken by Agriculture and Agrifood Canada in 1996. The future of the new genetic evaluation programme however, hangs in the balance as ZDSA do not have the software, appropriate computer hardware nor technical expertise to run the programme. On the other hand, they cannot afford to pay external organisations to carry out the genetic evaluations for them.

8. Conclusion

8.1 Looking into the future

Dairy herd improvement programmes in Zimbabwe are now well established and poised for growth to great heights. The country has gone through the most critical phase of setting up a self-sustaining system.

All the basic requirements for a valuable and efficient service are in place, however, the following issues need to be addressed in order to achieve the main goal of improving efficiency of production at national level.

8.2 Level of participation

At 28%, the level of participation of Zimbabwean herds in milk recording remains low, compared to most other ICAR members (Table 2). From herd owners who have been dropping the service, it appears that lack of knowledge on the value of milk recording is the main reason for this low level of participation. ZDSA therefore has to strengthen its extension services to farmers in order to promote the use of milk recording.

8.3 Participation of small holder sector

Although Zimbabwe is one of the very few countries operating an organised milk recording service in the small holder sector, there is a room for increasing the participation of these farmers. It is government's express objective to expand and increase the efficiency of milk production in the

Table 2. Details of participation of farmers in milk recording in different countries.

Country	% of recorded herds
Australia	35.0
Canada	62.7
Denmark	80.0
Israel	49.7
Japan	34.1
Portugal	2.8
Slovenia	18.3
Switzerland	67.0
Zimbabwe	27.6
USA	31.0

small holder sector (Ministry of Agriculture, 1997) where more than 70% of the country's cattle population is found (Central Statistical Office, 1994). Besides the dire need to evaluate and preserve the diverse genetic resources in these marginal developing country areas (Cunningham, 1992), animal recording can be used as key technology to increase productivity and sustainability in these production systems (Hammond, 1994). Government is expected to play a leading role in pursuance of this goal, mainly by creating an enabling environment.

There is also a need to modify the recording service rendered to small holder farmers so that it provides information that is simpler and easier to use.

8.4 Genetic evaluation

Genetic evaluation is one of the most valuable outputs of a milk recording programme. Zimbabwe therefore has to come up with a well thought out strategy for running a sustainable genetic evaluation scheme. There is a need to invest resources into setting up the country's own genetic evaluation system.

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Animal Recording in Morocco: Constraints and Possibilities for Improvement

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1. Presentation of livestock and animal productions. Importance of livestock

In Morocco, agriculture is a major component of the economy in which, livestock sector plays several functions. It represents about 25% of the agricultural gross product, contributes to population nutrition, constitutes a principal sector for employment (about two third of the rural population), offers products to the agri-industry and plays a banking role for the farmers.

The population living in rural areas represents about 50% of the total. Most of the farmers own a small size plot of land and/or herds (less than 5 ha, 1 or 2 cows and 10 to 20 sheep or goats). There are no specialized operations. A farmer may grow wheat, plant fruit trees and raise animals at the same time.

The animal population in Oct.-Nov. 1996 is as follows:

cattle	2 408 000
sheep	14 536 000
goat	4 595 000

2. Livestock production systems

Several systems are considered based on breed, production type, reproduction, feed and feeding management. The last one is a major constraint for livestock production (in regard to availability and quality) and is the principal parameter which determines the systems.

2.1 Cattle production systems

There are 3 principal systems based on breed (the cattle population is composed of 65% native, 25% cross-breed and 10% pure: Holstein, Friesian, Santa Gertrudis and Montbeliard), feeding (cultivated forages, wheat and barley straw or stubble, grains and agro-industry by-products: citrus pulp, molasses, beet pulp) and possibilities of milk marketing (the produced milk is either sold or self-consumed) :

- Dairy production system
- Combined system
- Beef production system

2.1.1 Dairy production system

This system exists in irrigated areas and is oriented mainly toward milk production even though, some farmers keep their bull calves and feed them out. The characteristics of the system are:
- forages produced on irrigated areas provide an important fraction of the animals' dietary needs for milk and meat production, if bull calves are fed out,
- pure breed or cross-breed are the most dominant animal types used,
- systematic marketing of milk through local collection centers.

2.1.2 Combined system

This system exists in favorable areas with no irrigation but, where the rainfall is sufficient to produce some forages to a certain limit, and also in some irrigated or partially irrigated areas. The breeds used are heterogeneous and with a variable production potential. The main characteristic of this system is that forages are less used for feeding than grains and by-products (including wheat or barley straw) which are extensively used.

2.1.3 Beef production system

This system is based on grazing, mainly the local breed type with the aim of producing young stock for feedlot operations. It exists in the major cereal production areas, semi-arid or arid areas and also in some irrigated areas (Tadla). Feeding is based on the utilization of wheat or barley straw and stubble (which contribute to more than 30% of animal needs). The grains and by-products are used but mainly during critical periods. In some areas forages can also be used.

2.2 Sheep production systems

The Moroccan sheep population is composed mainly, of native breeds. These breeds are generally, linked to geographical areas: *Timahdit* breed in the Middle Atlas (1 200 000 heads), *Sardi* breed in the Center (750 000 heads), *Bni Guil* breed in the East (2 300 000 heads), *D'man* breed in the Oasis (200 000 heads), *Boujaâd* breed in the Center (80 000 heads) and *Bni Hsen* breed in the North-West mainly (200 000 heads). The D'man is the only breed which has specific physiological characteristics (highly prolific). The other breeds have similar performances and cannot be distinguished based on this criteria except by the appearance. Therefore, excluding the oasis system, sheep production systems are not defined based on breed but based, on the feeding system. The 3 major sheep production systems are:
- Pasture system.
- Agro-pasture system.
- Oasis system.

2.2.1 Pasture system

This system is found mainly in mountain areas, the high lands in the East and in the Center, the South side of the High Atlas and some areas in arid lands. The sheep spend most of the time grazing. The pasture contributes to meet more than 50% of animal needs. Feed supplementation is limited and the feedstuffs used are mainly straw, grains and occasionally by-products. No forages are used. Wheat or barley stubble is also grazed.

2.2.2 Agro-pasture system

This system exits in the main cereal production regions (dry or irrigated). Again cereal by-products (mainly straw and stubble) and occasionally, cultivated forages are used to feed animals. Grains and agro-industry by products are used as supplement feeds during critical periods and in feedlot operations which are very common in this system.

2.2.3 Oasis system

This system is specific to the pre-saharian regions, the Ziz and Draa Valley and between Errachidia and Ouerzazate. The characteristics of this system are:

- Intensive irrigated agriculture on small plots of land (1 to 2 ha).
- A particular breed (D'man) with exceptional reproduction characteristics: highly prolific,breeding precocity and no seasonal anoestrus. This breed is raised only in confinement in barns and hard surface pens.
- The feeding is based mainly on the use of alfalfa with supplementation with date screening, grains, cereal by-products and straw.

2.3 Goat production system

Goat production exists mainly in mountain areas and depends on rangeland and forests for feeding. Feed supplementation is common during critical periods with use of straw, grains and by-products. Goats are raised principally for meat with only a few specialized milking flocks.

2.4 Dromedary production

Dromedary production exists in arid, pre-saharian and saharian areas. The camel number is about 55 000 head. Feeding is based on grazing shrubs and bushes and on grain and straw supplementation.

Camel are mainly, used for working, transportation and, meat and milk production. Racing and touristic activities are other limited uses.

3. Animal productions

Meat and milk production from animals in 1993:

Beef	160 000 metric ton
Lamb	90 000 metric ton
Goat	45 000 metric ton
Milk (cattle only)	900 million liter
Wool	15 000 metric ton
Hides and leather	60 000 metric ton
Chicken	152 000 metric ton
Eggs	1.4 billion

Annual per capita consumption:

20 kg of meat including 5.8 of chicken
68 eggs
41 l milk

The production meets the consumption up to 100% for meat and only, 80% for dairy products. The annual increase rate of meat production is, 2.8, 3.5, 1.2, and 7%, for cattle, sheep goat and chicken respectively.

The productivity is low, the average weight of carcass is about 135, 14 and 7 kg, for cattle, sheep and goat respectively.

In Morocco, animal recording exists only for dairy cattle and sheep productions.

4. Animal recording and breeding

4.1 Description and achievements

Dairy record keeping in Morocco is a government programme controlled and fully funded by the Ministry of Agriculture. It is considered as a mean for genetic improvement. The dairy recording started in 1968 by one public management company. The extension to other public and private farms resulted in the opening of breed registries (herd book) for 4 breeds (Holstein, Friesian, Red and White, and Tarentaise) at the Ministry of Agriculture. From 1973 to 1985, the recording was limited to public and a few private farms and concerned in the average, only about 120 herds for a total of 5 000 cows (mainly Holsteins and Friesians). In 1985 the recording was extended and concerned all farms considered as "nursery units"which received subsidizes for each selected animal in order, to reduce heifer importation. Now, the number of these "nursery units" is about 390 with 11 000 cows representing only 9% of total pure breed dairy cows.

In general, the recording is used for genetic improvement only, and the farmer receives no feedback information for herd management. The Ministry of Agriculture Agent measures milk weight and take a sample for fat test once a month. Data processing is very slow and often, is done by hand with a calculator. In some cases computer is used when it is available. The generated data with a score given to qualitative traits related to body condition and appearance, are used by the National Committee of Selection and Registration in Herd Books. This committee is composed of people from the Ministry of Agriculture, a representative of the National Association of Cattle Farmers (ANEB) and a breed expert. The selection is based on the method of independent culling levels. The used traits are milk weight, fat test and the given score.

The registered cattle from 1985 to 1995 was as follows:

Year	Cattle registered in herd books
1985	1 219
1986	779
1987	1 258
1988	2 025
1989	1 419
1990	1 071
1991	1 326
1992	1 318
1993	1 868
1994	1 612
1995	925

In parallel with the intensification of artificial insemination (AI) programme, a progeny testing programme was also initiated in 1989. It started with 30 bull calves from which, in 1995, 10 bulls were selected. In 1992, 1995 and 1996, 18, 16 and 16 bulls were selected respectively, to undergo progeny testing.

4.2 Constraints

1) Limited personnel, equipment and facilities
   In overall, there are about 50 agents responsible for recording (390 herds, 11 000 cows). The recording is seen as a secondary activity. The agent has several other duties. Visiting farms is considered as a difficult task usually complicated with problem of transportation (car or gas not available when needed). The activity is limited simply to weighing and sampling milk , and data calculations (usually without computer). The recording agent receives no incentives and considers himself underpaid compared to AI technician who apparently, is doing an equivalent job.

2) Limited funds
   The Regional Administrators of Ministry of Agriculture do not support the recording activity even though there is a small budget allocated for the purpose.

3) Farmer not involved
   The farmer is not enthusiastic about recording and considers it as a burden since he receives no feedback and no short-term benefit. This and the frequent absence of the farmer during the visit complicates the task of the recording agent who receives no adequate information or help from farm workers.

4) Lack of consistent extension work
Recording does not concern nutrition evaluation, disease data, reproduction performances and growth data. And there is no coordination between the recording agent and the AI technician who processes data on AI. In this situation, it is difficult to advise the farmer in regard to herd management.

5) Limited funds

5. Improvement of dairy recording programme

Recently, the Ministry of Agriculture is studying the reorganization of dairy recording and genetic evaluation of dairy herds programme. A new plan which will involve several partners is suggested. The partners are: Livestock Direction (Ministry of Agriculture), National Center of Dairy Recording (NCDR, to be created), Regional Centers of Dairy Recording (RCDR, to be created), ANEB (National Association of Cattle Farmers), Other regional dairy farmer association or cooperatives, Regional Centers of Artificial Insemination (RCAI) and Research Institutions (IAV Hassan II).

Livestock Direction has the responsibility for supervising and supporting the recording programme.

NCDR will be in charge of organizing the dairy recording programme. It will be responsible for record keeping, data processing, calculating selection index and producing reports.

RCDR will be responsible for recording data at the farm level and providing NCDR and Farmer Associations with necessary data.

ANEB created in 1990 regroups 8 regional associations, 7 cooperatives and 3 private dairy companies. ANEB is subsidized by the Government and most of its personnel is from the Ministry of Agriculture. ANEB is mainly, responsible of AI programme (100 000 AI realized in 1996 by ANEB, with an annual increase rate of 25%) and advising the dairy farmers. ANEB will be responsible of taking care of Herd Books and involved in dairy recording. It will interact with NCDR and RCDR and return analyzed data to dairy farmers in a short period of time in prospect of herd management improvement. This will encourage the farmers to cooperate and support the programme. The participation of the farmers was evident during a study conducted in several dairy farms about using a software (DairyCHAMP®) as record keeping system for herd management purpose.

CRAI will use generated data for progeny testing programme.

The faculty members of the IAV Hassan II will help by assuring scientific advising and calculating the selection index.

Funding of the recording programme will be a matter of the State and the operators in the dairy industry. Recently, partnership relations are taking place in some dairy areas between ANEB, the regional association or cooperative, the regional administration of Ministry of Agriculture and the milk processing companies in order to promote dairy industry. This may be considered as positive signal.

6. Recording in sheep production

6.1 Description and achievements

Recording in sheep production was initiated in 1972 in a few private and public herds composed of imported breeds for meat production. In 1982, recording was started for native breeds in private farms for a management purpose and not for selection. Unlike for dairy production, the recording in sheep production was accomplished with the involvement of National Association of Sheep and Goat (ANOC). ANOC was created in 1967. It is subsidized by the Government and most of its employees are from the Ministry of Agriculture.

Recording for genetic improvement was started in 1987. From 1987 to 1991, the recording system was not adequate because of data analysis problems. After 1991, the recording system was improved. Reproduction, growth and body condition traits are used for selection. The recording agent visits the farm every 3 weeks. He is responsible for identifying the lambs and measures body weight of male lambs during 4 visits and that of female lambs in 2 visits. Birth weight is measured if the lamb is born in the day of the visit. Data is used for herd management and selection. For this purpose, data is sent to France for index calculation as a support from the French Cooperation to ANOC. Selection indexes are used only for Timahdit breed. The selection programme of this breed includes a public farm where mothers of sires are gathered and raised .

ANOC achieved positive results. The productivity of the herds under ANOC control is 50% higher than of the others. Actually, the members of ANOC are 1 500 farmers organized in 27 groups dispatched in different areas of sheep production. There are 4 500 non member farmers who benefit from ANOC services. In over all, there are 550 000 heads under ANOC control from which about 13 000 animals per year are selected for reproduction by the National Committee. The actions of ANOC are: management improvement (health, nutrition and reproduction), genetic improvement, constitution of farmer groups and marketing. The native breeds under the control of ANOC are Timahdite, Sardi, Boujaâd, Béni Guil and D'man.

6.2 Constraints

1) Problems of data collection and processing
   Visiting farms at regular time is difficult to achieve because of distance, bad roads, herd movements, and some times weather conditions. Also, weighing the animals is a hard task, especially, without the farmer being

present. Data is sent to the regional coordinator then to the head quarter of ANOC in Rabat. This makes data processing and report writing very slow.

2) Selection index calculation
Selection index are not calculated in Morocco and concerns only one breed (Timahdit).

3) Organization problems
Regional coordinators of ANOC do not have sufficient specialized personnel and computing equipment for an independent and flexible work.

4) Limited funds

6.3 Possibilities of improvement

Compared to dairy recording, recording in sheep production is more efficient. But, there is a need to create specialized genetic services provided with necessary qualified personnel and computing equipment in the head quarter and regional administrations of ANOC.

Significant effort must be done to improve the marketing system through ANOC which may help generating funds to support the recording system.

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The Development and Maintenance of Animal Recording Schemes for Low to Medium Input Production Environments: a Case Study of Sheep Recording in Morocco

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1. Introduction

Arid and semi-arid areas in Morocco cover about 68% of total agricultural land and contribute more than 50% of crop production. In this environment water resources are determined by a low to medium rainfall, and the level of production is quite limited and highly variable. Poor infrastructure, and insufficiency of public and private investments are also constraints for production. In this system livestock takes a primordial place in agricultural farms, and plays various functions such as:

- High contribution to agricultural GNP (to 37.7%).
- Employment of 2/3 of rural population.
- Important role in agro-industry sectors (leather, wool, milk).
- Constitutes a permanent bank for most farmers.

2. Numbers

The main livestock product is meat, of which 96% is produced by sheep, cattle and, goats. The numbers of these species change from year to year with annual climatic conditions latest estimates are:

2.9 millions heads of cattle;
16.7 millions heads of sheep;
2.7 millions heads of goats;

3. Structure of national herd/flock

3.1 Cattle

The dairy improvement plan started in 1975 has resulted in significant changes in the national herd structure. The numbers in the improved breeds, grew by 32%. In Morocco, three genetic types are raised.

- Improved breeds: are essentially milk animals such as Pie-noir Frisonne, Holstein, Montbeliard, and Taranthese. All are imported. They make up 8% of the total.
- Local breeds: They are rustic animals and well adapted to local conditions, but with low level of production. They constitute 80% of the herd.
- Mixed breeds are a kind of crossing between imported and local breeds. They make up 12% of the total.

3.2 Sheep

In Morocco there are various local breeds of sheep. Each is adapted to different local conditions/area of the country.

These breeds are:
• Timahdit. (Midle Atlas area) 1.2 Millions heads.
• Beni Guil (Oriental area) 2.3 Millions heads.
• Beni Hsan (North area) 300 000 heads.
• Sardi (Central area) 750 000 heads.
• D'man (South area) 200 000 heads.
• Boujaad (Phosphate area) 80 000 heads.

These breeds are subject to specific action of genetic improvement in their environment.

Imported breeds. They are 20 flocks of 5 000 heads. Such as : Ile de France, Merinos, Noir de Velley, and Cosdulot raised in intensive systems and used for crossing with local ewes for meat production.

3.3 Goats

There are many genetic types in the goat herds in Morocco. Not yet well defined, they are used in mountain areas specially for meat production.

4. Sheep development strategy

The sheep production development is based on the plan of National Economic Policy. The target group of the program is the rural farmers.

The sheep production program has the objective to increase production by:
• Genetic means.
• Range management means.
• Health means.

4.1 Recording schemes

In order to increase sheep production by genetic means, the following strategy was adopted.
• Development of a selection scheme for each breed taking in account its production in the areas concerned.
• Valorization of local breeds by the development of crossing techniques with imported breeds.
• Support of the existing selection farms to insure extension and to distribute selected rams.
• Establishment of professional organizations to be actively involved in development programs.
• Involvement in applied research.

To achieve this strategy, it was necessary that an animal recording system be established.

Animal species involved: Animal recording is used only in sheep and imported breeds of cattle. The traits measured for cattle are related to milk production and quality of milk.

For Sheep: As a first step, a farm for selection was established in each breed environment. The purpose was not only to safeguard the local breeds in Morocco, but also improve their productive performances. For this purpose, selected and certified rams are produced, and distributed at subsidized prices to the farmers.

Since twenty years ago, the government has been interested in encouraging producers to practice selection techniques. Associations and farmers groups were then created in these environments. For instance, the National Association of Sheep and Goat was created for small ruminants.

This paper will investigate animal recording system for “Sardi” breed .

5. Sardi characteristics, qualities and environment

5.1 Characteristics and qualities

“Sardi” is a breed of big size. It is known as a good user for poor pastures. The animal has a white face with black spots on the muzzle, and the eyes, the legs, the neck and the flank extremes are without wool. The male has big horns. The performances of the breed are:

Weight of mature ram	90 to 110 kg
Mean weight of mature awe	50 kg
Mean weight at 10 days of age	7 kg
Mean weight at 30 days of age	12 kg
Mean weight at 90 days of age	25.2 kg
Daily rate of growth (10 to 30 days)	250 g
Daily rate of growth (30 to 90 days)	220 g
Fertility	97 %
Prolificacy	110 %
Fleece weight	1.4 kg for ewes; 2 to 3 kg for rams

5.2 Sardi breed environment

“Sardi” breed lives mainly in the Central Economic Region of the country South of Settat Province, North of Tadla plain, and Kelaa Province). This region is characterized by an arid climate with seasonal drought from May to September.

Precipitation: The mean rainfall varies from 200 to 250 yearly with erratic distribution over time.

Temperature: The mean temperature varies from 10°C in January to 33°C in July. The maximal temperature records sometimes 40°C, and the minimal temperature varies from 3°C to 6°C depending on the altitude.

Soils: The Soil is quite a limiting factor in Sardi environment. Its low depth, poor fertility, and harsh texture reduce the means for cropping. The type soils are subject to water and wind erosions.

Vegetation: The natural vegetation of the region is composed of several herbaceous species mainly annual with short growing season from November to March. Therefore, the ranges are of fair conditions, and contribute t only 50% of total nutrition needs of the animals.

5.3 Herds numbers

The livestock herd structure in Settat Province where the selection farm of Kra-Kra is located is composed of:
- 83 500 heads of cattle;
- 850 000 heads of sheep;
- 15 000 heads of goats;
- 17 00 heads of camels.

These numbers show that sheep are the dominant species raised in Settat Province. “ Sardi” breed contribute 38% to the sheep population.

The highest portion of sheep is raised in the south of Settat . The flock size distribution is:
- 87.2 % have between 0 at 50 heads;
- 9.6 % have between 51 at 100 heads;
- 3.2 % have more than 100 heads.

The percentage of the “Sardi” breed in the flock near the farm varies from 40% to 90%. Because of its high marketing quality many farmers introduced Sardi” breed in their herd flock.

For the purpose of maintaining and improving “Sardi” breed productivity and profitability of, the government has created a farm for Selection for each breed in the region concerned with this breed. In Sardi environment this Selection farm is Kra-Kra.

6. Kra-Kra sheep selection farm

6.1 Objectives

The Sardi breed development program started in 1953 based on the requirement of national objectives to satisfy the meat market and to:
- Save Sardi breed.
- Increase the local production.
- Increase the performance of Sardi breed.
- Offer extension services of sheep production techniques.
- Offer extension services of range management techniques.

To achieve those objectives, the farm has now between 250 to 350 ewes and 6 to 9 rams.Because of the importance of Sardi breed in this area, the ministry of agriculture has established this farm to improve breeding and production. In this sense genetic actions were given a particular attention.

6.2 Schemes

Nucleus. Flock

best ewes | Ewe Lamb | Ram Lamb | best rams

Testing Performance

ewes | rams

Commercial Flock : Target Population

Based on the above objectives, and selection scheme, the breeding programs is:
- Determination of traits influencing genetics technique available for serving the desired improvement.
- Now it is important to define traits emphasized for selecting both rams and ewes.

The following should be taken as general guidelines for ram traits.
- Acceptable conformation.
- Growth rate.
- Sexual aggressiveness.
- Breed criteria.
- Hardy and rough.

Ewe traits:
- Ideally a year round breeding.
- High fertility.
- Good milk.
- High size.
- Hardy.

The general implementation is:
- Select superior stock based on records.
- Screening base population for top quality ewes and identifying and selecting high producing ewe to be included in the elite or nucleus flock. Screening is done both through records and visually.
- Mate base population with selected rams derived from the nucleus stock.

In this farm, selection program is as follows;
- Control of breeding: period from 15 June to 15 August. Mating groups of 50 ewes and one ram are made. The ewes of one group are marked by one number.
- Control of birth: the period of birth is from 15 November to 15 January with 85 % in December.
- Control of body weight: to determining body weight at specific ages and ADG weights are measured each 21 days from birth to 120 days
- At 4 or 5 month after weaning, the first selection is made for to eliminate the undesirable individuals (Not acceptable breed characteristics).
- At 15 to 18 month of age, the National Committee ranks animals such as:
- Rams:
  - √ Superior Rams are kept for reproduction in the farm, the number of this category is very Small: 1 to 4 a year.
  - √ First, second and, third categories sold to farmers at encouraging prices.
  - √ The refused rams are sold to be slaughtered.
- Ewes
  - √ There are two (2) categories of ewes, the selected ewes are kept in the farm for reproduction and the refused ones sold to farmers. The National committee also certifies animals used for breeding.

6.3 The animal categories

Ewes and rams and their offspring (male, female) are the animals categories involved. In the recording process, the traits measured are related to the parent and their offspring (phenotype, conformation, weight at specific ages , daily growth rate), but no progeny testing is folowed.

Selection of rams and ewes in the farmers' flocks follows the same procedures as that at Kra-Kra state farm. Selected rams produced by ANOC farmers sold for breeding command US$ 250-600 price.

6.4 Purpose of the recording scheme

The success the program for genetic improvement of animal productivity is related to the recording process and control of production performances, and the environment factors. This allows for making many corrections or estimate parameters needed for better decisions (health, nutrition, breeding period, management ...etc.).

6.5 Animal identification

The identification starts with a tag on the left ear at birth. This allows controls of the lambs from birth to 4 or 6 mouth of age, then the animal are tattooed in the right ear generally with a number of 4 numeric codes. The first numeric of this code shows the year of birth.

6.6 The traits measured

The traits emphasized for animal selection are weight at birth, weight at specific ages , average daily weight gain, fertility, prolificacy, and other criteria or traits.

- Weight at birth: heavy lambs at birth grow faster. Birth weights reflect the feeding conditions of pregnant ewes during the last month of pregnancy.
- Weight at specific ages: they are indicators for individual growth and allow intervention at the right moment. The weight of animal are taken at 10, 30, 70 and 90 days of age. The data collected are used to determine, daily growth rate, and earning body weight.
- Daily growth rate: lambs will grow well only if their mothers have enough milk. The ADG between 10 and 30 days is affected by the amount of milk consumed. With this parameter, we can know if the ewe has had good feeding or not during a lactation period. Therefore, it is important to supplement a ewe at right time.
- Other traits measured:

Total productivity = Numeric production x the mean of weight of lambs sold.

- Fertility.
- Prolificacy.
- Wool production.
- Number of ewes by rams.
- Age at the first mating season.
- Number of families lambing twice a year.

All these necessary information is recorded in a lambing registers, declaration cards for mating and birth registers. For daily body weight, animals are weighed regularly at 21 days intervals.

6.7 Nutrition

Feeding is one of the most important aspects of livestock production. Applying correct feeding principles would help to achieve the expected target of production. In this farm, it is important to note that the management and feed requirement varies in relation to class and age groups of sheep. It is recommended that sheep farms having more than 600 heads should attempt to separate, their animals into various classes or groups. Adoption of proper feeding and other management practices would only then be possible to obtain a satisfactory level of productivity. In this farm two case can be presented.

- Normal year: the supplementation is necessary during mating season for more than two months. Each ewe receives 300 gr to 500 gr of concentrates feed by day and the rams receive 1 000 gr/day. Other supplementation is also required during the last month of and the first month of lactation. In this case each ewe receives 500 gr to 750 gr of nutritive feed/day.
- Drought year: all year long animals are fed with 500 gr of nutritive feed and cereal straw ad libitum. But the quantities can be significantly increased during critical periods (mating season, pregnancy, and lactation...).

6.8 Health program

Combination of regularly scheduled activities and good herd management designed to maintain optimum animal health and to achieve optimum production: Herd health should be defined as preventive on the farm. For the herd health program to be successful it is important to keep good and reliable records that can be used. The objectives are achieved by applying the concept of target of performances which is the level of animal health and production that is considered to be optimum and will yield the best economic return on investment. For that a health calendar is observed.

- Antiworming worms 4 times by year.
- Treatment against external parasites 2 or 3 times by year.
- Vaccination against anterotoxemia.
- Vaccination against clavelies.

6.9 Pedigree

Each year the National Committee selects the animals of the breed . The selection is based on the criteria recorded and the animals phenotypes.After animals ranking, this committee establishes pedigree for the animals accepted.

6.10 Types of analysis

- At farm level the analysis of crude data concerns calculating the means of the criteria measured and their comparison to the standard of the breed.
- At the central level, studies are now undertaken to establish “ index” of genetic values of each trait measured.
- The data are available on registers in the sheep selection farms.

6.11 Results

Since 1972 the farm produced about 3 000 selected rams used not only in Sardi flocks but also in other level in Morocco and other countries such as Tunisia, Senegal, Gabon.

- Daily growth rate is now 250 gr/day when it was only 140 gr/day in 1972.
- Weight at specific age is: 12 kg at 30 days. When it was only 8.0 kg.
- 25.2 kg at 90 days . When it was only 17.0 kg.

- Fertility grew from 85 % in 1972 to 97 % now
- Prolificacy increased from 102 % in 19972 to 110% in 1997
- Wool production increased from 08 kg in 1972 to 1.5%.
- The number of animal selected increased from 1981 to 1997

The production of selected rams by sheep select in Farm (F.S.O.K) satisfies organizations to produce selected rams. For this reason the government support group formation.

7. A.N.O.C.

7.1 Introduction

Sheep meat is the most preferred by consumers among all meats.
- Religious aspects: each family slaughters yearly one sheep at the Biram "Aid Al Adha" day.
- Sheep valorize poor feed resources more than other animals.

Taking these considerations into account , it was necessary to organize the producers. The first association was created in 1967 (Association of farmers for Selecting Breeds of Sheep). This association became in 1980, the National Association of Sheep and Goats (A.N.O.C).

The A.N.O.C is managed by an administrative council composed of farmers selected in general annually and of two representatives of ministry of agriculture.

In order to achieve the A.N.O.C objectives, the council is structured to suit the breed and production channels.

7.2 Objectives of the A.N.O.C.

The main objective of A.N.O.C is the improvement of farmers income by increasing meat production of sheep and goats in a variable socio- economic systems and to valorize the producer's/farmer's job in difficult environment. These objectives are described in government orientation to satisfy the market meat. The action undertaken at the farmer level concerned two aspects.

7.3 Repartition of A.N.O.C. farmers

The repartition is shown in the following table.

Species or breed	Goats	Boujaad	Sardi	Beni Guil	Timahdit	Imported	Total
%	5	10	17	18	39	11	100

7.4 A.N.O.C. identification by number

Number of farmers:	1 500
Other farmers:	4 900
Groups Number :	27
Number of heads :	550 000
Rams and ewes produced:	13 700/year

The sheme is actually implemented in the area by government officers who visit each flock twice a month. However, ANOC has actually started to have its own employees.

7.5 Regional organization

North. Sector goat livestock Midl Atlas. Timahdit Breed 5 Provinces | 2 Provinces East Sector Beni Guil Breed at 4 Provinces

A.N.O.C.

South. Sector D'MAN Breed Atlantic Sector Imported breed and Crossing | 2 Provinces South Center Sector Sardi and Boujaad Breed at 5 Provinces

7.6 The activity of A.N.O.C.

These activities have the to objective to produce selected rams and ewes for improving the traditional herd flock.

- Improvement of numeric productivity.
- Improvement of ponder productivity.

7.6.1 Improved of ponderal productivity

This aspect included what is related to the genetic improvement. The Scheme is the same as the program at the state Sheep Farm.

7.6.2 Improvement of ponderal productivity

This aspect included all actions, such as:
- Health program.
- Nutrition program.
- And assistance techniques.

To achieve this objective at the government farm level and other farms, more support is required.

The selection scheme is actually efficient, but concerns only farmers inscribed in the program of performance controls. The number of participating farmers needs to be increased.

In order to reduce high cost, farmers should play important roles in:
- Identification of animals.
- Lambing declaration.

• Lambing registers.
• Performance measurements.

7.7 The government and farmer involvement

The government supports group creation by subsidizing farmers on the basis of number of animals kept on the farm. Selected rams can be sold to various state farms at attractive prices.

Also, farmers take advantage of feed transport and feeds. Therefore, the scheme is easily accepted but the number of the farmers practicing selection in groups increases slowly from year to year.

Actually, the strategy in animal recording is to encourage farmer groups and associations.The charge to groups of farms are is only little percentage and they get a subsidy for each ram or ewe they produce, beside;
• The free herd health program.
• The technical assistance.

7.8 Type and nature of extension

Technical Support: A.N.O.C and DLG. in South Center organize information meeting, about health, nutrition, good animal housing for producers.
• Assist in animal selection.
• Training of technicians involved in selection program.

The number of total farmers in the region is 60, 36 of them are ANOC farmers, 15 do not belong to organized groups and 9 are from the area immediately outside the farm region.

7.9 Results

7.9.1 Number of recorded animal

The number of recorded rams and their repartition by breed at the national level are shown in the following table:

Period/Breed	1967 to 1983	%	Yearly means	1984 to 1993	%	Yearly mean
Beni Guil	741	6	41	1 480	9.3	148
Timahdit	2 374	19.1	132	6 804	42	680
Sardi	2 022	16.3	112	2 501	16	251
Boujjad	-	-	-	398	2.4	40
D'MAN	7	-	--	-	-	-
Total local breed	-	-	-	50	3	5
Imported breed	5 144	41.4	285	11 242	7.0	1 124
Total all breed	7 270	58.6	404	4 898	30	490
	12 414	100	689	16 140	100	1 614

The number of recorded animals has grown from 915 ram lambs and 1 048 ewe lambs in 1983 to the about 2 728 and 7 195 , respectively in 1993, making respectively 14% and 20% of increase yearly.

Comparatively to the period of 1966-83 the number increased by 30% for males and 40% for females.

7.9.2 Evolution of productivity parameters

The ponderal productivity of the breeds was significantly improved in farm advised by A.N.O.C. comparatively to national herd average. Technical interests were given to health, nutrition, reproduction and selection improved the ponderal productivity ass shown in the following table:

Parameters	Non ANOC Breeders before - after	ANOC Breeders before - after
Rate of numeric productivity	65 - 75 %	98-105%
Rate of mortality (young)	7 - 11 %	2-5%
ADG (10-30 d)	70 - 120 g	160-220 g
Age at marketing	5 - 8 mo	4-6 mo
Weight at time of sale	20-23 kg	25-28 kg

The production of selected rams by A.N.O.C. members satisfies now about 20% of the total needs against only 6% in 1983.

8. The reason for introducing and maintaining scheme

Improvement of numeric and ponderal productivity depends on the scheme of genetic selection and other environment factors (health, feed, housing etc.) and to keep good and reliable records that can be used to monitor and evaluate the targeted performances.

Records can be as simple as the individual life time sheep card used in the meat herd. Also major events are recorded, when do they occur and what action taken are recorded.

Every contact person knows the visiting schedule for the year with a checklist to help him in check the farm condition, animal nutrition, animal health, production, reproduction and so on. He takes necessary action needed such as clinical examination, treatments, vaccination, weighing, pregnancy diagnosis, drenching and treatments, vaccination, weighing, pregnancy diagnosis, drenching and analysis to make appropriate recommendations.

Milk Recording and Evaluation Information System in Production in Small Ruminants in Slovenia

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1. Slovenia general information

Total Area	20 256 km^2
Inhabitants	2 000 000
GDP/capita	9 500 US$
No. of farms (1991)	156 000
Arable land per capita	0.12 ha.
Agricultural land per inhabitant (ha)	0.45

A substantial proportion of the Slovenians (7,5%) live on agricultural households, but a relatively small number of these are active, i.e. fulltime employment on farms.

An average family farm cultivates only 3.2 ha of agricultural land. Dairy sheep and goat production in Slovenia is an alternative livestock enterprise suitable for many small-scale or part-time livestock operations. Sheep and goat milk is usually processed and marketed at home.

2. Animal production

General background of the livestock sector (number of animals):

Cattle	500 000
Pigs	560 000
No. of sheep total	30 000
No. of goats total	20 000
No. recorded goats	10%
No. recorded sheep	8%
Milk yield-goats	523 kg
Milk yield-sheep	217 kg

2.1 Goat breeding in Slovenia

2.1.1 Slovenian Saanen breed

10 000 goats
Milk recording (ICAR method A4)

2.1.2 Breeding value is predicted

Additive genetic variance for milk yield and milk content is computed (BLUP)
• common flock effect
• residual covariances

2.1.3 Future approach: developing

Test day for :
• milk yield;
• fat content;
• protein content.

2.1.4 Slovenian Alpine breed

20 000 goats;
milk recording (ICAR method A4).

Additive genetic variance for milk yield and milk content is computed (BLUP);

• common flock effect;
• residual covariances.

2.1.5 Test day

For:
• milk yield;
• fat content;
•protein content;
• lactose content.

2.1.6 Estimation

Of:
• additive genetic variance;
• common flock;
• residual covariances.

2.2 Material

Central database of Slovenian Selection Program for Small Ruminants.

Production Data for Goats:
• 24 044 records
• 1 805 goats - 489 Saanen and 1 316 Alpine
• 57 flocks

2.3 Pedigree

1876 animal - 966 with at least one parent known and 910 with unknown parents

2.4 Methods

Estimation:
- restricted maximum likelihood (REML)
- powell's algorithm in the computer program PeRun
- two trait analyses

Model:

$$Y_{ijklm} = Si+Bj+b_{11}(Z_{ijklm}-\overline{Z})+b_1(X_{ijklm}-\overline{X})+blll(W_{ijklm}-\overline{W})+biv(W_{ijklm}-W)^2 +fijk+aijkl+eijklm \text{ for DMY}$$

$$Yijklm = Si+Bj+bll(Z_{ijklm}-\overline{Z})+fijk+aijkl+eijklm \text{ for FC, PC, LC}$$

Independent variables	Fixed effects
Xijklm - litter size	Si - season (Year month interaction)
Zijklm - milking day	Bj- breed
Wijklm- parity	

2.5 Results

Table 1. Phenotypic variances, phenotypic co-variances and phenotypic correlation's of test day for milk yield and milk contents.

DMY (g)	FC (%)		DMY (g)	PC (%)		DMY (g)	LC (%)
735 797	-182.82	DMY (g)	741 230	-77.27	DMY (g)	751 970	21.21
-0.27	0.61	PC (%)	-0.20	0.20	LC (%)	0.07	0.12
FC (%)	PC (%)		FC (%)	LC (%)		PC (%)	LC (%)
0.62	0.14	FC (%)	0.60	0.03	PC (%)	0.20	0.01
0.39	0.20	LC (%)	0.10	0.11	LC (%)	0.06	0.11

DMY - Daily Milk Yield; FC - Fat Content; PC - Protein Content; LC - Lactose Content.

Table 2. Proportion of variances for dairy milk yield and milk contents.

	DM (g)	FC (%)		DMY (g)	PC (%)		DMY (g)	LC (%)
Residual covariances								
DMY (g)	0.393	- 0.144	DMY (g)	0.393	-0.137	DMY (g)	0.384	0.110
FC (%)		0.697	PC (%)		0.089	LC (%)		0.690
Common flock effect								
DMY (g)	0.295	-0.630	DMY (g)	0.304	-0.196	DMY (g)	0.312	0.226
FC (%)		0.107	PC (%)		0.089	LC (%)		0.102
Additive direct genetic effect								
DMY (g)	0.312	-0.347	DMY (g)	0.303	-0.366	DMY (g)	0.305	-0.103
FC (%)		0.196	PC (%)		0.235	LC (%)		0.208

DMY - Daily Milk Yield; FC - Fat Content; PC - Protein Content; LC - Lactose Content.

Table 3. Proportion of variances for fat, protein and lactose content.

	FC (%)	PC (%)		FC(%)	LC (%)		PC (%)	
Residual covariances								
FC (%)	0.680	0.316	FC (%)	0.707	0.020	PC (%)	0.676	
PC (%)		0.650	LC (%)		0.703	LC (%)		
Common flock effect								
FC (%)	0.134	0.433	FC (%)	0.108	0.202	PC (%)	0.092	
PC (%)		0.112	LC (%)		0.093	LC (%)		
Additive direct genetic affect								
FC (%)	0.187	0.587	FC (%)	0.185	0.343	PC (%)	0.231	0.258
PC (%)		0.238	LC (%)		0.204	LC (%)		0.207

FC - Fat Content; PC - Protein Content; LC - Lactose Content.

3. The health control for small ruminants in Slovenia

Part of the information system in small ruminant production serves also as a health control system

Monitoring in controlled flocks comprises of the following measurements:
- preventive program - dependent on and adapted to the breeding technology;
- parasitological examination;
- biochemical profile;
- pathological examination of dead animals;
- specific monitoring of selected infection diseases;
- quarantine control for the rams in central test station for rams in direct test.

All the data are collected from different breeding flocks and compared in the central data base. They serve for the preparation of health strategy for the following period and for the preparation of eradication health programme for different infectious parasitic or organic diseases.

4. The information system for small ruminants in Slovenia

The information system is based on a centrally organized database, located in the national breeding program headquarters.

Data recording is based on standardized forms and reports.
Events (lambing or kidding, purchases, breeding, culling, lossess, etc.,) are recorded by breeders.
The data are keyed into the computer and are stored in the central database.

Regular reports include: milk trait analysis, analysis of reproduction, testing of rams, and animal inventory.

The central computer system is connected to the Internet. The information system is organized as an intranet and access to the database and other information is available via the World Wide Web from any telephone outlet.

The data storage and applications are running on a UNIX work station using the relational database management system ORACLE.

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Animal Recording in Turkey with Special Reference to Sheep Recording

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1. Introduction

Objective orientated animal recording is the key for efficient livestock improvement (Pollott, 1995). However, due to the extensive, primitive, traditional, low-input-low income nature of livestock production in Turkey, farmers ignored the importance or essence of recording. It still is looked upon as something useless by the farmers. Therefore there has been very negligible amount of genetic improvement in almost every species and breeds in the last century.

In Turkey animal recording is practised in the universities, agricultural research centres and the state farms, disregarding species. However, most of this recording is for fulfilling the formalities in the case of the state farms and research centres rather than evaluating the collected data for specific breeding objectives. The same holds true for the university research units because most of the work is conducted for fulfilling the thesis or desertation requirements. Moreover, in all of these institutions, there is excessive amount of recording which creates a big financial burden on the limited budgets of the institutions concerned (Gürsoy *et al.*, 1996).

There is practically no breeding organisation to promote recording and utilise data for breed improvements (Yalçýn, 1986; Kaymakçý and Sönmez, 1996). Hence Turkish livestock sector is fairly virgin regarding animal recording in low input-low income farms. Recently there are some efforts by foreign funded projects which are organising and assisting the modern pure-bred dairy cattle (specifically Holstein Friesian) farmers to establish an information system and a breeders union for the genetic improvement as well as other expected benefits.

The objective of this paper was to describe the situation of animal recording in Turkey and propose some simple procedures for improving the so called "primitive breeds" which possess promising variation for efficient selection programs.

2. Livestock production in Turkey

Agriculture has a share of 15% in the GNP and of this 30% is contributed by the livestock sector. Where as it is over 50% in most of the developed countries of the west. The share of farms engaged in both livestock and plant production is 96.4% of the 4 million agricultural enterprises. The ratio of the farms engaged only in livestock production is 3.6%. Approximately 65% of the farms possess cattle and 35% small ruminants. Mean cattle, sheep and goat farm sizes are approximately 4, 39 and 27 heads respectively.

With the exception of the modern dairy farms and feed-lots, most of the livestock production has a very traditional extensive nature (Yalçýn, 1986). Feeding of these ruminants is primarily based on grazing the communal range lands, marginal lands, stubbles, fallow areas and also maqie and forests almost all year round. They are housed during the harsh winter days and supplemented with cereal straw and some grains. Almost all the breeds within the sheep, goat and cattle species are highly seasonal in mating and parturition (lambing, kidding and calving). They are the product of thousands of years' of natural selection and are fairly low producers, but very hardy to adverse climatic and nutritional conditions, very resistant to diseases and parasites (Table 1).

Table 1. Livestock statistics by species (000).

Years	Cattle	Sheep	Goat	Buffalo	Camel	Pig
1980	15 894	48 630	19 043	1 031	12	13
1985	12 466	42 500	13 336	551	3	8
1990	11 377	40 553	11 942	371	2	12
1995	11 789	33 791	9 111	255	2	5

Source: State Institute of Statistics 1995.

It is clearly seen that between 1976 and 1995 cattle, sheep, goat, buffalo, camel and pig populations decreased by 25.8 %, 30.5%, 52.2%, 75.3%, 83.3% and 61.5% respectively. In the case of cattle, its contribution to total milk production increased from 58.7 to 87.5% between 1980 and 1995 where as the shares of sheep, goat and buffalo milk production decreased by 53.7, 78.0, and 79.2% respectively (Table 2).

Table 2. Milk production by species (000 ton).

Years	Cattle	Sheep	Goat	Buffalo	Total
1976	3 100	1 004	623	278	5 279
(%)	(58.7)	(19.0)	(11.8)	(5.3)	(100.0)
1980	3 421	1 147	632	274	5 474
1985	7 994	1 073	363	240	9 670
1990	7 960	1 145	338	174	9 617
1995	9 275	934	278	115	10 602
(%)	(87.5)	(8.8)	(2.6)	(1.1)	(100.0)

Source: State Institute of Statistics 1995.

Meat production decreased significantly since 1990 in all the species including buffalo and camel. However mean cattle carcass weights increased from 128.1 in 1983 to 191 kg in 1995. In sheep mean carcass weight increased from 13.4 to 18.6 kg, the goat's from 15.7 to 16.8 kg within the same years.

Table 3. Meat production by species.

Years	Cattle	Sheep	Goat	Buffalo	Camel
1990	360 704	304 000	66 000	11 445	75
1991	339 478	303 000	64 000	8 810	105
1992	300 605	302 000	63 000	7 965	45
1993	295 995	301 000	62 000	7 125	30
1994	316 585	286 000	61 600	7 190	40
1995	292 450	273 000	61 300	5 665	40
1996	287 000	260 000	60 600	5 500	40

Source: State Institute of Statistics 1995.

Turkish economy is in a state of rapid transformation. This also holds true for the livestock sector. According to the recent projections of State Planning Organisation, in the year 2000 there will be a per capita demand of 24.6 kg red meat, 9 kg of poultry meat, 166 kg of milk and 8.5 kg of eggs. This means that red meat production has to reach almost 1 700 000 tons and milk 11 620 000 tons. This seems to be rather dreamy because of the rate of increase witnessed in the production of these commodities.

3. Animal recording in Turkey

Since the establishment of Turkey, animal recording has been primarily carried out by the government institutions such as agricultural research centres, state farms and university livestock research units with the objectives of either fulfilling the formalities or requirements of academic activities. Many a times recordings, started with clearly set objectives were not properly utilised for the genetic improvement of the breeds concerned. The only exception to this may be the recordings carried out in race horse husbandry in various state farms which are still being carried out along with the private race horse farms all over the country. Race horse husbandry is being encouraged both by the MARA and Turkish Jockey Club which generate big amounts of money from the horse races.

As far as the cattle production is concerned, many attempts were made for voluntary on farm recording to be performed by the farmers themselves with the objectives of genetic improvement. The most important one was initiated in early seventies with the World Bank funded Dairy Cattle Development Project. The General Directory of Livestock Improvement\MARA monitored the project which provided very favourable credit to the producers for the purchase of the imported breeding stock (mainly Holstein Friesian), tractor, silage and bale making equipments, milking machines etc. etc. These farms were expected to be the local breeding stock farms. Everything went well until the repayment of the credits, then almost all the farms went out of business because they could neither market their breeding stock nor their milk at expected prices. The data collected could not be utilised because the facilities were not sufficient for fast and reliable evaluation.

Another very old and serious recording in dairy cattle (Brown Swiss) was conducted in the Eskiþehir Sugar Factory of Turkish Sugar Company with the objectives of providing high producing breeding stock to the sugar beet producers. Unfortunately the recorded data between 1945-1979 were used for a Ph.D. desertation which aimed to estimate the breeding values of the bulls which were sired in 40's, 50's and 60's (Akar, 1981).

Recently Italian government funded "Turkish - ANAFI Dairy Cattle Improvement Project" was initiated in nine provinces in Western Turkey for a period of 7 years. Almost 40% of the total cattle population of these provinces is dairy breeds (mostly Holstein Friesian). The main objective of this project was to establish a suitable information system for the dairy cattle farms based on producer collected data and also establish a breeders organisation and gradually hand over the activities totally to the producers. Another dairy cattle improvement project funded by GTZ is carrying out recording in the Aegean and Marmara regions. The main objective is to accustom the producers to organise themselves and finally become breeding stock dairy farmers. Unfortunately these projects have very short lives because the nonent the foreign funding is terminated the project stops. This is mainly due to the farmers' and the government's inability to establish the infrastructure for the continuity of these efforts. Furthermore the farmers are generally indifferent because there are no solid benefits or incentives for them to continue.

State farms have very accurate recording in their dairy units. All the cattle are identified both with tags and tattoo. They have very accurate pedigree cards which also includes date of AI, calving date as well as monthly milk recordings. The whole data is utilised for individual performances as well as herd average performances. Presently the State Farms are the most dependable breeding stock providers locally. They are the most important breeding stock disseminators. Their stock is also better than the imported pregnant heifers with respect to adaptability and the meagre feeding and management conditions provided by the farmers in general.

Table 4 gives the mean farm sizes and their distribution in the country. It is clear that almost 83% of the farms possess less than 9 cattle of all ages. Only 0.12% of the farms have more than 50 cattle of all ages

Table 4. Cattle farm sizes in Turkey.

Number of animals	Number of farms	Percentage
1-4	1 681 714	59.68
5-9	797 846	23.30
10-19	281 076	9.97
20-49	54 634	1.93
50-99	2 976	0.11
>100	211	0.01
Total	2 818 457	100.00

Source: State Institute of Statistics 1987.

It is extremely difficult to record domestic cattle in Turkey. In 1972 only 9% of the cattle population was exotic dairy breeds and their crosses. Presently of the 11 789 000 cattle present in Turkey 14.4% are pure exotic dairy cattle, 40.5% are cross-breeds and the remaining 45.1% are the local breeds (SIS, 1995). This shows that dairy farming is increasing and the demand for exotic breeds and their crosses is extremely high. Hence an efficient animal recording is urgently needed for the improvement of these dairy cattle and their crosses.

Among the local breeds only the Kilis (very similar to Shami breed) variety of the South-eastern Anatolia Red Cattle is a promising genotype and it can be utilised in breeding programs but it is defective in milking because it has to be hand milked.

Of the 34 million sheep in Turkey almost 85% are fat- tailed and the remaining 14% are semi-fat tailed or thin tailed (Table 5).

Table 5. Sheep breeds of Turkey.

Breed	Proportion	Milk prod.	Live wt	Prolificity
Fat tailed				
Akkaraman	43.2	50	45	1.05
Morkaraman	24.4	60	45	1.05
Daglýc	12.3	40	40	1.02
Awassi	2.3	150	45	1.10
Thin tailed				
Kývýrcýk	7.7	70	40	1.15
Karayaka	3.5	40	35	1.05
Cross-breeds	3.0	..		..
Others	3.7	..		..

Source: FAO Animal Production and Health Paper No. 60.

Turkey wasted a lot of time and resource for Merino crossbreeding between 1930-60 for developing Anatolian Merino. Unfortunately these efforts did not bring expected benefits because milk production decreased, mortality increased, uniformity in coat colour was very adversely affected due to the occurrence of coloured patches. Furthermore significance of fineness in wool decreased and nowadays carpet wool is in higher demand and Merino cross-bred wool is not suitable for carpet industry. Had the same intensive allocation of resources were diverted to pure breeding and selection of the local breeds, a great improvement would have been achieved because of the existing great variation in these breeds.

Recording is very limited in most of these breeds and State Farms provide breeding stock to farmers in the case of Awassi, Chios, Akkaraman and Tahirova (1/4 Kývýrcýk 3/4 Ost-Frizland). The only progeny tested nucleus breeding is employed on Ceylanpinar Awassi population under the supervision of the University of Çukurova (Gürsoy *et al.*, 1997).

4. Awassi improvement project

Awassi breed makes up 2-3 % of the total sheep production in Turkey and is well known for its high milking ability and growth performance. It is the major breed in the whole Arabian peninsula. It has proven to have a higher milk production and growth performance than the Iraqi, Syrian and Jordanian strains (Al-Rawi *et al*, 1994; Bahhady *et al.*, 1994).

Since 1987 Awassi population (30 000 ewes) in Ceylanpinar State Farm (size 170 000 hectares) is being carefully screened each year for exceptionally high milk producers (approximately 500 ewes) and placed in the pre-nucleus flock. This flock is individually identified and milk recorded the next year and those eligible enter the nucleus flock. Nucleus flock provides the test rams, rams for the nucleus flock from the planned mantis (AI) of top producing ewes with the progeny tested rams. The surplus pedigreed rams are used in the multiplier and production flocks.

Table 6. Data collected from the Awassi improvement project.

Mating (AI)	Lambing	Growth	Milking
Weights	Lambing Date	30th day wt.	ICAR- A-4
Semen charact.	Birth wt.*	Weaning wt.	Traditional
Date of AI	Sex of lamb	Mid-fattening wt.	
Sire No.	Type of birth	Final wt.	
Ewe No.		6th month wt.	
		12th month wt.	

*Ceased since 1997(previously determined values are used if needed).

University of Cukurova is monitoring the data collection and evaluation. The State Farm is providing the animals, essential inputs such as feed, labour, facilities and other consumables. All the data (Table 6) is loaded to two computers one in Ceylanpýnar and the other in the Cukurova University. Since 1992 three groups of tested rams have been used for planned matings with the top producing ewes of the nucleus flock in order to meet both the ram needs of the farm and also the test rams for the progeny testing scheme. In Ceylanpinar Awassi population milked yield per ewe increased from 70 kg to 152 kg within 7 years. Part of the increase may be attributed to the ongoing progeny tested selection and the outcrossing with the Israeli Awassi rams introduced to the population in 1977 and 1991 (Gürsoy *et al.*, 1997).

Table 7. Mean milked yield and the dissemination of breeding stock.

	1990	1991	1992	1993	1994	1995	1996	1997
Ewes milked (000)	23.3	17.9	15.5	12.1	14.4	13.0	12.5	13.0
Milked yield/ewe	66.9	81.3	90.1	133.6	118.3	136.0	141.5	152.3
Males dissem.	1026	524	391	384	239	2 512	177	NA
Females dissem.	5 285	1 940	3 134	3 498	7 502	2 260	2 499	NA

5. Recording proposal for small holder farms

As mentioned earlier the small holder producers do not have the consciousness, social, cultural and economic infrastructure as well as the incentives to record by themselves or establish breeders associations or unions and perform the task together for the genetic improvement of their animals. Therefore government bodies such as the MARA, Universities, Agricultural Research Centres must participate and carry the task until they themselves are prepared to overtake the responsibility. Hence the following steps sounds proper for the small holder farms:

- Organise each province within itself.
- Establish X Breeders Association and register the innovators from each village as members.
- Let them screen their own flocks and identify the exceptional animals at the peak of the season and register only the exceptional animals.
- Establish or identify a centre for the management of the exceptional animals (pre-nucleus).
- Record the animals if possible with the labour of the producers themselves and meanwhile train them for animal recording.
- Use innovative producers' livestock for on farm progeny testing.
- Show them the superiority of the nucleus animals and let the farmers do their own comparisons.

- Organise scientific and social events for bringing together the farmers participating and let them feel they are different from those who do not participate.
- The government should give incentives and/or side benefits (subsidies) for the participating farmers through the Breeders Association.
- Organise some of the farmers to be nucleus breeders and catalyse the sale of the breeding stock of those farmers.

Provision of cheap inputs, low interest credits, markets and other essentials will definitely bring success and in a short time let them start overtaking some of the responsibilities and eventually hand it over. Furthermore the government institutions MARA, universities and the Agricultural Research Centres should always be close to them as co-ordinators, moderators or catalysts.

6. What to record?

Depending on the breeding objectives of the breed in question a minimum set of data may be recorded with a moderate loss of accuracy in the precision of the breeding values. As far as milk is concerned recording may be further simplified without appreciable loss in precision (Bariellet, 1993).Table 8 suggests a minimum set of data for the genetic improvement of milk and growth merits.

Table 8. Minimum data required for the genetic selection for milk yield and growth performance.

Milk	Growth
- Sire and dam identification	Date, sex and type of birth
- Date of parturition	Weaning weight (60 days)
- Monthly morning and evening milk recording after weaning (for 90 or 120 day estimation)	Final weight (if fattened 6th month wt.) 12th month wt.(mature wt)

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The Development and Maintenance of Animal Recording Schemes for Low to Medium Input Production Environments - A Case Study on Animal Recording Systems in Greece

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1. Characterisation of the animal recording system in Greece

Animal species involved: cattle, sheep and goats

Breeds of the species involved:
Cattle: Holstein Friesian, Brown Swiss, Simmental
Sheep: Mountain breeds: Boutsiko, Sfakia.
Plain breeds: Karagouniko, Serres, Arta (Friesarta)
Island breeds: Chios, Lesvos (Mytilini)
Goats: Skopelos breed

2. Overall input level of the production environment

Dairy cattle in Greece is kept in environments which range from the upper medium to high level of inputs and for that reason in the present case study more consideration will be given to the recording systems of sheep and goats. Nevertheless, in Greece the general purposes, procedures and conditions for recording are the same for all species and breeds.

There are three main systems of sheep production:
1. The extensive system with transhumance. Breeds involved are: The Mountain breeds, Vlachico, Sarakatsaniko, Sitia, Sfakia and Boutsiko.
2. The extensive or semi-intensive system without transhumance: Breeds involved are: Occasionally the Mountain breeds (Vlachico, Sarakatsaniko, Sitia, Sfakia and Boutsiko), the Plain breeds (Karagouniko, Serres, Frisarta upgraded sheep, etc.) and occasionally the Island breeds (Chios, Kymi, Lesvos, Skopelos and Zakynthos).
3. The Intensive system: Breeds involved are: the Island breeds (Chios, Kymi, Lesvos, Skopelos and Zakynthos) and occasionally the Plain breeds (Karagouniko, Serres and Frisarta).

There are four main systems of goat production:
1. Extensive system with and without transhumance. Breeds involved are the different populations of local goats.

2. Semi-intensive system and
3. Intensive system. In both these two systems the breeds involved are: the local Skopelos and the imported Malta and Saanen breed or crossbreds of local goats with Malta, Saanen and the Skopelos breed.
4. Home-fed system. Breeds involved are: The Malta and Saanen breeds or crossbreds of local goats with Saanen.

3. Number of herds/flocks and animal recorded

Table 1. Dairy, sheep and goats milk recording in Greece: populations, number of recorded animals and herds.

Species and breeds	Total population	Recorded animals (% recorded)	Total herds per flocks	Recorded herds (% recorded)
Dairy cow breeds (data from 1996)	216 000	61 867 (28.6%)	n.a.	1 425
Holstein Friesian	203 000	61 508 (30.3%)	n.a.	1 411
Brown Swiss	13 000	225 (1.7%)	n.a.	9
Simmental	n.a.	134	n.a.	n.a.
Sheep breeds (data from 1994)	561 800	31 611 (5.6%)	8 645	429 (5.0%)
Mountains of Epirus (Boutsiko)	28 700	2 450 (8,5%)	300	24 (8.0%)
Sfakion	75 000	1 650 (2.2%)	1050	20 (1.9%)
Karagouniko	208 000	14 800 (7.1%)	3210	210 (6.5%)
Serres	38 000	2 200 (5.8%)	670	32 (4.8%)
Frisarta	27 800	5 011 (18.0%)	835	73 (8.7%)
Chios (purebred)	7 300	1 000 (13.7%)	350	10 (2.9%)
Lesvos	177 000	4 500 (2.5%)	2230	60 (2.7%)
*Goat breed**	8 000	3 296	n.a.	n.a.
Skopelos (data from 1994)	8 000	3 296 (41.2%)	n.a.	36

*local goats populations are not controlled
n.a.=not available

Table 2. Number of livestock species in Greece ('000).

	Years						
	1965	1970	1975	1980	1985	1990	1993
Cattle	1 131	971	1 184	900	776	687	608
Sheep	8 338	7 355	8 340	8 397	9 939	10 149	10 069
Goats	4 007	4 003	4 549	4 637	5 696	5 904	5 821

Source: National Statistical Service of Greece.

4. Animal categories involved in the recording process

In each controlled farm/flock, all females (cows/ewes/goats) and subsequently all their female progenies (calves/lambs/kids) which are maintained as replacements, are involved in the recording process. Performance recording on the Agricultural Research Stations involves all the animals in the flock (sheep, goats only), which act as breeding nucleus for the genetic improvement of the relevant breed.

4.1 Purpose(s) of the scheme

In general, cattle, sheep and goats performance recording aims at improving through mass selection milk production and estimating the necessary genetic parameters for milk yield, needed for the operation of the genetic improvement scheme.

We recognise in Greece two types of recording schemes. On-farm and on-station performance recording

On farm performance recording for dairy cattle, sheep and goats was conceived to provide firstly data for the genetic improvement of the animals and secondary to supply management and technical information for the farmers. Is carried out, until recently, exclusively by the Ministry of Agriculture and nowadays, the trend is going towards the farmers organisations.

Performance recording on the Agricultural Research Stations aims at collecting data for studying the various native sheep and goat breeds of the country and is carried on without the involvement of the livestock keepers. Furthermore, some of these flocks (the Chios breed at Chalkidiki Agricultural Research Station) are considered as nucleus breeding units for the genetic improvement of the breeds. These institutions are supervised by the National Foundation for Agricultural Research.

4.2 Animal identification

Identification is made by plastic eartags. This unique official number consists actually of two numbers, namely the herd number and an animal number made up by the year of birth and an in-herd running animal number. Identification for milk recording and A.I. applied for genetic improvement in cattle, are identical. Furthermore, the Greek Veterinary service is using for all species a second plastic eartag aiming at the identification of the animals for health purposes.

4.3 Traits measured

The traits considered and the collected information are:
1. Individual identification of all animals
2. Mating and lambing/kidding dates and consecutive number
3. Type of birth, sex of the lambs or kids and litter size
4. Monthly controls of milk yield (a.m. and p.m.) after the suckling period
5. Fat, protein and lactose content of milk.
6. Live weight records of lambs at regular intervals (birth, before and after weaning).
7. Live weight records of ewes at mating and lambing

Actually, not all these traits are measured. Well working is the recording of the traits 1, 2, 3 and 4.

The method of milk recording is the official A one, once a month two milkings per day. The controller records for each ewe in his first visit after lambing/kidding, the identification number, the age in years, the data and the consecutive number of the lambing/kidding, the number and the sex of the lambs/kids born alive (after the first 24 hours). The visits are repeated once a month and the milk yield is measured in the first visit after the suckling period. Measure is taken place by a volumetric tube with markings of 1/100 lt. This is done until the end of the lactation period of each ewe/goat, which is considered when daily milk drops under 0.05 lt. (~ 50 gr). The collected data with a sample for measuring the milk contents is delivered immediately after the visit, to the responsible Animal Genetic Improvement Centre.

4.4 Other information collected

Information regarding feeding or health traits is not collected. Pedigree information derives, when properly registered, from the individual identification and lambing data.

4.5 Types of analysis of data

No analysis of data is undertaken on the farm/flock. Milk samples are analysed at the Animal Genetic Improvement Centres (Drama, Thessaloniki, Karditsa, Ioannina, Athina) by two in each Centre MILKOSCAN apparatus (type 104 without printing and 133 with printing device), capable to measure fat, protein, lactose, Solids without and with fat, in a rate of 700 samples per hour. After milk content is determined, the results are matched with milk recording data and finally sent for processing to the central computer. The trend is going towards storing and processing the collected data at local PC's (in one Genetic Improvement Centre is already done).

4.6 Computerisation and storing of the data

The processing of the data is accomplished centrally. At the beginning of the application of animal recording a small scale computing centre was established in co-operation between the Ministry of Agriculture and the Department of Animal Husbandry - Laboratory of Animal Genetics and Breeding of the Aristotle University of Thessaloniki, in the University Farm. This computing centre provides facilities for processing milk and reproduction control data collected in northern and central Greece (where the major part of the dairy cattle population is kept) while the southern and western regions of the country are using the computing facilities of the Ministry of Agriculture in Athens. In the mean time a part of the processing work is accomplished by personal computers in an Animal Genetic Improvement Centres using home made software.

Processing for the cattle recording data is taken place every month and the results are sent back to the farmers. At the present time processing for sheep and goats is accomplished once, at the end of the production period and the advice to the farmers is based on the results of the total lactation of each ewe/goat and the average production and the standard deviation of the flock in relation to the average and standard deviation of the whole region for which the Animal Genetic Improvement Centre is responsible.

4.7 Government and farmer involvement

Responsible for the proper application of the on farm performance recording is the Greek Ministry of Agriculture and the financial support comes from the Greek government.

At this point, it should be remembered that in Greece the basic adverse factor for the promotion and improvement of the animal recording and the livestock structure in general, has been the absence of organised initiative from the part of our livestock breeders. As a consequence, in our country there are no genealogical books belonging to farmers organisations, fact that is also implemented in other Mediterranean regions with similar conditions.

The constraints of the recording are not balanced by the individual and collective interest of the results provided and there is also a degree of breeder resistance to recording because of the tedium of the milk sampling and weighing and the slowness of response time, apparently for the optionally cost of recording. The current trend is to simplify the recording and to accelerate data turnaround.

4.8 Who pays for the recording

The responsibility for the on farm performance recording has been undertaken exclusively by the Ministry of Agriculture and the financial support comes from the Greek government. Performance recording on the Agricultural Research Stations is supervised by the National Foundation for Agricultural Research, which indirectly takes financial support from the Ministry of Agriculture.

Furthermore, during the previous periods (since 1993) the Ministry of Agriculture granted the farmers considerable premiums to join the recording and genetic improvement scheme.

4.9 Type and nature of technical support

The recording and genetic improvement scheme gets scientific and technical support from the Ministry of Agriculture and the Agricultural Universities.

The Direction for Inputs to Animal Production which is responsible for Animal Genetic Improvement in the Greek Ministry of Agriculture, operates five regional Animal Genetic Improvement Centres (Drama, Thessaloniki, Karditsa, Ioannina, Athina). These Centres monitor the milk recording and genetic improvement scheme, process and evaluate the collected data in collaboration with the Animal Production Department of the University of Thessaloniki , informed the producers on the relevant results and give them properly technical advise on feeding, breeding and selection. Further technical advice to the farmers is also given by the Regional Agricultural Development offices of the Ministry of Agriculture.

4.10 Principal people involved in the development and maintenance of the scheme

The Ministry of Agriculture, Direction for Inputs to Animal Production with five regional Animal Genetic Improvement Centres (Drama, Thessaloniki, Karditsa, Ioannina, Athena).

The Agricultural Universities (Thessaloniki and Athena) support the scheme with computer facilities, software for processing the collected data and scientific methodology for the genetic evaluation of the recorded populations.

4.11 Main reasons for introducing and maintaining the scheme

The official animal performance and especially milk recording is applied in Greece for about 50 years and it can be divided in four periods.

The first period, which could be characterised as an introductory one, covers the years between 1952 and 1962, when milk recording was planned by the regional services of the Ministry of Agriculture and intended to identify only the variability of milk yield of sheep raised in farms, without being an integral part in the frame of a genetic improvement programme of the known breeds.

The second period covers the years from 1963 to 1977 and is characterised from the issuing by the Ministry of Agriculture of the relevant decisions and regulations for the organisation and operation of the herd book and milk recording of the common bovine, sheep and goat dairy breeds. Milk recorders were employed by the regional services of the Ministry of

Agriculture in order to carry out milk and fat content recording, body conformation measurements, collection of feed intake information and processing of the data.

The third period covers the years from 1978 to 1992 and is characterised by the establishment in the Ministry of Agriculture of the Direction of Animal Genetic Improvement (later renamed to Direction for Inputs to Animal Production) and of five regional Animal Genetic Improvement Centres (Drama, Thessaloniki, Karditsa, Ioannina, Athena). These Centres monitored the milk recording and genetic improvement scheme, processed and evaluated the collected data in collaboration with the Animal Production Department of the University of Thessaloniki and informed the producers on the relevant results. In 1978 and 1982 the regulation of animal milk recording of 1963 was amended, as well as the relevant decision concerning the organisation and operation of herd book.

The fourth period, which is a continuation of the previous , has started in 1993 and lasts until now (1997). In this period, also, the Ministry of Agriculture is still in charge of the organisation and operation of milk recording and herd book keeping, but there is the intention to totally involve the co-operative organisations, under the supervision of the Ministry.

4.12 Most significant activities and design peculiarities that have enable the Scheme Initiated

The genetic improvement scheme, which has been introduced since 1978 and with minor modification is carried out until today, is characterised by the establishment in the Ministry of Agriculture of the Direction of Animal Genetic Improvement (later renamed to Direction for Inputs to Animal Production) and of five regional Animal Genetic Improvement Centres (Drama, Thessaloniki, Karditsa, Ioannina, Athina). These Centres monitored the milk recording and genetic improvement scheme, processed and evaluated the collected data in collaboration with the Animal Production Department of the University of Thessaloniki and informed the producers on the relevant results. Now (1997). The Ministry of Agriculture is still in charge of the organisation and operation of milk recording and herd book keeping, but there is the intention to totally involve the co-operative organisations, under the supervision of the Ministry,

4.13 Maintained

During the last period milk recording was carried out more systematically, on a larger scale and in the frame of a more specific genetic improvement programme per animal species and breed. A number of milk recorders has been employed, but it was not enough to cover the needs of the milk recording programme. Furthermore, a close co-operation has been established between the competent services of the Ministry of Agriculture and the Animal Production Department of the University of Thessaloniki. The use of computers has been started and as a result, the whole programme has been improved, as far as the collection, evaluation and use of all the relevant data by the farmers and the responsible scientists are concerned. In addition to the milk yield, data of milk composition and data related to artificial insemination and parturition were collected.

5. Changes to the design and operation of the scheme

The farmers' organisations will be responsible for the identification of the new-born calves/lambs/kids, the application of milk recording and analysis of the milk samples for fat and protein content, the collection of reproduction data and the keeping of a data base for production and pedigree certificates. For these activities, separate organisations for bovine, sheep and goats re under way to be established. Especially, sheep and goat breeding will be carried out in collaboration with several research institutions, which will act as breeding nucleus. Progeny testing, calculation of genetic merit and evaluation of secondary traits, will be carried out by the regional Genetic Improvement Centres, in collaboration with the University of Thessaloniki.

In the mean time a part of the processing work is accomplished by personal computers in the Animal Genetic Improvement Centres using home made software.

Decentralising of the production records by region (input and output) would give more flexibility to the recording programme and allow the farmers to have the relevant records sooner. Furthermore, the development of communications with the use of modems between the computing centre and the on farm personal computers of the co-operative members will allow them to interact directly with the data bases

6. Future directions

Motivation of the foundation of independent co-operatives or non-profit organisations, in an attempt to spread out the animal performance recording and apply specific genetic improvement projects more systematically.

The farmers will be motivated to contribute economically to the milk recording programme.

Application of simplified methods of recording, appropriate for low to medium input production systems.

Managing by computers. One of the most important factors for the farmer who produces milk, especially under the milk quota restrictions, is the economy of the milk production. It is planned to collect all the necessary data related to the economically important factors of the milk production in the frame of the official milk recording system, in order to establish a good basis for planning the production and managing the whole farm.

Performance Recording in Dual Purpose Cattle in Venezuela

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1. Introduction

Venezuela lies in the north of South America, bordering the Caribbean sea. It stretches from 1º to 12º North and from 60º to 70º West. The Andes occupy a small area in the north west, which consequently has a temperate climate, but most of the country is lowland tropics with a rainy season of 5 to 10 months a year and between 600 and 2 000 mm of precipitation annually. Mean maximum, minimum and overall temperatures are 35º, 16º and 31ºC, respectively.

With a population of 21.4 million people, only 11% of the economically active are in the rural sector. The country has a deficit of food and depends on importation to satisfy demand. In 1994, food importation (excluding fish) reached a value of US$ 886 100 000. Of foods of animal origin, milk has one of the highest deficits. The large negative balance of agricultural imports and exports is made possible by Venezuela's production of oil.

According to the Central Bank, the overall economy suffered a contraction of 8.3% in 1989, with agriculture reduced by 5.1%. Despite overall growth of 4.4% in 1990, agriculture again fell by 1.3%. In the animal production sector, reductions occurred in milk (-3.4%), pigs (-15.3%), poultry (-1.9%), eggs for consumption (-22.5%) and hatching (-l.6%). Similarly, in the period 1980-90, the production of milk per capita fell by 2% annually, while the population grew at a rate of 3%, according to the 1990 census. Milk consumption per capita fell by 4.9% annually in the same period, due to the reduction in real income and despite the policy of consumer subsidies. The supply of milk decreased from 140 litres to 85 litres per capita between 1980 and 1990, and the tendency continues to date. The milked cow population was estimated at 1.3 million in 1994, with an average yield of 1 268 kg milk/cow/year. A large area of the country is devoted to pastures (17.4 million ha.). To satisfy the demand in 2 000, it is postulated that yields per cow will need to be increased to 1 800/litres/year, with a population of 2 427 000 cows in milk, an increase of 1.2 million hectares of grassland (1 AU/ha.) and a volume of 1 456 000 MT of concentrate feed (600 kg/cow-calf/year). Unless an improvement is made in current technology, the requirements will be for 3.5 million cows in milk and an increase of 2.2 million hectares of grassland (Montenegro, 1992). The low carrying capacity of the pastures (0.79 AU/ha.) presently limits animal production, but on the other hand offers important opportunities for improvement through rational utilisation and management.

2. Official milk recording service (ROPL)

Between 1956 and 1994, the country had an official national milk recording service. It was initially run and financed by the Ministry of Agriculture and Breeding (MAC), but was limited to the central-western states and data were processed manually. By 1972, electronic processing was introduced and the work carried out under agreements with two of the largest universities in the country. Information was obtained from the farms by an authorised supervisor, collected together by technical personnel from the Ministry and sent for processing to a central computing office (MAC-BAP-IAN). The resulting reports were then returned to the various regional offices for distribution to the farmers. The producers who requested the service had to meet certain conditions, as a result of which the herds included had above average levels of management. The processing methodology and report format closely followed temperate climate models.

Table 1 shows trends in numbers and yields of cows and farms enrolled in the service. The relatively large herd size is a notable feature. It may also be observed that yield per cow/day increased only 0.8 kg between 1972 and 1986. From 1980 onwards, an incentive of US$ 0.02/litre was given for herds in the system which led to a significant increase in the number enrolled, so that by 1984 more than 2 000 herds were included in the service with over 350 000 cows. The same year, herds were obliged to use artificial insemination in order to receive the monetary incentive. This new requirement led to a decrease in herd numbers. By 1989, it was estimated that 25% of the dairy herds in the country and 28% of the national dairy herd was enrolled in the service, producing 35% of the country's total milk yield (F. Salvador, personal communication).

Table 1. Number of herds, cows and milk production in the official milk recording service.

Year	1972	1981	1986
Number of herds	32	456	1 236
Number of cows	11 402	111 297	273 997
Cows per herd	356	244	222
Total milk production (kg)	44 032	389 558	1 270 537
Milk/cow/day (kg)	3.8	3.5	4.6

Modified from Hahn (1988).

In 1993, the Ministry terminated the contracts with the two universities and the service was discontinued. The government's decision was partly due to costs, but also attributable to:

- delays in processing the data and returning the information to the farms (several months after data collection);
- the fact that little or no use was made by the farmers of the monthly reports, partly because the reports were so late and partly because most farmers were not sufficiently knowledgeable to interpret them;
- lack of technical assistance to the farmers.

On the other hand the veracity of the data was frequently questioned, especially once the incentive was paid per litre, because so little supervision was given to the monthly weighings. Also, limitations in the data collection and herd management on most farms meant that the records were not usable for estimating the breeding value of bulls through progeny testing.

3. Dual purpose cattle recording

Work on the performance recording of dual purpose cattle was started in 1990 as part of a research project on the evaluation and genetic improvement of this type of cattle (Vaccaro *et al.*, 1996). The project was financed by the IDRC of Canada with the Universidad Central de Venezuela, and carried out in private dual purpose herds (production of milk and a calf for beef) which expressed particular interest in the research. The phase of the project which is of particular interest in the context of this Workshop had the following objectives:

- definition of traits to be measured in dual purpose cattle for describing productivity and genetic improvement through selection
- development of methods appropriate for field recording under tropical conditions
- development of computer programmes for data processing with a view to:
  - providing farmers with timely information for taking decisions on the management and feeding of their herds
  - listing cows in each herd according to their estimated genetic merit for production, and encourage the use of the information for selection
  - helping with other aspects directly related with the genetic and phenotypic evaluation of the cattle used in this production system, on the basis of the information obtained.

4. Choice of co-operator herds

The herds were chosen on the basis of the production system (because of its predominance in Venezuela and throughout tropical Latin America), the interest of the owners in participating in the research, the type of cattle used (crossbred *Bos taurus x Bos indicus*) and the number of cows in milk (at least 40). Each farm contributed information required to meet at least one of the project's objectives. Because of the progressive attitude of the farmers and large herd size, the herds cannot be considered typical, either nationally or regionally. However, they are considered to be representative of the dual purpose system as found throughout the tropical region, in terms of feeding, milking system (usually by hand with restricted calf suckling), general management and the absence of performance recording.

5. Project operation

Co-operator herds were located in four states, at between 198 and 748 km distant from the headquarters in Maracay. The number of farms varied between 12 and 20 over the years, with between 1 552 and 3 077 cows under monthly performance recording. Initially, milk and calves were actually weighed by project staff, with the help of farm workers but later clock balances were bought and the farm workers assumed the responsibility, with occasional supervision from the project. Rectal palpation was carried out every three months initially by the project, but after the third year the farmers themselves did the pregnancy diagnosis at intervals of approximately six months in most cases. An aspect of vital importance was the monthly visit of the project technician, as well as frequent visits from thesis students and the university professors responsible. The calendar of farm visits was adhered to rigorously over the years. The herd located furthest away from headquarters (748 km) was visited every three months after the third year, and then every six months. In the intervening periods, data were exchanged by fax and courier.

At every visit, the project technician carried out the following duties:
- supervision of the milk testing, and collection of data recorded by the farmer (dates of calving and drying off, services, deaths/sales, etc.)
- direct recording of some of the data (e.g. calf weights)
- delivery and explication to the farmer of the previous month's report
- discussion of the work programme for the immediate future

The following sheet was used for field data collection:

--- DUAL PURPOSE CATTLE BREEDING PROYECT --- HERD ____________ TEST DATE ____________

*** INFORMATION ON PRODUCTION, REPRODUCTION AND CALF'S WEIGHT ***

IDENTIFICATION — CALVING — CALF

BREED Number Date /Day DATE Milk Numb. LAST SERV. DIAGNOSIS Serv. Sex Wt PALPATION DATE DRYING OBSERVATIONS Number Name

With the computer programme which was actually used, it was considered important that:
- all information collected on a given cow at each visit should be written on a single sheet (not different sheets for different types of information), because the data were transcribed into the computer according to the identification of the animal, not the type of information (e.g. milk weight or calving date).

- a master sheet for data collection should be prepared which can be photocopied or printed, with all cows and heifers in service listed in order, instead of preparing a new sheet each time different cows enter or leave the herd in milk.

6. Computer programme

The commercial programme used permits the processing of the field data with certain limitations with respect to speed. It offers multiple options for calculations, but these have to be done using combined functions. It also permits the management of the information in numerical or alphabetical order. Information is transcribed for each animal using windows or the presentation of each field in sequential order. The calculations made in the processing of field information for each cow include:

- Milk yield (kg) in the last period.
- Accumulated milk yield in the present lactation.
- Accumulated days in milk in the present lactation.
- Expected calving date for cows reported pregnant.
- Number of days open.
- Accumulated milk yield in the first 244 days of lactation.
- Calf weight adjusted for sex and age at 120 days.

7. Monthly reports

These reports contain the following sections:

*Cows in milk: I*dentification, breed group code, calving number, calving date, days in milk, test day milk yield, accumulated milk yield in current lactation and up to 2 44 days, service date, number of services, expected calving date, calf sex, 120-day calf weight, days open and observations. Cows are listed in increasing numerical order.

Dry cows: Identification, breed group code, last calving number, last calving date, last service date, number of services, expected calving date, days open, observations. Cows are listed in increasing numerical order.

Cows with above average daily yield: Identification and basic data. Cows are listed in increasing order of last test day milk yield.

Cows to calve in next 90 days: Identification and basic data. Cows are listed in increasing order of expected calving date.

Cows with over 150 days in milk and not pregnant: Identification and basic data. Cows listed in increasing order, according to identification number.

Cows reported dry in previous month: Identification and basic data on last lactation. Cows listed in increasing order of calving number.

Monthly summary: Herd; recording period; numbers of heifers, cows in milk and dry cows; average yield of cows in milk; average days in milk per cow; number of cows reported pregnant; services/pregnancy of heifers, first calf and older cows; number of cows with over 150 days in milk and not pregnant; number of days open per cow pregnant; average calving interval; average days open for first calf and older cows; number of cows reported dry; mean days in milk and mean milk yield per lactation of cows reported dry; request for missing information or clarification of apparently abnormal data.

8. Estimated genetic merit listings

Every six months, farmers receive a list of their cows with estimated genetic values for milk yield per lactation, days open and 120-day calf weight. Cows are listed in increasing order of merit for milk yield. The calculations are made using a programme especially designed by the project. It assumes hypothetical heritability values for the three traits, and makes use of available information from all calvings of each cow. Corrections are made for calving number, year and season. The decision to include estimates for days open was based on the evidence of reasonable heritability values for female reproduction traits in American zebu populations, and the negative genetic correlation between milk yield and fertility found in the project's cow population. The genetic merit listings are accompanied by a table which gives the herd's mean values for each trait, according to calving number, year and season. A list is also supplied which summarises performance data of all cows (live and dead) in the project data base for that herd, ordered by cow identification number. It includes actual yields and the corresponding deviations from contemporary means for each trait. Finally, a simple text is included, explaining how the calculations are made and how the information should be used for selection and culling.

9. Project staff

The work is carried out by one university professor who dedicates about half time to the project, with the occasional support of two more professors. One technician is primarily responsible for all field work, with one or two research assistants, depending on the number of herds at the time. The research assistants transcribe, process and analyse the data, not only for the farm reports but also for different aspects of the research carried out. They also prepare texts for publication and have minor administrative responsibilities. However, all members of the team share the work in a flexible manner which contributes greatly to the ensuring strict and punctual coverage of the work calendar. A decisive factor has been the level of training of the technical team. All of them have undergraduate degrees in animal production, two finished their Masters' degrees while working in the project and two more took graduate level course work. All of them were ex-students and had been tutored by one of the project's professors for their undergraduate thesis work. This is believed to have helped greatly in the selection of suitable candidates, and to have contributed to the excellent team spirit.

10. Equipment

The project has a four-wheel drive vehicle for the exclusive use of the field technician. The first one had to be replaced after three years. The total distance travelled in seven years was 387 552 km.

Work started using an IBM microcomputer with 12 Mhz, 1 MB of RAM memory and a hard disk of 60 MB. The acquisition of faster machines became necessary partly because of the difficulties encountered in repairing the machines in use, and partly to accelerate data processing. In the fourth year, the project bought an Epson 486 with 99 Mhz, 4 MB of RAM memory and a hard disc of 210 MB, and in the sixth year a Compaq Presario 5226 Pentium was acquired with 100 Mhz, hard disc of 1 GB and 16 MB of RAM memory. On average, it has been necessary to have two computers operational all the time in order to meet deadlines without exception. Poor public transport facilities and major problems of personal security make it impossible to work routinely by night as well as by day.

11. Operational costs

The project was financed completely by the IDRC for four years. As external funding decreased, the farmers unanimously agreed to contribute to costs and have, without exception, done so from the fourth year on. In the sixth year, additional support was received from the University. The total annual budget is presently about US$ 27 000

Total operating costs are estimated as US$ 0.80/cow/month, of which the farmers presently pay US$ 0.33/cow/month, besides offering food and lodging to the field technician. It is important to emphasise that the project is not simply a field recording service, but has specific research objectives. Thus, in the period 1990-96, a total of 60 scientific publications were generated, as well as extension materials for the co-operating farms and others.

12. Project impact

Twelve project farms participated in the project throughout the whole period. Between 1990 and 1995, national average milk yield/cow/year decreased 1%. On the project farms, mean milk yield/lactation increased 6%, days open decreased 10%, 4-month calf weight rose by 9% and calf mortality fell by 22%. This gave a total increase of 10% in '(milk + calf)/cow/year' in six years. The four most progressive farms increased milk yield/lactation by 22-83%, and yield of (milk+calf)/cow/year by 38-79%. However, in four herds, yields fell. This was attributed to the closure of the local milk plant due to falling demand, continued changes in farm personnel and, importantly, to the irregular presence of the owners on the farms due to security problems. It was concluded that major progress could be made in many other dual purpose herds in the region, through the co-ordinated use of technologies already available in the fields of genetics, feeding, health and management. However, factors beyond the farmers' control are often responsible where progress is not made.

13. Lessons from the project

Traits to be measured. It was concluded that milk yield/lactation, calving interval, calf weight and survival are the minimum required for herd monitoring, breed group evaluation and selection programmes for dual purpose herds. The high repeatability of milk yield suggests that selection decisions can be taken after the first lactation for milk yield, though more records are preferable for selection for fertility and calf weight. The frequency of abortions and stillbirths was so low and subject to so little variation, that these traits may not usually need to be recorded.

Milk recording. Monthly sampling led to unacceptable errors in the prediction of lactation yield, where cows are milked by hand with restricted suckling of calves. Weekly samples or two weighings every two weeks are recommended, particularly where the objective is to distinguish between cows of different productive capacities.

Editing of milk records. The proportion of lactations of zero days duration was 9%, and 19% lasted less than 100 days. Fifty four percent of cows whose calves died, went dry within 30 days. It was concluded that the frequency of short lactations is so high in all breed groups, including high grade European crosses, that they cannot be considered abnormal. Their exclusion from data analysis can lead to serious errors in the evaluation of systems, farms, breed groups and individual animals.

Body weights and measurements. Calves up to 200 kg were routinely weighed with a spring balance, and adults with a portable electronic one. Serious problems were encountered in taking body measurements on some zebu-type cows, even in the milking herds. Weights of calves and adults could be predicted quite accurately from body measurements.

Data processing. Experience led to the recommendation that the possibilities should be explored of using available commercial programmes for data processing, rather than writing a new one.

Farmer co-operation. One of the outstanding results of the project was the uniformly high degree of co-operation given by the farmers. Some of the reasons may be extrapolable to recording programmes in other developing countries. First, great importance is attached to the initial selection of the farmers, according to their interest in participating in research. This process was facilitated in the present case by contacts through students and old alumni, which is a particular advantage of any university. Second, it is vital that farmers participate in setting the research agenda, and that the latter includes studies which will produce useful results in the short, as well as longer, term. Third, useful services and technical assistance must be provided to the farmers, in order to maintain their interest and support. The ability of the field technician to establish communication and links of respect and co-operation is of key importance. In the present case, the monthly herd reports, the lists of cows in order of genetic merit, the annual reports of time trends in each herd and the summaries of the research results, written in simple language, are also considered to have played an important role. Fourth, it is considered essential to carry out the work calendar strictly as planned, without exception. The difficulty of doing this under typical conditions in the tropics should not be underestimated. In our case, the problems included violent civil disturbances, danger of assaults and robbery, strikes, frequent and prolonged suspension of electricity and communication services, extreme climatic conditions which complicated travelling, and mechanical faults in the vehicle and computing equipment. Overcoming these types of problem depends on having a very highly motivated, versatile team, with a high sense of responsibility and initiative. Human qualities probably contribute even more than technical qualifications under such circumstances. On the other hand, the economic support of IDRC made it possible to establish good working conditions for the technical staff. This contributed importantly to stability and the development of an excellent team spirit.

14. Constraints and the future

There is presently no governmental organisation of milk recording. This is mainly due to the absence of infrastructure required to organise it efficiently, and to reduced public spending in agriculture. Technical assistance work is reluctantly being taken over by producers and the private sector is struggling to revert this attitude. A sustainable recording service should depend partly on support from the beneficiaries. A basic point is therefore to ensure and to demonstrate the value of the service to the producers. Local programmes with reduced coverage, such as that described here, have increased in number, often with partial funding from institutions such as universities and from the farmers. These have a research as well as a service function. Their success will depend on their efficiency and the benefits obtained by the producers.

Future genetic improvement programs in third World countries should be incorporated into field performance recording programs. Uncontrolled mating makes emphasis on female evaluation the more important as a tool for genetic progress. The use of a test day animal model analysis with a relationship matrix based on the maternal line is an alternative developed at Cornell University which is being explored in Venezuela.

15. Acknowledgements

The research described in this paper was financed by IDRC (Canada) and the Universidad Central de Venezuela. Special thanks are expressed to the participating farmers for their constant support and enthusiasm.

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Experiences with Performance Recording of Dairy Cattle in Brazil

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1. Introduction

In their book "Modern Developments in Animal Breeding", Lerner and Donald (1966) identified four categories into which the many purposes of recording may be condensed:
• Selective breeding.
• Management.
• Research.
• Publicity.

Some or all of these purposes may be the basis of a recording system, although they may also conflict among themselves. For example, recording the better cows in the herd may serve publicity of an elite farm selling seedstock, since the average herd yield will appear better than it really is, but such data would not be useful for genetic improvement purposes (Henderson, 1983). Thus, clear specification of the purposes of a recording scheme is important to design it according to the desired end.

Recognising the purpose of recording is also important to establish who should pay for it. In principle, it may accepted that those who benefit from the recording should bear the expenses involved.

The objective of this paper is to describe some experiences with performance recording of dairy cattle in Brazil, which might perhaps also be of interest to other developing countries.

2. Dairy production

Milk production is one of the main agricultural economic activities in Brazil. The number of milked cows and milk produced are shown in table 1. It may be seen that dairy production is concentrated in the South/Southeast Regions.

One striking characteristic of the Brazilian dairy industry is the tremendous variation in production systems simultaneously coexisting in the country. This is due in part to the wide geographic variation, to differences in development, both between and within regions, and also to differences in income/education between farmers, even in the same region. In the South

Table 1. Herd strength and annual milk production in Brazil (1991)[1].

Region[2]	Number of cattle ('000)	Number of milked cows ('000)	Milk production ('000 kg/yr.)	Milk per person (kg/yr.)	Yield per cow (kg/yr.)
South	24 827	2 890	3 389 354	153	1 173
Southeast	35 742	7 902	6 990 638	112	885
Center-west	36 116	3 458	1 840 341	196	532
Northeast	22 391	3 917	2 174 500	51	555
North	8 966	1 797	684 354	67	381
Brazil, total	128 042	19 964	15 079 187	98	755

[1] Source: Zoccal, 1994

[2] States grouped into regions as follows: South: Rio Grande do Sul, Santa Catarina, Paraná; Southeast: São Paulo, Minas Gerais, Rio de Janeiro, Espirito Santo; Center -west: Mato Grosso, Mato Grosso do Sul, Goiás; N ortheast: Bahia, Sergipe, Alagoas, Pernambuco, Paraiba, Rio Grande do Norte, Ceara, Maranhão, Piaui; North: Pará, Acre, Amapá, Amazonas, Rondonia, Roraima

Region, comprising the States located south of the Tropic of Capricorn, dairying is based on temperate pasture species and on *Bos taurus* breeds, mainly Holstein-Friesian, while in the rest of the country tropical pastures are used and dairy cattle are mainly *Bos taurus* x *Bos indicus* crosses. The Southeast Region includes the larger urban concentration, which attracted dairy production, in areas 400 to 1 200 m over sea level. It has been estimated that milk production in Brazil increased by 45% in the period 1980 to 1993, while the number of milked cows increased by 18% (SEBRAE, 1996).

A trend of migration of dairy farming is apparent, from expensive lands in the state of São Paulo, where crops such as sugar cane and oranges are more profitable, to cheaper lands, in the same state and farther away, in Minas Gerais and Goias, in more tropical areas formerly devoted to beef ranching. In the period 1985 to 1992, the annual rate of increase in milk production in those two states has been 4.3 and 4.8 %, respectively, while the rate of increase in São Paulo was 2.1% (SEBRAE/FAEMG, 1996).

3. Marketing and consumption of dairy products

As shown in table 1, milk availability per capita is low. The annual imports of dried milk, cheese and butter (1990 figures) were, respectively, 23, 22 and 9 thousand metric tons. Because of the low income of a large sector of the population, liquid milk and dairy products have a high income elasticity (Madalena, 1986). Thus, the drastic reduction in inflation rates after 1994 has caused an important increase in consumption of dairy products, because it effectively increased purchasing power of that sector.

Some 55 percent of the milk produced is marketed through dairy plants subjected to federal sanitary inspection. Half of this is sold as liquid pasteurised milk and the rest is processed mainly into dried milk (25%) and cheese (20%) (Zoccal, 1994). Three milk qualities. A, B and C, are defined by federal regulations. However, these are based on farming criteria, such as health practises, machine or manual milking and milking parlour facilities, rather than on milk bacterial counts. In 1992, the percentages of liquid milk sold as types C, B, A, sterilised and re-hydrated were, respectively, 79, 10, 5, 5 and 1 (Zoccal, 1994). A major factor in the recent evolution of the Brazilian dairy industry has been the rapid growth of the consumption of ultra-high temperature (UHT) sterilised milk, which increased at a rate of 25% per year between 1988 and 1993 and continues growing. This milk, being offered in tetrapak boxes, is very convenient for distribution through supermarkets. One should bear in mind that some 80% of the human population of Brazil lives in urban centres. The A and B types have not been able to compete, and in fact the number of B-type dairy farmers has decreased at a rate of 5% per year in the recent years. The increase in consumption of UHT sterilised milk has contributed to accelerate the migration to more tropical regions described above.

An analysis by SEBRAE (1996) notes four other major factors that had an impact on dairy production in recent years. Milk prices, at all industry levels, which were formerly fixed by the government, are now freed. The GATT agreements reducing milk subsidies made imports less competitive, particularly from Europe, attracting local investments in dairy plants. Economic competition influenced concentration of milk processing in fewer plants; in 1994, forty two percent of the milk was processed by six firms, three co-operatives and three private, including two large international groups. Finally, the establishment of the MERCOSUL free trade agreement favoured imports from Argentina and Uruguay, where cost of production is low, thus posing a strong challenge to Brazilian dairy farmers to adopt production systems that effectively utilise the natural resources available to them.

4. Farming practices

Description of dairy farming practices is complicated by the wide variation noted above, Elite farms with very high production levels and modern technology exist, but these are a minority, and low input/low production systems predominate, including, in some regions, the milking of only part of the herd, during the rainy (favourable) season,

Some characteristics of dairy farms in Minas Gerais are shown in table 2. Manual milking, with the calf at the foot of the cow is the commonest practice. However, it should not be taken for granted that machine milking without the presence of the calf is universally more convenient (Madalena, 1993). Better techniques are used in the larger herds which obtain higher milk yield per cow (Table 2).

Table 2. Characteristics of dairy herds in Minas Gerais stratified by milk volume produced.[1,2]

	Daily milk production, litres per day				
	<25	25 to 49.9	50 to 99.9	≥100	Total
Number of farms surveyed[3]	104	78	50	59	291
"Beef cattle" farms[4] (%)	1.0	2.6	10.0	11.9	5.2
Area (ha.)	25.2	49.9	50.0	174.8	67.4
Number of cows in milk	5.3	10.3	14.4	36.1	14.6
Number of dry cows	4.6	7.4	9.3	24.0	10.1
Daily milk production, rainy season (l.)	24.6	50.4	98.9	327.1	106.0
Daily milk production, dry season, (l.)	13.9	31.6	64.6	250.1	75.6
Daily milk yield per lactating cow, (l.)	3.7	4.5	6.5	8.2	5.3
Cows milked once a day[5] (%)	94.6	95.0	69.6	33.2	78.3
Manual milking with calf stimulus (%)	99.0	97.4	96.0	81.4	94.5
Artificial insemination (AI) only (%)	1.0	2.6	0.0	8.5	2.8
AI and/or hand mating	4.2	19.5	18.0	50.8	20.6
Natural mating only	95.8	80.5	82.0	49.2	79.4
Herd European "blood fraction"[6] (%)					
<1/4	75.0	52.3	53.2	27.6	55.6
1/4 to 3/4	24.0	46.1	39.5	50.3	37.9
>3/4	1.0	1.6	7.3	22.1	6.5

Source [1] Source: Madalena *et al*. (1997).

[2] Means and percentages refer to farms in stratum, unless otherwise specified.

[3] Slight variations in the number of farms for each item answered in survey.

[4] Only part of the herd milked.

[5] Of total cows in stratum.

[6] Means of percentages in each individual farm.

5. Official pedigree and milk recording

Official pedigree and milk recording in Brazil are the responsibility of the Ministry of Agriculture, Provisioning and Agrarian Reform (MAARA), but this is only formal, because this responsibility is delegated to the breeders associations. The main organisations for milk recording have been the Holstein-Friesian Breeders Association in several states, the Brazilian Zebu Breeders Association, at a national level, which records Zebu herds, and the Brazilian Breeders Association, recording all breeds. In recent years it has become possible for those associations to sub-delegate milk recording to official institutions or to regional groups of breeders\institutions.

The associations handle the milk record files to the National Dairy Cattle Research Centre of the Federal Research Organisation (EMBRAPA). The Centre, located in the city of Juiz de Fora, Minas Gerais, organises the "National Milk Records File", which is used for genetic evaluations. published as sire summaries. The Centre conducts its own research and also makes available the data to universities and other centres for research purposes. The data used for the 1995 sire summaries are described in table 3.

Traditionally, milk recording has been performed by centrally located recorders travelling long distances to the farms, but in recent years local recorders are being employed. There is no supervisor scheme. Milking in the presence of the recorder officer is required on the afternoon before the recording day to guarantee the recording time period. Thus, the recorder has to sleep in the farm and the farmer has to be advised of the visit in advance. On farm fat testing by the Gerber method is still used, but there

Table 3. Numbers of herds, cows and lactations in the National Milk Records database.[1]

	Hol[2]	Jer	Bs	Gir	Guz	Nel	Mes	Total
Herds	1 863	144	87	196	28	11	26	2 355
Cows	117 235	2 339	2 329	141 41	1 000	1 091	2 199	140 334
Lactations	205 204	3 685	4 213	36 128	2 075	2 315	4 061	257 681
Utilised for sire summaries[3]								
Milk yield	176 399	3 302	3 554	17 116	1 361	1 682	3 222	206 636
Fat	147 824	2 703	1 506	10 413	359	1 333	2 409	166 547
Milk, kg[4]	5 859	3 717	4 193	2 568	2 423	1 594	2 120	-
Fat, %[4]	3 64	5 03	4 01	4 86	5 03	5 12	4 02	-
Sires	772	27	26	131	7	13	68	1 044

[1]Source: MAARA (1995).
[2]Hol = Holstein-Friesian; Jer = Jersey; Bs = Brown Swiss; Guz = Guzerá; Nel = Nelore; Mes = Mestiço (*Bos taurus x B. indicus* hybrids).
[3]Data edited out for calving before 1980, short lactations, age outside 20 m to 18 yr. or missing birth/calving dates, sire, bred or upgrading generation.
[4]Lactation mature equivalent averages.

is a transition towards lab testing. Farmers are usually charged on a per cow basis, and the farmer may record as few cows as he chooses from the herd. These practices stem from the fact that the main purpose of recording is official certification of individual production, which in Brazil has an important economic value. Milk and fat yields are calculated from monthly records by the test interval method.

Official milk recording used to be subsidised by the Federal Government but nowadays it is no more so, the costs being met by the farmers.

6. Milk recording in the state of Paraná

Milk recording in the sub-tropical state of Paraná is outstanding both for the number of herds as for the technical operations. Official recording for all cattle breeds, buffaloes and goats is conducted by the Paraná Holstein-Friesian Breeders Association in co-operation with the Federal University of Paraná. Ribas (1996) described the operations. The programme grew from 88 cows in three herds in 1966 to 17,176 in 385 herds in 1995. There are 32 recorders and one supervisor, (who however does not re-record). Recording is done on two normal milkings per day. Fat, protein and lactose testing and somatic cell counting are performed at a central laboratory, using Bentley electronic equipment. Data are processed electronically to produce reports for herd management and also for certification of yield of individual animals. Average milk yield in 1995 was 24.1 kg per test day, with 3.39% fat and 3.11% protein and 596 000 cells per ml. Paraná is the only state where protein in milk is paid to the farmer. The Dutch colony in that state has had an important influence in all aspects of dairy farming.

7. Other experiences on milk recording

A milk recording programme is run as an extension activity of the School of Agriculture ESALQ in the state of São Paulo. Milk recording, fat, protein and lactose testing and somatic cell counting are offered using Bentley equipment, plus conventional reports on herd and individual cow performance. Computer software was developed for this programme, including an on-farm input section. Only operational costs are charged, which run at about US$ 1.6 per cow per month for the whole package, although farmers may choose only some modules. Official certification adds some US$ 0.6 to the cost. There are currently 130 farms in the programme, with more than 12 000 cows, averaging 21 litres of milk per test day (Prof. Paulo F. Machado, ESALQ, personal communication). A similar programme is run by the Institute of Animal Science of the Secretary of Agriculture of São Paulo state, also for extension/research/development reasons. Data are processed using the Daisy software. Farmers are offered several modules, the most commonly used being those producing individual and herd summaries for yield, reproduction and health, Only operational costs are charged, of US$ 1.4 per cow per month up to

100 cows. In the period 1989 to 1996 14 000 lactations of 6 500 cows in 52 herds were recorded. Average 305 d yield in Holstein-Friesian and hybrid herds was, respectively, 5 885 and 4 519 kg (Freitas *et al*., 1997).

The MAARA initiated in 1993 a programme of technical assistance combined with farm monitoring based on the Monty-Panacea software, based on co-operative or other organisations. with (usually) monthly visits of their own or hired technicians. Typically, the cost, 2% of the farm milk receipts, is mainly borne by the co-operative. The scheme has engaged 65 co-operatives up to now (A.D. Almeida and T.L. Machado Jr., personal communication).

In the early dairy cattle crossbreeding and selection field experiments conducted by EMBRAPA/FAO/UNDP (Madalena, 1989), a total of 104 farms were involved, in an area larger than 1 000 000 km^2 in the Southeast Region. Milk recording was carried out by local personnel of several institutions in various sub-centres. One full time EMBRAPA technician centrally located plus two part-time technicians located at sub-centres supervised the recording. Extension agents were extremely effective in helping with the execution details. Milk samples were collected in containers with 0.1% w/v $K_2Cr_2O_3$ and sent to the National Dairy Cattle Centre for protein and fat testing (using Foss Electric Milkotester and ProMilk equipment). Samples were usually sent by bus, taking one to three days to arrive. However, poor organisation in processing the samples resulted in some 2% of them being analysed up to 28 d after collection. In a study of 13 189 samples, Ferreira *et al*. (1995) showed that fat content remained constant for 6.5 days and then declined at a linear rate of 0.0147 percents units/day, while protein content remained constant for 11 days, then declining by 0.0062 % units/day, except in the hotter sub-areas, where corresponding values were 7 days and 0.0178 % units/day. Although on the whole the operations worked well for their research purposes, de-centralisation, forming nucleus to collect records and milk samples in smaller areas, would be less costly in terms of transport and communications for routine recording. On the other hand, centralisation of milk component testing proved feasible. The main constraint to efficient operation was poor organisation common in public administration, which makes it difficult to have things done correctly and in due time. This problem exists in many countries and should by no means be overlooked, as erosion in the quality of detailed execution may bring down an otherwise well designed programme.

8. Animal breeding

Modern genetic evaluation methods are slowly taking the place of show ring and milk yield contests in Brazil. A study on factors affecting Holstein imported semen prices showed that 69% of the variation in prices was accounted for by relationship with famous bulls, while progeny testing information explained only an extra 10% (Madalena *et al*., 1985). However, a more recent study indicated the semen prices of Milking Gir are influenced only by data on progeny testing for milk yield, (Madalena *et al*., 1996). A similar evolution is starting in beef cattle breeding, which counts with more than ten modern selection programmes advertising EPDs for liveweight. The Brazilian Society of Animal Breeding (SBMA) was created in 1996 to bring together academic staff, breeders and companies.

It is estimated that only 5% of all cows in Brazil are artificially inseminated, and this has been so for the last 20 years. Total semen sales in 1993 were 3.3 million doses, of which 2.5 million were national and 0.7 million (21% of total) were imported (Anonymous, 1994). Semen sales grew 25% between 1989 and 1993. Semen is produced by 22 private companies, two of which hold 67% of the market. There are also 33 companies selling imported semen. Semen of dairy breeds represents 41.6% of total sales (29.3% of Holstein-Friesian). Insemination is usually done by farm personnel trained in specific short term courses.

A recent study estimated the genetic correlation of yield in the USA with yield in Brazil for 149 Holstein sires with Holstein daughters in both countries using an animal model with the MTDFREML programme, with 266 764 first lactations in the USA and 21 515 in Brazil, mainly in the South Region (Houri Neto, 1996). The rather low estimate, rg=0.61, indicated that a local improvement programme would be justified. At present, only a very small scale progeny testing of Holstein-Friesian bulls is being conducted by one of the private AI firms and the Paraná state co-operatives.

The first progeny testing scheme in Brazil was an experimental project on hybrid *B. taurus x B. indicus* bulls commenced in 1977 by EMBRAPA with FAO/UNDP co-operation (Madalena, 1989). The project has been discontinued, but it managed to test some 90 bulls. It did show that the operations were feasible and that there was a market for semen of progeny tested hybrid bulls.

Based on the previous experience, the Milking Gir Breeders Association (ABCGIL) and the National Dairy Cattle Centre initiated a progeny testing programme for this breed in 1985. This is a small scale, conventional programme, testing approximately ten young bulls per year with both pure-bred and hybrid progeny in 31 to 44 farms specifically recruited for this purpose. After 1995 an animal model-BLUP has been used for genetic evaluation of bulls and cows (Verneque, 1996). Up to 1997, five batches have completed their test, totalling 41 bulls with average 35 daughters each. Predicted transmitted ability ranged from -154 to +314 kg 305d milk yield and reliability ranged from 75 to 89% (mean = 82%) (EMBRAPA\ABCGIL, 1997).

Economic success in the Gir programme, through increased semen prices (Madalena *et al*., 1996) and sales, including important exports, prompted other breeds to follow in the same track. The Guzerá Breeders Association initiated a similar programme with the National Dairy Cattle Research Centre in 1994, and the new breed Girolando (Holstein-Friesian x Gir) is organising a programme on the same lines.

A group of Guzerá breeders is running a MOET nucleus selection scheme since 1994. This is a private venture with technical co-operation of the Department of Animal Science, Federal University of Minas Gerais. Donors are screened in the whole breed on the basis of absolute milk yield, confirmed at a central farm when necessary, and moved thereafter to a private MOET centre. Pregnant recipients are transferred back to the farm. where progeny are being tested for growth and milk yield. The aim is to produce full-sibships of 4 males and 4 females. Eight out of the first 22 donor cows were not suited for MOET. On average over 41 flushes, 10.7 structures were collected per flush and 5.8 were transferred resulting in 4.1 pregnancies, so the results are considered satisfactory (Penna *et al*., 1998).

9. General considerations

When considering ways of increasing recording one could start by stating the objectives. Clearly, publicity should not be a concern of public efforts, since it only benefits some herd owners. Indiscriminate subsidies for recording did not result in genetic improvement in the past.

Genetic improvement is a major reason for recording, but the cost should be borne mainly by those directly benefiting from it, i.e. selling improved animals or genetic materials. The main constraint for the implementation of modern breeding programmes in Brazil and other Latin-American countries is the lack of investors in that field. Where they exist, such as in the small scale operations described above, they manage to organise and to pay for the necessary recording, generally with the co-operation of universities or research centres. Also, nucleus breeding strategies could be adopted to make genetic progress even when there is no generalised recording (Smith, 1988), coupled with the subjective screening recommended by Timon (1993).

Thus. improved management stands out as the main reason for action to increase recording, There is a sector of farmers that may pay for technical assistance and that would easily buy modules of milk recording packages, provided they are offered quick and reliable report returns, as shown by the incipient experiences described. In my opinion, the main reason why these packages have not grown before was the certification-oriented official milk recording. As a result of industry deregulation and increased national and international competition, it is likely that improved management will drag along recording. There are already several Brazilian computer softwares in the market, plus some foreign ones, and some private recording firms have been established.

On the other hand, there is a large sector of small farmers that would have extreme difficulties to pay for recording. This stems from the strong inequality of income distribution and it is likely to continue for a long time. Some argue that those farmers will be pushed out by "the market", which seems to me a naive view, considering the social consequences of migration to urban centres increasing unemployment and criminality. Moreover, we have a re-flux movement claiming for land, and it does not make sense to feed it with more people expelled from their farms.

A survey of 920 small dairy farmers conducted by Silvestre (1996) showed some results relevant to recording. The sample was restricted to farmers registered at the extension agency of Minas Gerais (EMATER-MG) that used mostly family work and obtained at least 80% of their income from the farm, which should be smaller than 50 to 100 ha, depending on locality. Average herd size was 14 milk and 8 dry cows (plus followers) and average daily milk production was 70 l. Thus, a cost of recording of US$ 1.4 per month (the lowest operational cost of the schemes described) would imply in an expenditure of US$ 19.6 per month, equivalent to 3.4% of milk receipts, which is clearly too much when the legal minimum wage is about U$ 88. Thus, milk recording in those farms ought to be funded from specific programmes, preferably with an extension/technical assistance aim. Also, low cost recording schemes must be devised, as. for example, through farmers own recording. A technician visit would still be necessary to supervise record keeping and to show how to use the reports, which could be tied up with other extension activities. Dairy plant involvement would be essential to collect forms and milk samples.

Although education level of farmers in the above sample was low, incidence of recording was surprisingly high and suggest that it could be augmented by appropriate promotion. Only 3% of farmers were illiterate but 76% had just primary education (36% incomplete). Nonetheless, 32% recorded bull servicing/calving and 14% recorded milk yield, while 15% kept accounting records.

It is interesting to note that 90% of the farmers owned the farm and 81% lived on it. They had, on average, 3.9 children, 41% of which worked only in the farm and 26% were just studying. Income from dairying was 73% of total income. These figures show the social importance of dairying.

The role of universities and research centres in the development of milk recording, both for large and small farms, is absolutely essential as it is there that lies the country's technical leadership. Real life data for research and post graduate education have a very high value for those institutions to devise solutions for the national dairy industry problems. It should not go unnoticed the fact that we face a tremendous thrust of propaganda\lobbies to sell expensive inputs, including cattle and genetic materials, distracting attention from the pursuance of locally suitable solutions. In particular, there is a dearth of data on economic returns from different production systems which could be obtained from recording programmes.

Finally, it should be considered who is going to do the job of increasing milk recording, should funds be available for it. In my personal opinion, recording will grow through the efforts of dedicated individuals, rather than of governments or institutions, as did happened up to now. The real challenge of any scheme to promote recording is to locate, support and integrate those individuals throughout the country, developing many other pilot schemes as the ones already established, possibly on a free trial basis for, say, a couple of years. As has happened in other countries, the demonstration effect of such programmes would have a major impact in multiplying the number of herds and regions adopting the scheme.

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Part III
General Papers

Integrated Information Systems for Animal Production

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1. Background

In 1985, when the Universidad Nacional (UNA), Costa Rica, and Utrecht University (UU), The Netherlands, started a co-operation project to improve clinical training of veterinary students, it could not be foreseen that one of the most important results would be in the field of information systems for animal production. The principal catalysing event in this process was the arrival in Costa Rica (1986) of the VAMPP system (Noordhuizen, 1984), developed at UU to support veterinary herd health and production management. In Costa Rica, the system was translated to Spanish and introduced on a few farms. After a successful field validation, positive information was obtained about the feasibility of adapting the system to tropical conditions and broadening it as to serve other actors than veterinarians.

From 1988 on, an ambitious effort was undertaken to develop an integrated and decentralised information system for Costa Rica and other developing countries. Our general objective was to increase knowledge and information on livestock production systems, as to contribute to increased efficiency and sustainable development. The specific objectives were and are:

- to support of health and productivity management at farm level;
- to generate regional and national databases for livestock statistics, research and analysis in the fields of genetics, epidemiology, economics, nutrition, etc.;
- to generate information for planning and priority setting in research, extension, training and policy making.

Research co-operation was sought and found with universities in other Latin American countries, the USA and Europe. In system development, a new standard was set with the VAMPP Dairy 5.0 system (1995), that adapts to a very wide range of dairy production systems, from small holders to large commercial operations. The VAMPP Swine 3.0 version, presently in the last testing phase, obeys to the same standards. The dairy information technology was transferred to the Costa Rican dairy sector and 12 other countries in Latin America and Africa, where it is now used on about two thousand farms.

2. Organisational structure

Keywords in the structure of the information systems we support are: decentralisation, privatisation, standardisation and institutional participation.

2.1 Decentralisation

The system is organised and operated by users in the field that are not directly dependent on nor permanently linked to a national/regional centre. On-farm data collection (including data quality assurance), data processing (herd management, field trials and local studies) and data concentration (in regional databases) are all carried out in a decentralised way. Portable computers (with the complete farm databases) are often used for farm visits.

2.2 Privatisation

The majority of the users, and so the funding of the system, are private: farmer organisations (with technicians for monitoring and farm advice), veterinarians and other farm consultants, individual farmers, etc. In some cases, institutions carry out the monitoring and advice activities (CIAT in Bolivia and KARI/DRSK/ILRI in Kenya).

2.3 Institutional participation

To obtain maximum benefits, the decentralised users should not operate in isolation. An important added value to their efforts is obtained by data centralisation on behalf of (research) institutes (in Costa Rica the UNA School of Veterinary Medicine), for analysis on a national level. Research projects can be undertaken to find diagnosis or solutions for problems that cannot be solved at the local level. Part of the results can be incorporated in the decentralised software, e.g. correction factors for milk production, equations for growth, simulation and optimisation models. User training at different levels and product support and development are other important tasks of the co-ordinating institution. The UNA also manages a 25-farm dairy pilot project for software testing, research and training. Local users can generate reports and administrative documents for their breed organisations. In some countries, the breed organisations intend to use the VAMPP system as their main database.

3. Description of activities

3.1 Product development, distribution and support

Products and development lines are indicated below. The distribution and support are carried out by CRIPAS, a non profit organisation of the UNA. The VAMPP Dairy 5.0 version can be bought or leased. For farmers, a licence (3 farms) costs $1 000 and leasing $365/year. For farm advisors, a licence (50 farms) costs $ 2 000, leasing $730/year. For organisations with multiple licences, discounts apply up to 40%. VAMPP can be supplied as regional or (inter)national database.

3.2 User training

The UNA provides training at several levels: basic and advanced software operation, herd health and production management, epidemiology and field trials, both as short courses, in the veterinary curriculum and at Master course level.

3.3 Research

Research lines are aimed at increasing efficiency and sustainability of animal production. The scope is gradually changing from animal to farm, and from farm to sector level. Important research co-operation programs were or are:

- Epidemiological research with UU, University of California, University of Missouri, USDA-APHIS (El Salvador).
- Reproductive research with International Agency for Atomic Energy, Swedish Research Co-operation (SAREC), Autonomous University of Mexico (UNAM).
- Genetic research was carried out with Yucatan University (Mexico), NRS (correction factors for daily and lactation yield) and Wageningen University (PhD bioeconomic animal evaluations, breeding objectives under sustainability constraints).
- Pasture and nutrition research with Wageningen University (resulting in VAMPP pasture and nutrition module) and Edinburgh University (PhD on integration of models for grassland, cow requirements and herd dynamics). Presently ODA finances a joint research project with Edinburgh and CIAT, Bolivia.
- The "Regional Centre for Training and Research in Sustainable Animal Production" (RESAP) is a 4 year research program (sustainable animal production), currently starting with Wageningen University and International Institute for Aerospace Survey and Earth Sciences (ITC).

4. Information systems

The VAMPP software is the backbone of the decentralised information system.

4.1 General characteristics

- The program is elaborated in the M language (formerly called MUMPS), which is one of the four computer languages certified by ANSI (American National Standard Institute). The Micronetics Standard M version 3.0 of 1994 is used. M is characterised by high speed and efficient storage and provides facilities for a fully integrated database with rapid checks for quality control. Database size has little effect over access speed: a 30 times increase will bring speed down by about 15%, not by 3 000% as in most other systems.
- Although VAMPP can be run on mini or mainframe computers, a personal computer will do well for a VAMPP dairy database. A 1 Gigabyte hard disk can store up to 1 million cow years (including health, production, reproduction, growth aspects, etc.).

- VAMPP has no limitations for the number of farms, the number of animals per farm or the number of events per animal (naturally within data quality restrictions).
- All original data (including culled or dead animals) remain always stored, allowing for valid historical analysis (150 animal and farm records are provided, one record contains e.g. calving details).
- Apart from original data, VAMPP generates and stores also about 500 calculated parameters. The calculation system is autonomous (e.g. automatic regeneration after changes in original data), only periodic activation by the user is required.
- VAMPP is multi-user under MS-DOS. Several terminals can simply be connected to a standard computer by using serial cables.

4.2 Standardisation

- VAMPP is a standardised program (independent of language), but at the same time adaptable to the needs of individual users (50 system management parameters). No specific software adaptations are supplied to individual users, with the exception of a country level customising (reference databases for political division, ecological zones, bull catalogue, correction factors for milk production, equations for growth, etc.).

- With the exception of comments on events, all data are completely codified (e.g. cows, bulls, breeds, inseminators, disease and (re)productive events). This permits valid comparisons within and between farms, and within and between regions and countries.

4.3 Integrated data quality assurance system

Internal data validity in the technical/biological sense is the prime concern, comprising consistency, accuracy and completeness. The assurance mechanisms (which form the main component of the software) can be described as:

- Easing on-farm data collection, including user training and feedback (motivation!) and system generated recording forms for routine measurements coupled to data entry.
- Facilities during data entry, like error trapping (almost 2 000 checks on referential data and possibility/probability ranges) combined with instructions for the user. In the case of animal data modification, both past and following history are checked. References files are also provided, e.g. 10 000 internationally used sires, partly with current genetic index.
- Data validation (after entry) by the final user, the database manager and researchers.

• High operational safety, even with inexperienced users (fool proof) and under adverse conditions (electricity supply), with protections against unauthorised access (three levels: farm, farm administrator and system administrator).
• Related aspects are: storage of all original data (culled animals, test day yield, etc.), completely integrated database (e.g. genealogy is automatically derived from reproductive data) and high access speed for immediate checks.

4.4 Ease of operation

• All pathways are easily found. A course book for basic operation is supplied to all users. The duration of an introductory course is from 3 hours for users with computer experience, up to two days for computer illiterate farm personnel.
• A complete reference manual is provided.

4.5 Hardware requirements

• A personal computer (IBM compatible), XT, AT 286, 386, 486 or pentium with a 10 Mb hard disc and 512 Kb RAM memory.
• A Sentinel protection device provided by CRIPAS is required for operation.
• Printer (optional, but strongly recommended).

4.6 VAMPP as a farm management tool

The first step in the control of management is monitoring, for which numerous facilities are supplied. Once the data have been entered, daily management is supported with attention list for the planning of activities and spotting of problem animals. For tactical herd management, a Herd Abstract is provided to evaluate strong and weak points (and the effect of previous measures) in milk production, reproduction, health, body condition and young stock growth. When problems are detected, detailed analysis can be carried out to define the problem precisely and to support the diagnostic process (testing of causal hypothesis by quantitative analysis). E.g. if conception at first service is found as a weak point, the service intervals can be studied. When most repetitions are in the 18-24 days interval, the next logical step is an analysis of conception rates of individual bulls and inseminators. To confirm the causal hypothesis, often the farm, the management procedures and the animals have to be examined and sometimes laboratory analysis has to be done. Once a diagnosis is achieved, adequate measures can be taken. Pasture/nutrition evaluations can also be made (using NRC equations), including margin over feed cost.

4.7 VAMPP as a population database

With the consent of the final users, the farm databases can be centralised with simple procedures in regional or national databases. With the so-called splitting module, all farm reports can be made available for a certain population, e.g., all pure-bred Holsteins in the country or region. This way routine population statistics and reference values can be generated by non specialised personnel, with the same ease (and hardware) as for one farm. The module supports also field trials and the diagnostic process (e.g. reproductive performance can be analysed for cows with/without lameness). Populations and herds can also be compared in "farm comparisons". Files can be extracted (after definition of quality standards) for research, genetic analysis, etc. Additional data validations can be carried out at population level. Due to low hardware requirements, high speed is maintained even in very large databases.

5. Achievements

5.1 Software development

The original Dutch VAMPP package has been upgraded from a veterinary support system for Dutch conditions to an integrated management information system (MIS), applicable under a wide range of conditions, including in developed countries (NRS-Holland tested the package with positive results, but the report is internal). To the MIS function, the population database function was added. The database is used frequently for all kinds of research and the quality is considered very high.

5.2 Software distribution

In Costa Rica, about 30% of the milk production comes from 400 herds registered in VAMPP. In ten Latin American countries VAMPP users can be found, while in some countries large scale projects are being developed (hundreds of farms in Bolivia and Ecuador). Many Universities are also involved. Recently activities were started in Kenya (Naivasha Research Centre and Bahati smallholder monitoring) and Zimbabwe (dairy herd health program by University of Zimbabwe).

5.3 Training

Many hundreds of users of many countries have been trained in the past years, from basic operation to herd management. Fifteen students from the region obtained a Master degree in herd health and production management.

5.4 Research

The decentralised use of MIS has proven to be an excellent, practical and low/cost method for the quantification of livestock production systems. The VAMPP database is an inexhaustible resource for research. Two PhD theses were carried out (epidemiology-Utrecht, grassland/nutrition modelling-Edinburgh), two are ongoing (decision support-Edinburgh, genetics-Wageningen), two in preparation (GIS-ITC, epidemiologic modelling-Wageningen). The results are not only published in scientific and farmer magazines, but also used to upgrade the VAMPP system (e.g. corrected daily and lactation yield, growth equations), where the users have daily access to these scientific results.

6. Funding

The implementation of the decentralised component is almost completely funded by the private sector, in some cases by local institutions. CRIPAS sells its software products and courses, and the farmers that contract the monitoring service pay a fee to their advisors or organisations.

The centralised component (product development, research) is only partly funded by the sales of products and services. Funding of part of the running cost is provided through the international co-operation projects while the Dutch International co-operation has been funding several experts (presently one). The UNA has been in a financial crisis for many years and imposes a complete stop on new personnel. At the same time we have not been successful in interesting international co-operation agencies in system development. As a consequence, we have not been able to increase our development capacity and several VAMPP development projects are awaiting financing:

- Integrated data base and information system for all bovine production systems and buffaloes (with system specific interfaces).
- Farm economics integrated with nutrient balances, including decision support and expert systems (with LEI/DLO, The Netherlands).
- Electronic data interchange between farms/industry and with electronic farm devices.
- Decision support and expert systems.
- Graphical user interface (GUI).
- Additional (international or national) reference databases for treatments, medicines, feeds.
- Standardised national reports (ICAR format if available).

7. Constraints

The main problem has been the funding of (expensive) software development projects, which has been mentioned above.

7.1 Legal aspects

Minor problems have arisen about the ownership of electronic databases in a decentralised structure. We are developing a code for our users, where the principle is that farmer owns the data, but he has to pay for the electronic format if this is supplied by an agency. The agency can deny the transfer of the electronic format when the owner has not paid for it. All users have so far agreed on data-sharing under privacy protection, no formalization was yet required.

7.2 Data certification

In a decentralised system, the local databases are under local command and can be modified by the end user, although some constraints apply in VAMPP (e.g. genealogy). However, certification of the local database by a national organisation is technically feasible. Certified data could be “sealed” and/or copies maintained at the central level, with facilities for data comparison.

8. Future programs

Standardisation of IT is a main problem all over the world. Different applications use different definitions, calculations rules and data quality control mechanisms, so farm or sector statistics cannot be compared. A general problem in developing IT applications for livestock production in developing countries is the enormous variation in production systems, technology and management procedures, which requires a high system flexibility. Yet data quality control has to be very strict, which is more difficult to achieve in flexible systems, and the same applies for ease of operation. Thus, the cost to build a quality management information system with a universal applicability is very high (minimal US$ 1 million). However, countless development efforts are carried out in many parts of the world with much lower budgets, often resulting in a waste of time and money, deceptions at user level and increase of the existing babylonic confusion. Many large research efforts were undertaken to collect and analyse production and health data, with the final conclusion that the deficient data quality didn't permit any valid conclusions.

So there is an obvious need to join efforts, and international organisations like FAO, ILRI and ICAR should support this. Our group has sought contacts with potential partners to found an international consortium dedicated to the development, distribution, training and research for a standard information system for animal production in developing countries. With our experience and products we hope to make a significant contribution to the proposed standard.

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Low Cost Recording Schemes Using High Tec Systems

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1. Introduction

- What are the costs ?
- Can it be done ?
- NMR's own experiences ?
- The power of the new technology ?

2. Where are the costs ?

Typical recording organisation

Cost	% of total
Data Recorders	35
Office and Laboratory Staff	35
Information proceeding	12
Plant and equipment	6
Other	12
Total	100

3. Can technology reduce costs ?

Recorders
- Maximise animals recorded per recorder day.
- Validate data at the point of data collection.
- Provide reports at point of data capture.

Staff
- Maximise samples tested per staff day.
- Maximise records updated per staff day.
- Maximise reports produced per staff day.

Information processing
- PC based client server systems.
- Remote data entry, file transfers.
- PC based processing and report generation.
- Multi lingual systems and reports.

Plant and equipment
- >10,000 milk samples /machine/day

4. What can be achieved ?

Impact of technology on cost

Cost	% total	% var
Data Recorders	35	100
Office/laboratory	35	75
Information processing	12	75
Plant and equipment	6	75

5. Can it be done ?

Cost	%total	%Var
Data Recorders	35	100

- The multi function recorder.
- Farmer and co-operative records.
- PC based data entry and file transfer.

Cost	% total	% var
Office/Laboratory	35	75

- Laboratory.
- Multi shift staffing of expensive facilities.
- Electronic data transfer to database
- Office.
- Exception based processing.
- Desk top report printing.

Cost	% total	% var
Information processing	12	75

- Client server - distributed processing power.
- Relational databases - data held once only.
- Lean system - simple function.

Cost	% total	% var
Plant and equipment	6	75

- Re-usable sample boxes and pots
- Low cost PC’s for basic data entry/reports
- Centralised database
- Distributed processing and printing
- Data files and software for data users

6. NMR's own experiences ?

Started	Moved to	Now on
Farm register	Mainframe	Micro
11 offices	7 offices	2 offices
11 labs	7 labs	2 labs
750 staff	450 staff	250 staff
60 000 cows	1 m cows	2 m animals
35 days	15 days	1-5 days

7. The power of the new technology !

In the field
- Automatic milking machines
- Lap tops and portable phones

In the laboratory
- 7 seconds per sample analysed
- Fat, protein, lactose, Urea, Somatic cells

In the data centre
- Pentium II and >20 gigabytes of data on line

In the processing office
- Multilingual user PC interfaces
- Universal application functions
- Language independent databases
- Multilingual dictionary/report generators
- PC software for analysis and reporting
- Internet and Intranet based services

The Impact of PC Power
- Significantly reduced development costs
- Significantly reduced operations costs
- Wide area networks offer low cost structure
- Low entry cost for starting new operations
- Standardisation through shared technology
- Flexibility and scaleability of core systems
- International and International recording

8. The future

Technology based rapid change
Technology driven standards creation
Information explosion
Breed improvement and development
Improved quantity/quality of production
Improved dairy income

9. The challenges

To avoid re-inventing the wheel:
- To rent or buy what does not need to be built.
- To learn from the experiences of others.

To use the technology to meet the needs:
- Languages and symbolic presentation.
- Using networks to overcome distances.

To help the farmers to achieve the benefits:
- R&D, Communications and Extension work.

10. What was the question ?

The question was:
How to provide the greatest benefit.
To the greatest number of people.
At the least cost to people and Government.
In the shortest possible timescale.

- By improving the efficient of production.
- By increasing the amount of milk produced.
- By improving the quality of the product.

11. The conclusion

The tools are available.
The technology is available.
The skills are available.
The standards are available.
The Guidelines need more development.
ICAR provides a focus for development.
The difficult bit is actually doing it!

ICAR and the Developing Countries

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1. Introduction

Assisting new recording services.
Providing standards and guidelines.
Meeting developing country needs.

2. Meeting developing country needs

Why promote recording ?
- Recording promotes:
  - Increased milk yields.
  - Improved milk quality.
  - Improved genetic merit.
- Recording increases:
  - Animal values.
  - Product sales income.
  - Farmer income.

- The problems:
  - Macro-Infrastructure.
  - Geographical challenge.
  - Diverse organisation presence and capacity.
  - Dairy industry infrastructure still developing.
  - Transportation and postal difficulties.
  - Telecommunications limitations.
  - Computer systems and networks limitations.
  - Extension service still developing.
  - Micro-infrastructure.
  - Small herd size.
  - Low literacy rates.
  - Low awareness of importance of records.
  - Lack of incentives for recording.
  - Lack of producer based breed associations.
  - Lack of producer based recording organisations.
  - Limited training and support services.

3. Assisting new recording services

Information.
ICAR News-letters, developing country news ?
Participation in ICAR and Interbull.
Skills Transfer.
Developing country workshops.
Specialised training programme ? exchanges ?
Consultancy and advisory services ?
Logistical support.
Recording materials and equipment.
Laboratory hardware, software, services.
Processing office hardware, software, services.
Central database hardware, software, services.
Hardware, software for R&D and extension.
Staff and farmer training materials.

4. Providing standards and guidelines

Meeting the needs of developing countries.
Guidelines for recording additional breeds.
Guidelines on dual purpose animal recording.
Guidelines on recording of additional traits.
Recording methods and calculation standards.
Recording and analytical equipment standards.
Record processing and reporting standards.
Genetic evaluation of animals in small herds.

5. ICAR and the developing countries

Meeting developing country needs.
Help developing recording services.
Information.
Skills transfer.
Logistical support.
Standards and guidelines.

Together, developing recording systems.

Part IV
Seminal Papers

The Impact of Socio-Economic Aspects on the Development and Outcome of Animal Recording Systems

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Preliminary considerations

Basically, an animal recording system is a process dedicated to the collection of information on animals involved in animal production units, and completed by its processing and by the interpretation and dissemination of the results in a perspective of decision making for chosing breeding animals in view of the further generations. It is usually achieved by mobilizing a complex and technological organization aiming to combine joint registration of birth and of measurements on the individual animals, procedures of writing and registration of the information, transfer and computer processing. In fact, it is also an association of various types of actors - farmers, recorders, technicians, researchers - each of them having a specific function in the process. Under this point of view, animal recording system is not only a technics, it can also be considered as a particular social network (Flamant, 1991).

However, it has to be clear for anybody, that animal recording system does not have a justification *per se*. It is only a tool the conception and the management of which having to be in close relation to the goal it contributes to pursue. In this paper, It is stress that animal recording system is not only of basic importance for any breeding programme but can be also “a lead technology” (Hammond, 1995) for all actions which aim at the improvement of the global productivity and efficiency of farm systems.

Animal recording systems were evolved in developed countries over several decades in high input animal production systems as the basic tool of pure breed genetic improvement programmes. They were the support of the development of high productive modern breeds which now spread out allover the world, mainly in cattle and pig species (Bougler, 1990). These recording systems usually involve a large number of animals and animal husbandry units. They need a costly organization associating on-farm recording to high level investments in performance testing and progeny test stations, and requiring the support of informatics systems, information networks and specialized analysis laboratories on milk components or on wool or meat quality traits. Efficient programmes were particularly achieved in dairy cattle production in accompanying intensive production systems at the farm level. Their development was aided by the use of reproductive biotechnics as artificial insemination and embryo transfers, and they are based on the theoretical models built by research in the field of quantitative genetics. In these situations, the studies demonstrated that the realized genetic progress highly valorized in the long term the investment achieved (Poutous et Vissac, 1962).

Despite these successful results, there is need to examine more attentively the usefulness of animal recording systems and to precise their functions in medium-to-low input systems, more particularly in developing countries, with major needs to increase animal production and productivity in these low input, higher stress production environments. Several explanations can also be searched for their relatively rare use in these situations: difficulties to involve a large number of poor small farmers in a development project, low investment capacities of the government and few current means for functioning, weak technical level of the farmers, insufficient technical and scientific framework.

On the basis of programmes experimented in various situations, mainly reported in congresses on animal breeding and genetics improvement, this paper presents and discusses four principles which underly the interest and the implementation of animal recording systems in low-to-medium input systems, more particularly taking into consideration the case of developing countries:

1. despite its contribution to the development of breeding programmes, there are numerous factors limiting on-farm animal recording;
2. in contrast to its specialized role in the high input pure breed selection programmes, on-farm animal recording appears to be a multi-purpose tool for development and also a concrete and recognized means for establishing personal relations between the farmers and the officers;
3. the establishment and the organization of an animal recording system need progressive approach, with successive preliminary phases;
4. several types of strategies of animal recording systems for breeding purpose have to be distinguished, each of them having their interest and there limits.

These four principles provide basis for discussion on economical and organizational aspects of animal recording systems under three types of considerations:

1. practical implementation in relation to socio-economics and cultural\educational conditions;
2. cost and evaluation of economical efficiency of animal recording systems;
3. requirements of animal recording systems and human and economic conditions; final recommendations.

1. Factors limiting on-farm animal recording

The reproductiveness of the success of animal recording systems in high-input animal production systems has to be questioned in low-to-medium input production systems. In fact, this issue cannot be correctly iconsidered without reference to the various types of animal husbandry situations characterized by their social and economic dynamics able to be mobilised within a global development view. Animal recording system can be one of the tools assisting a specific project for development, and animal recording operations can meet constraints specific to every type of animal production systems concerned with.

1.1. Various animal production systems

The purpose here is not to give an exhaustive description of animal production systems at the world level and to discuss their respective way of evolution - an example of such an attempt can be found in the exhaustive survey and analysis carried out by Nardone (1996) in the exemplary case of Mediterranean cattle husbandry - but to propose simple keys for analysing the situation in respect to the interest and the constraints for carrying out animal recording operations. The basic asumption is that considering the level of input is not sufficient. We need to also take into account: the level of richness/poverty of the farmers, their degree of integration in the marketing chains, and their level of technical competences and of general education. These points will be mobilised in the following pages in order to inform the issue of the animal recording systems.

Low-to-medium input animal production systems are currently likened to “traditional” and “extensive” systems in contrast to “modern” and “intensive” systems. In fact, preliminary precautions have to be taken with these expressions: “traditional” does not obligatory means “extensive”, and vice versa. Various types of extensive animal production systems have to be identified.

Extensive systems in developed countries are carried out in large farms in the framework of countries and regions with high living standard, low population densities and large land availability with low rent rate per hectare. The farmers are largely involved in the international market of wool or/and meat from sheep or/and from cattle, and usually have a good technical and educational level and are assisted by efficient extension services, with close relations to research and universities.

Animal production have large potentialities in developing countries which harbor the majority of the world animal population. For instance Meyn (1984) outlines that for cattle species, developing countries have got 65% of the world population, but only produce 30% of the total supply. Limiting factors for their development come from structural and financial aspects or from the traditional management systems and not only from environmental constraints strictly speaking. Here simply three types of situations are distinguished:

1) Large traditional extensive farming systems: they are carried out in mountainous, or steppe and even desert areas in nomadic or transhumance systems, less developed for their relation to market economy than for their social significance. Their management is strongly linked to the collective live of the societies. They require assistance for maintaining herd health and preventing them against the consequences of heavy droughts periods. They suffer from limitations to their deplacements, with strong tendencies towards sedentairising, and also willingness of young people to go out from this living style.Large extensive animal husbandry is also achieved in ranching systems, like in Latin America, where farmers with low technical and educacional level could be far from the extensive technical model of developed countries.
2) Small to medium poor farmers in countryside areas. they are not specialized units and output can involved as well milk, meat and wool as draught, manure, skins... They are associated to cereal and crop production in mixed farms (Guessous *et al.*, 1992). Local breeds are the usual germplasm but they are insufficiently well known. Market purpose of the farmers are mailny to supply the family income, but it can be mixed with social and cultural considerations linked to the tradition. The dynamics for development has to be organized and stimulated at the local level. But in any case as in Africa, new situations for animal production come from the interest for the development
3) New small specialized farming units: dairy farms were developed for last decades in most developing countries, dedicated to supply cities market with fresh milk. The level of input could be low to medium, as well as the technical level of the farmers. The germplasm is usually composed by crossbred animals from local cows or goats with cosmopolite breeds (Holstein, Saanen, Alpine). Farmers have an economic project and they are receptive of assistance in feeding, breeding, artificial insemination, veterinary... These systems can be linked to forage production in irrigated areas or only related to animal feeding purchases into out-soil systems even with low milk yields.

1.2. Limiting factors for animal recording systems in developing countries

In the extensive large farming systems in developed countries, the main limiting factor to on-farm animal recording comes from the usual management system - ranching - and the difficulty to have in these conditions a close and engaged relation with the animals. This hampers for instance the possibility for marking them at birth and for frequent registration of there performances (mainly their live weight) at monthly intervals even if there is interest from farmers with good technical level.

In the various situations observed in developing countries, outside the rare case of large artificial intensive dairy or fattening units which are carried out on the model of developed countries, several authors listed and commented limiting factors for on-farm animal recording, for instance:

- In the case of dairy buffaloes farms in Pakistan (Usmani, 1996), structural factors which limit the possibility of organizing performance recording systems appear to be: small herd size, low literacy rate of the farmers, lack of awareness of importance of records, lack of incentives for recording, lack of breeders associations.
- In tropical Latin America, with large ranching cattle and sheep conditions (Ordoñez, 1990; Vaccaro *et al.*, 1994), it is often asked if on-farm recording is justified in such difficult conditions as illiterate herdsmen, lack of technical personnel at the production area, great distances and deficiency of transportation and communications particularly during the rainy season.
- In north Ivory Coast, Poivey (1987) describes the difficulties for the practical recording operations on traditional cattle collective herds carried out in collective pens at the village level: difficulties for identification of the animals, disappearance of the animals, lack of weighing equipment of the cattle pens, doubt in age determination, problems in handling of the information and computer treatment...
- In south Saharan African countries, on the basis of the ILCA experience, Peters and Thorpe (1988) give an exhaustive description of the constraints to "livestock-on-farm-testing" (LOFT) coming from the characteristics of the animal production systems. The authors produce a comprehensive table which identifies 11 types of problems ([a]), and express for each of them issues for animal recording system and propose solutions. This table seems to be useful as a basis of the inventory of the problems to solve in every situation where it is aimed to initiate an animal recording system. From their analysis, it's evidently clear that frequent monitoring and feedback towards the animal owners, completed by only light technical and statistical means, are determining conditions for efficient on-farm animal recording system.

([a]) 1. representative sample of households and animals; 2. ownership of animals; 3. particular owner attitude; 4. animal mobility; 5. length of production cycle; 6. asynchronous production; 7. management variability; 8. communal grazing; 9. multiple output; 10. small herd/flock size; 11. single sire herd/flock

2. On-farm recording system: a multipurpose tool and a platform for development

2.1 Arguments for an on-farm recording system

Low-to-medium input farm systems are not usually well studied in developing countries. In so far there is a governmental objective for increasing productivity and income of small farmers, there is a basic need to better know the conditions of the management of their production systems, particularly in paying attention to the association between the feeding resources and the reproduction traits, the performances and the characteristics of the local animal material, the specific products of the units, and more generally the principles of their management and the social functions of animal husbandry at the village level.

Consequently, despite the limiting factors mentioned before, on-farm recording systems have a fundamental interest, considered as a multi-purpose tool and not only, in these low-to-medium production systems, with the unique objective of animal genetic improvement. Its means clearly that the analysis and assessment of the individual animal performances for breeding purposes are not the only way to pursue through animal performance recording.

Peters and Thorpe (1988) review the first animal recording systems achieved in developing countries during the years 70s and 80s, namely in south Saharan Africa, and regret that they only gave priority to breeding purposes and underestimated the interest of this tool as support for improving management, production efficiency, and health status of in-field animal production systems, in contrast to those achieved more recently under the framework of ILCA. For the last ten years, the literature notably provides a large agreement among the authors on "farmer-oriented" animal recording systems from a large field of experiences coming from Egypt (Abdel-Aziz, 1996), India (de Groot, 1996), tropical Latin America (Plasse, 1988), sub-Saharan Africa (Poivey *et al.*, 1986; Poivey, 1987; Peters and Thorpe, 1988). They can be summarized in considering that knowledge of the qualities of the animal material through on-farm performance recording can be a key for a larger knowledge and appraisal of the production units, and can provide an organized support for further developments.

Another consideration favorable to animal recording as a multi-purpose tool, concerns the issue of the cost, to be shared between the expected genetics progress by the breeding scheme and the support to farm monitoring. In other words, the investment for long term genetics improvement could be acceptable if the operations are also useful for decision-making concerning short-term herd/flock management (Ordoñez, 1990). It is also remarkable to observe the evolution towards this principle in on-farm animal recording systems carried out in developed countries for purebreed selection purpose, due to the need for a better economic valorization of the high costly information recorded on individual animals (for instance: Cournut and Rehben, 1988, on beef cattle and sheep in France; Ponzoni, 1988, in extensive Australian conditions). See also the remarks by *Nicoll et al.* (1986).

In the context of sub Saharan Africa, Peters and Thorpe (1988) outline that "performance testing is a progress-oriented, systematic process of collecting and analyzing data on economically important performance traits and production practices under defined conditions". They outline that the objectives of animal recording system have to include:

1. identification and quantification of non-genetic constraints to performance in order to improve husbandry, hygiene and feeding practices;
2. economic evaluation of the production process and different technical interventions;
3. characterization or evaluation of breed performance under defined production conditions;
4. and finally breed improvement.

It is interesting to compare this list of objectives with that proposed by Plasse (1988) in tropical Latin America extensive systems, and to observe the evidence of the convergent views:

1. the design and control of management, sanitary control, pasture, feeding, breeding and selection programmes as well as the evaluation of alternatives;
2. the estimation of the breeding value of males and females as a basic requirement for selection;
3. the economic evaluation of the production process.

Clearly, there is a change for the last 10 years in the consideration for on-farm animal recording system. In fact all the literature now available can be read and interpreted considering three main purposes for animal recording systems:

- observation and diagnostic of animal production in a given territory, testing and experiments;
- support for farm monitoring and organization of actions for development;
- basis for the organization of breeding programmes.

Consequently, animal recording has to be considered as a multipurpose tool and a platform for development which can be achieved into various forms related to various objectives in respect to the specific local situations of animal production systems.

2.2 Appropriateness of recording at the farm level

2.2.1 Principles and expressions

It is usually admitted that the development process is facilitated by organizing networks which should link the farmers involved at the local level and by establishing close confident relations between these organized farmers and the officers. Within this view, the recording systems at the farm level can be considered by the officers as an appropriate starting point - a concrete means for establishing relations between institutions and farmers. In fact, at this local level, the interest of the farmers is not firstly for increasing the national food production neither reducing the state financial deficit, or even not the genetic improvement of the breed. These objectives are those of the responsible of the governments or of international institutions.

Several inquiries revealed first importance consideration given by the animal owners to health and diseases of their animals, to the reproductive activity of the sires and to their choice, and to the opportunity offered for marketing the products. Certainly, the first chance to be taken by the officers of recording systems is to pay attention to breeding animals - particularly to the sires - and to meet this interest of the farmers before to consider the “official” quantitative objectives. If this principle is admitted by the officers, it is clear that their initial efforts have to be put in order to know and to meet the subjects of interest for the farmers and animal keepers. There is no doubt that the farmers, or the animal owners, or the village herders, have their own criteria for the choice of sires - their own performance testing - and that in some situations, they don’t need the measurements and the organization of a large scale coordinated programme (Plasse, 1988). In the situation of dairy cattle production with Friesian x Zebu crossses in Malawi, Kuettner and Wollny (1997) report the results of an inquiry through smallholder farmers about their claims to extension services for their enterprise: they put in first rank the high cost of supplementary feed and the poor artificial insemination service.

2.2.2. Theoretical basis

Conceptual basis of these attitudes and principles can be found since the beginning of the years 1990 in the successive International Symposium of Livestock Farming Systems (Gibon and Matheron, 1992; Gibon and Flamant, 1994; Dent et al, 1996; Sorensen, 1997). They promote systemic approach of animal production farming, taking into account the coherence of the existing goals of the individual farmers and of their families. Gibon et al (1996) conclude, from on-farm research-and-development programmes carried-out in various situations of animal husbandry in European countries, “the livestock farming system (LFS) to be a dual entity”. They consider that LFS has a bidimensional aspect, at the same time as a biotechnical system in which animal material plays a biological function for transforming vegetal raw material to animal products, and as a farmer decision system in which the animal farmers and their family are central actors. (Figure 1).

According to this view, a livestock farm is a human activity system and the success of a development project has to begin by taking roots within own consistent goals of the farmers before applying top-down solutions from larger political aims. Gibon and Flamant (1994) and Vissac and Beranger (1994) gave arguments and described the evolution of the conceptions of animal production research, particularly in France, from a “top-down” technological progress which proves a remarkable efficiency

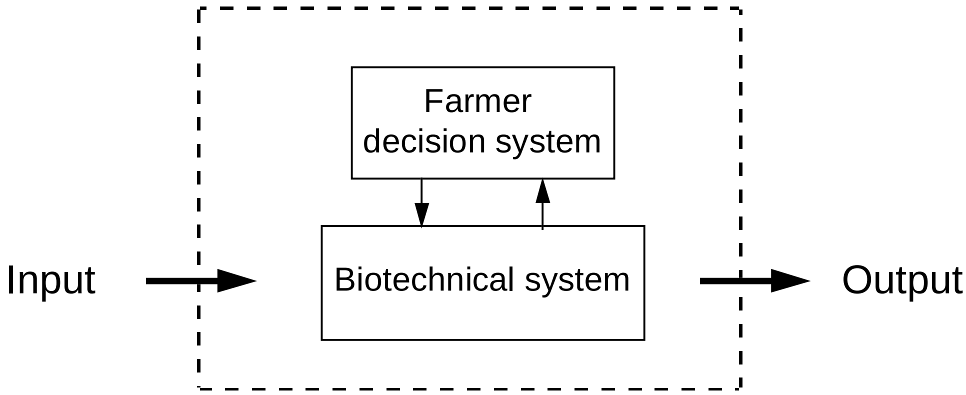

*Figure 1: Common conceptual model of a livestock farm
(Gibon* et al., *1996).*

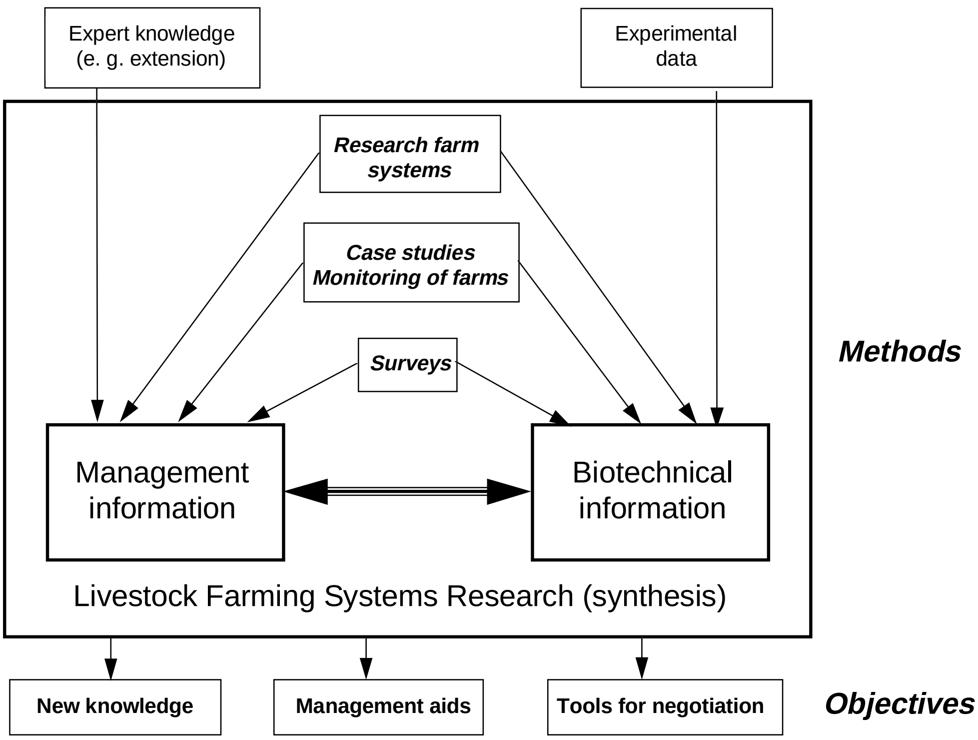

*Figure 2: Objectives and methods
of Livestock Farming Systems Research at the farm level (Gibon* et al. *1996).*

for transforming the agricultural industry at the national global level, towards focal interest for the diversity of the animal production systems in a given local territory.

In this context, LFS research has been for the main objectives of gaining better understanding of the whole system at the farm level by collecting both biotechnical information and management information. Three types of operation are pursued by the researchers: case studies, farm monitoring, modeling (Figure 2). Herd/flock animal performances inform the components of the biotechnical system piloted by farmers when taking decision and as a response to farm management strategies. In other words, animal recording provides quantified basis of production, the level and quality of which being explained by the management and the condition of the system.

The suitability of this theoretical approach can be asked for developing countries. In fact, one has to outline that these concepts were primarily built in the context of European mountainous or Mediterranean regions "in backward development", in respect to the European economy, where the classical intensive way for development of animal production was not suitable. It is also interesting to note that this approach was considered as convergent with the issues observed by various French, German or British scientists working in African or Asian countries (Gibon and Matheron, 1992).

2.2.3 Adaptation of theoretical basis to functional and cultural traits

Even if "the common understanding of the dual entity of LFS" seems to be of first usefulness for studying animal production systems in developing countries, it does not mean direct application of the methodology without adaptation to achieve. It needs to consider particularities which are not relevant from biotechnical features but from the human and economic aspects of the animal husbandry and which differ from the basis on which the systemic concepts where built.

The first difficulty, outside European countries, could be the identification of the pertinent production unit considering the social role of animals which can be of higher importance than the commercial one. For instance, Moulin and Lhoste (1996), providing a good illustration of the usefulness of the systemic approach assisted by animal recording in the village herds\flocks in Sénégal, explain they needed to make the choice of recording and monitoring the "concession" herd/flock gathering the animals belonging to owners in the same family "concession". In fact, the batch of animals belonging to every individual owner was not a pertinent management level in these conditions. Poivey (1987), in Ivory Coast, has to face the same type of question regarding the suitable animal unit. He chose to organize animal recording on the basis of the village collective pens and not on an individual animal owners basis. These examples mean that the "farm-family system", structure clearly identified for instance in

French conditions where there is close linking between the production unit and the farmer and its family, is less readible in other cultural conditions whith active enlarged family and strong collective habits at the village level.

A second type of methodological questions to solve comes from the various functions of animal production. It has for consequences that the nature and significance of the traits to be recorded could not be the same in the traditional conditions of developing countries than in the farm units in Europe or North America. For instance, Moulin and Lhoste (1996) underline that in Sénégal small ruminants production contribute not only to the family income by marketing milk and young males, but has also a savings function mobilised for cereal purchases during the soldering season, participates to the needs for ceremonies and also contribute to the women personnal funds. The respective role of the men and women in the societies and in respect to animals of the various species has also to be taken in account and attentively examined in considering the responsability of the management of the animal production systems. In the Indian conditions, another example is given by Rushton and Ellis (1996) who report the function of cattle production systems in relation to cereal systems by producing castrated males for draught and manure, the milk production being mainly assumed by buffaloes and not by cows. It means that the productive functions of the same species can be differ from one country to another one.

2.3 Contents and processing of on-farm observations

2.3.1 Recorded traits

Convergence of interest appears between on-farm animal recording and global appraisal of livestock farming systems coming from the fact that the fundamental characteristics of on-farm animal recording system is to be achieved at the farm level, which also is the management unit of livestock. However, clarification is needed about the conditions of the usefulness of animal recording system for livestock farm management.

In the conditions where the first purpose of recording individual animals which composed production units, is the genetic improvement of the whole population, we can assume that the efficiency of the breeding scheme in the long term will have consequences on the improvement of the individual herds/flocks which are part of the population. In the short term, interests of the farmers involved in such breeding scheme are also met if animal recording provides help for selection within the herd/flock, mainly of the females by the way mother/daughter. These short term interests are also more immediatly satisfied if “accompanying technics” of the breeding programme - for instance: heat synchronizing, artificial insemination, early mating of the females... - are also “improving technics” for the management of the herd\flock and acceptable by the farmer (Flamant, 1991).

If considering first the interest for management of the global livestock farming system, recordings on individual animals do not provide sufficient information and have to be accompanied by recording traits and practices concerning the herd/flock considered in the whole, or a particular batch of animals, like fattening animals, young females for breeding, mature animals at mating season, etc. In this respect, Gibon et al (1989), considering that animal production systems are management systems of biological cycles and technological systems of transformation of plants into animal products by animal material, propose in the condition of sheep and beef cattle farms in Pyrénées mountains (France), to complete the current animal recording systems achieved for sheep breeding purpose (registration of births and of individual weights). They recommend to pay attention to the various annual cycles which are components of and organize the production systems, by observing namely:

- the exploitation of the forage plots in the farm territory, at the origin of the feeeding resources of the herd/flock, by direct grazing or through various types of stored forages as hay or silage;
- the mating period and birth of the youngs animals, and their specific feeding regime and breeding management;
- the pathological events in the flock/herd;
- the economic aspects, by marketing, and main expenses and returns from animal production.

They promote the use and adaptation on the local animal material of body conditions scoring which provides information on the evolution of the state of the energy reserves of ewes (Dedieu *et al.*, 1994). They also outline the need of close talks and exchanges with the farmers in order to better know their systems and also better address the needs of the farmers (Hammond, 1995).

In the same line and in the African conditions, Peters and Thorpe (1988) point out the fact that the exigencies of monthly records for the estimation of the performances of individual animals are coherent with the need of frequent monitoring and efficient feedback by officers towards the farmers. As an illustration of the above considerations, Moulin and Lhoste (1996) provide a very interesting example of the use of recording system in sheep and goat production units in Sénégal. The method they used is that of "herd/flock follow-up" including: records of individual animal performances, demography of herds/flocks, productions of the herd\flocks, farming practices, and pathological events.

We can conclude that if it is recognized that the purpose of animal recording systems is not only the recording of performances but also that of events occurring in the herd or flock, of the feeding regime, the health status, the management practices... then there is there a consistent basis for method of monitoring the animal production systems including the use of animal performance recording.

2.3.2 Processing of on-farm observations

From the above considerations, it is clear that information coming from on-farm recording can be processed and interpreted within two types of considerations, in respect either considering individual animals and the population to which they belong, or the characteristics and the management of the production units.

In another part of this study, description and discussion are made about the calculation of indices from records on individual animals in the framework of an animal population. Our interest here is focused on the processing of information on the livestock production units.

Gibon (1994) provides an exhaustive review of methodologies used for establishing farms typologies on the basis of systems approach from in-field surveys. Typologies building means to obtain a comprehensive view of the farm diversity in respect to a limited number of groups which are considered as homogeneous for structural and technico-economic traits. From the collected data, automatic classification methods or even manual processing, are achieved in order to identify several farming “types”. In-field applications are well illustrated by Rey and Fithzugh (1994) in the case of the ILCA’s experience in south Saharan Africa.

Gibon (1994) also makes an inventory of various methods of “farm monitoring” or “continuous survey”: frequency, recorded traits, choice and size of the farm sample. Examples are provided of methods which permit to graphically put into relation biotechnical characteristics of monitored herd\flock with practices of the farmers, and the seasonal variations of the herd\flock condition with the feeding resources and the breeding events. Epidemiological approaches can also been achieved in this same framework, combining the herd/flock characteristics, the animal performances and the sanitary events (Bernues at al, 1994; Lescourret *et al.*, 1994).

In further parts of this report, information will be given on the implementation of these methods in animal recording systems.

2.4 Animal recording system: an observation and diagnostic tool for development

From experiences achieved in various countries there seems to be a good agreement that animal recording systems are considered as an observation and diagnostic tool for development. We can consider that it is a logical consequence from its bidimensional aspect, outlined before, either in respect to animal resource, or in respect to the production units in which animals are managed.

The case of the experience carried out by Poivey in the Ivory Coast, either for sheep (Poivey *et al.*, 1986) or for cattle (Poivey, 1987), demonstrates the role of recording system operated as an observation system at the village level permitting to gather a great number of data, supplying results to be used as a basis of dialogue between the farmers, the technical officers and the scientists. More than individual animal performances, this platform opens the way to approaches in the fields of animal management (feeding, reproduction control), agronomy and pastoralism, socio-economy. It also can be a support for analysing the attitudes and receptivity of the farmers faced to technical and economic evolutions. Poivey (1987) pushes further in that direction, considering that, from own experience in Ivory Coast villages, the first function of on-farm animal recording is to be a permanent observatory of the issues of animal production systems at the farm level. Consequently, he considers it needs to be an obligatory accompanying tool of any development programme in order to minimize the risks of unadequacy of the official objectives to the farmers and local realities, and to make a possible adaptation of the strategy of developemnt to the evolution of the production systems.

If we come back to the use of animal recording in respect to animal resources, it provides information for describing and assessing the local animal material at a regional level in order to develop animal production on the basis of the animal material used by the farmers and not exclusively by the introduction of exotic breeds (de Groot, 1996). It can be also associated with the evidence of the existing traditional networks of exchanges of sires between farms: "this sire come from?": farmer, locality... These existing and spontaneous networks of exchanges can serve as a basis for the consistence of a local breed, being in the mind that domestic animal breeds are social creations by the human societies (Flamant, 1991). It could be put in relation with the social system of compromise associating the members of the same family groups. There is a particular interest to detect such networks at the village and local level.

Confronting these various approaches enligthtens the opportunity, through the animal recording systems, to identify the issues of the animal production systems at the farm level in relation with the issues identified at another scale (regional development, local food security, marketing organisation): place of the animal production in the local economy and society, problems in the farm management, traits and potentialities of the local germplasm managed by the farmers. More precisely, in so far as animal recording system provides information derived from individual animals combined with information at the farm level, it offers the possibility of better understanding of the links between the animal production traits with territorial, meteorological, sociological, and economics local issues.

Moulin and Lhoste (1996) remark that this type of approach produces results dedicated to the institutions which have in charge the policy for animal production development at governmental and administrative levels:

- production of technical, health and socio-economics reference data on animal production in-farm;
- identification of the technical and socio-economic constraints for better control of their animal production systems by peasants;

- technical in-farm experiments in order to evaluate the practical ways for minimizing the constraints and making a cost-benefit evaluation.

For all the before reasons, an animal recording system, considered for its technical significance but also as a human and social basis for building development, can be used as a "platform" for various types of projects in the fields of extension service, marketing organization, on-farm demonstrations and experiments, breeding organization... Finally, various actions can benefit from the organization of an on-farm animal recording system:

- the monthly contact with farmers provides the possibility of grafting help and assistance to the farmers for animal health problems and feeding, then for the choice of the breeding animals;
- the concrete knowledge of the production systems makes effective the assessment of the possibilities to improve the input level of the animal production systems;
- the follow-up of a group of farmers can be a basis of the organization of relations between them involved in a development project: technical groups, collective marketing of the products, local animations by manifestations as the "ram days".

3. Need for progressive approach of an on-farm animal recording system

In this part, the purpose is to illustrate the possibilities of mobilizing concepts, methodology and various tools conceived and used by researchers for better knowledge of farming systems... in order to carry out effective and useful animal recording in difficult and adverse conditions. All the potential of actions opened by on-farm recording systems cannot be attained in a short time. There is a need for a progressive approach before considering the achievement of a new on-farm recording system. Principles of this progressive approach can be found in authors which aimed to carried out on-farm "participative researches".

In this respect, Gibon (1994) reports the successive steps defined by Tripp (1991):

1. Diagnosis: Review secondary data, informal and formal surveys.
2. Planning: Select priorities for research and design of on-farm experiments, in relation to target farmers and research priorities.
3. Experimentation: Conduct experiments in farmers's fields to formulate improved technologies under farmers' conditions.
4. Assessment: Farmer assessment; agronomic evaluation, statistical analysis, economic analysis.
5. Recommendation: Demonstrate improved technologies to farmers.

Other similar sequences of operations can be found in Landais (1986) on the basis of various programmes of research-development experimented on animal production systems in sub-Sahara Africa:

1. Available knowledges and preliminary in-field surveys.
2. First typologies and identification of the development issues, constraints and resources.

3. Provisional diagnostic; expression of research issues.
4. Choice of farms sample ; surveys, monitoring, experiments.
5. Processing and analysis of the data.
6. Diagnostic of the situation.

From these schemes, we can conclude that the successive phases have to be clearly identified: “in which phase have we achieved?” and “is it necessary to go to the further phase and which means are needed for that?”

A possible scenario for a progressive establishement of a new on-farm animal recording system could be as following fccording to the previous principles.

3.1 First phase: diagnostic survey

A first inquiry is needed in order to have a diagnostic survey for the knowledge of the diversity of the production systems at the local level. The collected information in-field can be organized in a document composed as follow, each of the items being relevant to a brief description and tables illustrating the various categories observed.

A first part of the document has to deal with to the expression of the official interest for the improvement of animal production systems.

Namely, the document has to recall what are the official developmental purposes and objectives in the territory considered, and to give justification as why animal recording is a pressing need for the inhabitants and the animal production systems in the concerned territory.

In the same manner, it is desired that people responsible for the project state what they consider as the main issues for animal production systems, for instance: need for association between resources from steppe area and resources from limited irrigated area or from cultivated areas, or solving the competition between extensive animal production and sedentary, or action in favor of the development of animal production in specialised crops areas, or supplying production of protein food for local or cities consumption, or lastly approvisioning national or export markets.

A second part of the document has to be deal with a description of the place and function of the animal production systems in the local economy and society, on the basis of socio-economic information (see 2.2.2). In this part, attention has also to be paid to the identification of the operational level of management and property of the animal material: individual farmer, family group, village community.

The third part of the document provides information and data from an in-field diagnostic survey:

- average size and variability of the flocks or herds: only some heads, several tens, hundreds, thousands;
- types and species of animals composing the production units;
- type of products and of their functions, association of the products to social life and cultural/religious manifestations, place of the market;
- components of the feeding systems: grazings and pastures, forage crops, cereals and other feeding complementation; first description of seasonal variations of the feeding resources;
- profile of the reproduction rates: strictly seasonal, partly seasonal, largely spread out along the year;
- estimated rate of reproduction: fertility, size of the litters, renewal rate, longevity;
- preliminary inventory of the main diseases and vulnerabilities in the animal production systems.

This survey can be performed by collecting information from available informants but combined with data collected during extensive visits on the field.

The duration of this first phase cannot be less than one complete year, in order to include the seasonal events.

3.2 Second phase: typology of the animal production systems and on-farm data collection

On the basis of the data collected with this first extensive survey, a first classification, or typology, can be built of the animal production systems in the region (see 2.3.2)

From this typology, one can achieve a choice of a sample of farms representative of the various pertinent types, being in the mind the specific goal of the local development. The objective of recording for genetic improvement should not precede, but preferably follow, this specific goal. It is clear that the personal receptivity of the farmers has a determinant role to play in this choice. In any case, it could be impossible to find receptive farmers for one or several of the identified types. If the criteria of receptivity of the farmers are really strongly determinant, it is very helpful to have the possibility to identify the types to which they can be referred.

A sample of 10 to 15 herds/flocks (individual or villages) followed-up at monthly intervals during one complete yearly cycle seems a maximum number for one officer when the purpose is to identify the pertinent traits to record (Gibon et al, 1989). This number will be able further to be enlarged till one herd/flock per day after this preliminary observations step, that it could mean approximately 25 animal units per month and per recorder.

Information recorded from this preliminary on-farm data collection are as following:

- age and social position of the farmer, family composition;

- structure of the units: size of the herd/flock; size, land use and spatial structure of the farm or of the grazing territory; characteristics of the land and of animal property;
- demography of the units: renewal rate and mortality; times for breeding, sale and slaughter; birth rate; estimated longevity;
- establishing of the feeding calendar of the herds/flocks, origin of the resources in the farm and environmental territory;
- description of the causes of mortality;
- origin of the sires and criteria used for their choice;
- variability of the performances (litter size, growth rate, mature size, milk production, wool) in respect to the conditions of production: responses of the animal production to the variability of the feeding systems.

3.3 Third phase: choice of the objectives

From the information gathered and analyzed in the first two phases, the organization of a recording system needs a clear definition of the objectives, global objectives in a strategy of development and specialized objectives for breeding animals and selection. This phase now needs clarification about methods for defining objectives either in respect to strictly breeding purpose or more largely for development purpose.

3.3.1 Breeding objectives

Theoretical approaches for the definition of breeding objectives are provided by the works of authors working in the technical and economic conditions achieved in good technical level farms. Ponzoni (1986) stresses the need to clearly distinguish the breeding objectives from the selection criteria. He considers that the breeding objectives are related to the economic interest of the farmers and they identify the traits the genetic improvement of which influencing the return. The selection criteria are the characters recorded and used for the assessment of the breeding animals within a genetic improvement scheme. Several available studies aim to give a comprehensive approach of the choice of the breeding objectives considering the fact that the genetic progress is operated in the long term, while the income of the farmer is submitted to immediate variation of the market. It provides a discussion which will be revisited when considering the methods of estimation of the economic efficiency of animal recording systems (6.3.1). At the present stage, we could simply retain the assumption of Pearson (1982) which considers that “weighing traits by their effects on profitability should provide the best genetic basis for improving long term profitability”. However, if the question is a comprehensive one, the response needs deeper discussion considering that even in the favorable farming conditions for milk cattle production, in developed countries, the possibility to take into consideration “functional traits” as breeding goal, and not only productive traits as milk yield or growth rate, is now largely discussed. For instance at the European level, Groen et al (1996) make an extensive review about the economic weight of these “functional traits”: health traits, fertility, calving ease, body weight, feed intake, persistency, milking speed, longevity. They discuss the efficiency of their indirect versus direct selection in the usual situation where there is no direct information on the corresponding traits. It is not a marginal issue for the future development of animal production. It means that even in very favorable conditions, we can no more consider that breeding schemes can be conceived as if there were no limitations for quantitative output based on milk yield records (Groen, 1989). The general situation in the long term is with environmental and economic constraints related to a set of diversified animal traits.

In low-to-medium input systems, the constraints are closer and more immediately sensible that in high input systems, and the efficiency of animal breeding programme has to be questioned. Particularly, McDowell (1977) considers that under strong constraint conditions there are too high limitation for efforts in genetic improvement if the animal diet is not exceeding by one and half the maintenance requirements. It is interesting for our discussion about the various ways for animal recording systems, to report here the comments of Poivey (1987) who considers that the remark of McDowell can be used as an argument for insisting more on the interest of animal recording as a help to the improvement of livestock condition than at first for breeding schemes.

In respect to this question of the constraints of the production systems, the Philoetios group (Flamant and Morand-Fehr, 1989) proposed to make a deep analysis for identifying the various types of constraints and not only to envisage the degree of constraints in respect to the level of input. Examples of this approach are given in the case of Mediterranean sheep and goats, in combining the knowledge of the farming production systems in a given area and the data provided by on-farm animal recording systems. This type of qualitative approach can provide a justification for the existence of local breeds. The methods proposed in these difficult poor environments can be very profitable for the assessement of any local breed. Flamant (1997) and Gabiña (1997) provide in this respect exhaustive review of the present state and evolution of Mediterranean germplasm.

3.3.2 Objectives for local development

In contrast to the above discussion on the objectives of animal breeding and the original traits of the local animal resources, there is less available publications about the definition of objectives for local development using data from farm units. It is less easy to describe explicit methodology in order to clearly identify the objectives of a global strategy for development on the basis of the datas collected from a better knowledge of the production systems and of the characteristics of the local animal germplasm. This fact needs clarification, and we'll attempt to discuss how such a strategy could be built.

A first reason of the lack of publication could come from the fact that the great majority of the development projects are "top-down", with global objectives coming from macro-economics analysis on statistical basis. They are achieved with the support of technical packages and improved breeds with quantitative objectives - increasing the volume of milk or meat production for instance - and ignoring the basic qualities of the local livestock.

A second reason is that the publications concerning the analysis of local development rarely give a description of how one passes from global national objectives to more precise objectives in a local given territory, or how in coming back the identification of specific local objectives can be taken in charge and support at the national level.

And thirdly, it is simple to make the remark that the approach by the breeding objectives of the local animal resources is more specialized and easier to model than the complexe issue of the local human and economic development.

However, the content of the publications of International Symposium on Livestock Farming Systems can provide some ways to go through according to various tools available for analyzing the specific case of animal production systems:

1. Farm typologies express the diversity of the existing production systems at the local level. From them, arguments can be expressed for carrying out diversified proposals for improvement adjusted to the diversity of the objectives of the individual farmers in contrast to a unique technical package to be applied.
2. From modeling, which provides description of the characteristics and constraints of the main production systems achieved in a given territory, one can deduced the function of the animal material and the possibles objectives for its improvement, but also the role played by each part of the territory and their possible contribution to a better efficiency of the feeding system.
3. Considering livestock farming systems in there local social and economic context, the system approach put the point on the possible role of animal production system in the coherence of the society and in the organization of market chains.
4. In a more specialized step, the organization of breeding strategy on local breeds with the participation of the farmers should lead to the organization of a human group taking in charge various aspects of the local development.

All these aspects can be considered as a contribution to the conception of a global plan for development carried out at the local level from it owns traits, constraints and potentialities.

4. Strategies of animal recording systems for breeding purpose

The literature clearly indicates two types of approaches for the breeding strategies and consequently the organization of animal recording systems in developing countries regarding the relation with the farmers. Bearing in the mind the factors limiting the effectiveness of the operations of on-farm recording systems in low-to-medium input systems, and considering the need for intensifying the production systems in order to meet the increasing demand for animal products from the urban consumers (de Groot, 1996), the first approach is based on precise and complete recording and breeding in controlled environment (in-station). In a second approach, the activities of animal recording systems founded on closer relations with the farmers or animal owners, and for keeping adaptation traits of the local animal germplasm, are strong argument to make desirable the strategy of on-farm animal recording system. In fact, there is a third strategy which combines on-farm recording and in-station recording.

4.1 Strategy of stations and closed nucleus

The difficulties for achieving the recording operations in-the-field, at the farm or village level, confronted to the necessity felt by the administration to organize the improvement of the animal material and of the management conditions, are apparently resolved by building central breeding farms and performance test stations. Stations can also be dedicated to experiments on improved breeds, breeding technics, intensive feeding, etc.

In the field of this strategy, we can find two types of situations:

- Firstly, as it is mainly the case for dairy cattle production, the purpose is to organize the spreading of improved and imported germplam by crossing with the local females, and with the support of extension services. Trevedi (1996) presents the Indian organization in this respect with stations and central breeding farms, along with frozen semen production centers for artificial insemination for crossing local cows with improved breeds. The disadvantage of this strategy is the low adaptive traits of the up-graded crossed animals to the current farming conditions and also the limitation of the number of farmers involved to those receptive to these technics. However, in the long term, this strategy can be in the origin of new dairy small farms around cities (see 1.1.) in so far market organization and support to the improvement of the farm management are achieved, as it is well illustrated by Eddebbarh (1996).
- Secondly, if considering the interest for fitness qualities of the local breeds, mainly their specific traits of adaptation to constraints as demonstrated in the case of the Mediterranean germplasm (see 3.3.1.), closed nucleus can also be established for the knowledge, appraisal and selection of the local animal material, in view of further spreading in farms selected and controled sires.

The apparent advantages of this strategy for animal recording are the possibility for complete procedure and the control of the successive breeding phases of a selection scheme. In fact, there are also large limits to this apparent efficient solution: improved management conditions of the stations are usually far from those of the on-farm production systems, the breeding animals produced from the stations demonstrate low adaptation capacities to the conditions of the local herds or flocks, the selection efficiency is very low in closed nucleus with a reduced animal stock. Organization for grading-up schemes with intensive dairy imported germplasm from central stations may be ignorant of the consequences on the true genetic composition of on-farm livestock and of its relation with the farm management conditions. In fact, in developing countries, this strategy usually expresses the difficulty of the official framework to face the logics of the on-farm management of the farmers and to include it in a development process.

4.2 Strategy of on-farm recording

Chapter 2 exposed the interest of on-farm recording systems as a basic tool for development: a multipurpose tool, appropriateness of recording, a platform for development. In contrast to the closed nucleus strategy, strategy of on-farm recording considers: firstly the interest to work on the local animal material; secondly, that the public expenses for the salaries of officers are best valorized by addressing the effective needs of the farmers than by the unique maintenance of stations with artificial conditions. In the case of India for instance, de Groot (1996), explain the interest found in appointing part-time recorders chosen and trained in the villages, carrying out the close contact with the farmers and the local societies.

Many authors (Poivey *et al.*, 1986; Poivey, 1987; Peters and Thorpe, 1988; Plasse, 1988) also underline that even if the on-farm recording procedures are less complete than in-station one, and are achieved on only a few number of traits, with a loss of precision, the major interest comes from the opportunity for selection on a large population, and of keeping the characteristics of adaptation of the local animal resources to the constraints of the environment and of the production systems. Limitation to the level of genetics progress could come from the absence of artificial insemination or of recording mating for progeny testing. But Poivey et al (1986) and Poivey (1987) point out to the possibilities offered to carry out selection through dam-son way at the farm or village level and in a large population either on cattle or sheep.

4.3 Strategy combining on-farm recording and open nucleus recording

In the progression of on-farm recording and breeding systems, could appear the need to have the control of the young males detected in the private herds or flocks for better testing them. The individual selection of young males, primarily chosen from on-farm extensive recording, is completed in performance test central station with more complete recording on reproductive ability, own growth rate and conformation, wool characteristics... before coming back to the farmers of the best sires.

Another scheme, combining on-farm and station recording, comes from the condition of animal ranching systems in Australia and New Zealand. Private open nucleus flocks or herds are achieved by the farmers who provide the best females chosen from a large number of animals by extensive and low cost on-farm recording (Turner and Parker, 1984). Originally, this scheme was conceived by groups of farmers unsatisfied with the sires they purchased in the traditional elite Merinos flocks, and they wanted to make a more efficient selection with scientifically based on recorded traits, but the difficulties came from the management conditions of the large extensive flocks. In fact the adopted solution of the open nucleus can also be included within an official breeding programme, under national or regional organization, with small to medium size of the herds or flocks which does not authorize efficient on-farm selection, as demonstrated in the case of the selection of the sheep Thimahdite breed in Morocco (Bouhamar and Bouix, 1991).

In these two types of situations, attention has to be paid to the management conditions of the testing station or of the nucleus herd/flock which have to be far from of that of the current farms. As mentioned by Poivey (1987), this danger can have several reasons, for instance the necessity of standardizing and improving the feeding system for better expression of the genetic variability with the risk of deteriorating the adaptation traits.

In fact, as assumed by Peters and Thorpe (1988) in African conditions, there are compatibility between on-farm animal recording considered as a platform for development and on-station testing in so far as it is possible to organize at the local or regional level an association between a network of farmers involved in on-farm recording and a station which gathers several tools: a flock or herd on which more complete recording is carried out in order to better know the local animal material in complement to traits recorded on a large population, an open breeding nucleus for testing and producing sires coming from the farms, and a support for specific demonstration and experiment in various field of interests (feeding, reproduction techniques, cereals and pastures, material, sanitary practices, etc) and estimation of their economic efficiency. In the case of grading-up schemes for dairy cattle production, examples are given of the usefullness of the association of on-farm animal recording with central breeding farms in order to monitor the evolution of the germplasm in relation to the evolution of the feeding and management conditions (de Groot, 1996).

Such schemes were also achieved in Mediterranean countries as an evolution of previous State regional stations, isolated from around animal husbandry systems and local breeds. In these conditions, Philoetios network provided reference methodology in order to identify the specific qualities of the local sheep and goat breeds in response to the constraints of the production systems (Flamant and Morand-Fehr, 1989) for meat or milk production.

5. Practical implementation of animal recording systems in relation to socio-economics and cultural-educational conditions

One can ask what it has to be considered as a complete on-farm recording system. In the case of beef cattle in Latin America, Plasse (1988) provides a list of the components of what he considers as desirable:
- "recording of the basis data on farm;
- listing of the data;
- coding of the data and preparing them for the computer input;
- processing of the data in the computer, listing and statistical analysis;
- making the list available to the producer at certain strategic dates according to the production cycle;
- interpreting the results (producer technician scientist);
- drawing conclusions and making decision (producer - technician - scientist)".

In the case of Ivory Coast, these successive steps are also identified in the establishing of recording systems on cattle and on sheep (Poivey, 1987 and Poivey *et al.*, 1986) . In a first approach, we'll consider this sequence of operations as a reference one, but preliminary conditions have to be filed and problems solved before to make operational an animal recording system: identification of the individual animal, age identification, operations of recording data, transportation facilities, computer treatment. Another remark is that the solutions are not only technical but are in relation with the human and economical issues at the local or national level.

5.1 Practical and technical aspects

5.1.1 Individual identification

For all the authors and the practionners, the individual identification of animals is considered as a basic condition for achieving animal recording system for breeding purpose. The assumed reasons are firstly the need for successive records on the same animals at regular time intervals, and also to register youngs at birth in relation to their mother. To insure this possibility, it is also recommended to registr all the animals of the same given flock/herd in order to avoid confusing situations and facilitate the correction of possible errors. One can remark that if the purpose is a global appraisal and monitoring of the production system, ther may be no need for individual identification of the animals, but for example the same mark on individual of the batch monitored. But if animal recording system is established for using for various purposes as a tool for further developmental actions, problem of individual identification has to be solved.

The usual system of marking consists of a plastic ear-tag on which a number is readable at distance, combined with a fixed and definitive tattooing. Several authors mentioned a lot of difficulties, even if there is acceptance by the animal owners: wearing away of the number on the ear tags, losses of the tags, tearing of the ear in the field conditions particularly in grazing and brush environment... It is also well known that the tattooing can face difficulties with black eared animals.

For the organizers of an animal recording system, other problems can occur coming from the lack of availability of the material and ink for marking at the national market, needing importation and even long administrative steps. In some cases, where herd/flock size is small, the solution was used to include the name attributed to each of his animals by the owners or the caretakers (see for instance the practical remarks of de Groot, 1996; in the case of goat herds in India).

In order to face the consequences of loosing the ear tags, Poivey *et al.* (1981) describe how they imagined a solution in changing the number of the ear-tag of individual animals but outline the need of permanent number for processing the information, using pretabulated lists established on computer for every monthly record in one given herd. This needs regular exchanges of information between the recording place and the computer center.

5.1.2 Age identification

The preliminary enquiry on the demography of the herds/flocks (see above) and the initiation of the inventory of the animals make useful a method for age attribution of the existing animals. Information from the animal owner or animal keeper can be useful, completed by using a dentition pattern adapted to the characteristics of the local livestock and productions systems as outline by Poivey *et al.* (1981).

5.1.3 Operations of recording data

Firstly, considering the need for frequent contacts between animal owners and technicians in a global project of development for advise and monitoring, it is clear that the recording operations have to be achieved by officers and not by the farmers themselves as it can be the case in large extensive farms of developed countries (Plasse, 1988).

Secondly, many practical problems occur for taking the information as it is the case for recording the live weight of the animals and for the transport and the use of weighing bridges. The equipment for sorting and containing animals, very useful for these operations of recording, are also useful for other purposes as antiparasite, sanitary and prophylactic treatments. In fact, it is recommended (Poivey *et al.*, 1981) to use methods which limit the need for material by using an indirect weight recording by body measures, as for instance chest girth, with prediction equations established on the local breeds themselves and adapted to their conditions of production.

5.1.4 Transportation facilities

The problems of the transportation is mentioned above in respect to the weighing material. More generally, transports can be a limiting factor in developing countries. Usually, the first demand from the officers is the frequent use of a vehicle to achieve engaged relations between the central office and the farmers. The appointment of local recorders, even at part-time, is a solution to limit the weight of this constraint and to optimize the use of the financial availability. De Groot (1996) gives other arguments favorable to this solution, considering the need for confidence and close relations between the recorders and the farmers at the village level. That induces a need for training this local part-time recorders which can also contribute to other aspects of the development programme.

5.1.5 Computer processing of the data

It is obvious that all the recording system projects include the use of computer systems even in the situation of developing countries. At the present time, it seems difficult to conceive any recording scheme without including this technology which is basic for any large field of activities in the societies.

But clearly also, there is various types of using this obligatory mean. Minimum solution consists in using a central computer, in part-time with other purposes, on the basis of data processed manually at the farm level by the recorders. Poivey (1987) illustrates the interest of frequent feedback from the computer to the recorders in establishing pretabulated listings of animals to be recorded. But we need to outline the importance of frequent and reliable relations, even during the bad season, with the central computer. For instance, in the case of Ivory Coast, Poivey (1987) stresses the advantage of regular meetings with the chief town Abidjan where the central computer is located. It is not a generalized situation.

The description of a "pilot cattle information system", designed for small dairy farmers in Egypt (Abdel-Aziz, 1996) aims to create a data processing center at the Cairo University (College of Agriculture) mobilizing current computer material but also adaptating software specialized for animal on-farm recording created either in Canadian conditions or by ILCA.

A basic remark of many authors is also that the synthetic result be available for decision making at the strategic periods for the herd/flock. It is a condition of the credibility of the system for the farmers. Peters and Thorpe (1988) for instance, outline that "the lack of effective mechanisms for analysis and feedback of results and recommendations to farmers, researchers and extension agents, remains a major constraint on livestock development". (**)

The evolution of the computers towards portable microcomputers makes possible the direct computerisation of the information at the herd or flock level, which opens the possibilities for local immediate treatment. But as in the case reported just above by Abdel-Aziz (1996), it needs appropriate software adapted to the local treatment of the information including the various purposes of animal recording (management and breeding).

(**) Plasse (1988) consider in the conditions of beef cattle production systems in tropical Latin America that the "production data need to be available at the following stages of the production cycle: (1) after the end of the calving season; (2) after the last weaning; (3) after the last weighing post-weaning; (4) after pregancy checking; (5) at the time of selection between pregnacy checking and the beginning of the breeding season; (6) after the beginning of the breeding season."

Finally, in the most sophisticated recording systems, there is a remarkable evolution towards automation (Hammond, 1988; Bibé et al, 1997) which permits to avoid many errors in rewriting the data, and also which facilitates the relation between on-farm and off-farm information from analysis laboratories or from slaughter house, related to the same animal, in large breeding schemes. The cost of this equipment and the practical possibilities for their maintenance in difficult environmental and climatic conditions have to be submitted to preliminary evaluation. It can be out of the possible field, but acceptable for stations and nucleus in a further phase of development. As it is well argumented and described by Tomaszecski (1993) in the conditions of large high producing herds in the States, the ultimate step of this evolution is the current use of integrated information system at the farm level (or "total farm information management system": Hammond, 1988), by the farmers themselves, as a support to the herd management. Obviously, these systems need farmers with high technical level.

5.2 Human and educational aspects

Human and educational aspects were mentioned before in this report, when considering the factors limiting the possibility of achieving on-farm recording systems in developing countries (see 1). Low literacy rate of the farmers is frequently mentioned as one of its major obstacles, in so far as this tool is on written basis, taking roots in information as individual number of every animal, reading and transcription of quantities and measurements, lists of numbers, quantified results, etc. The languages used in the computer system and software, mainly English or French or any other European language, can be different from the local language used by the farmers. Partial solutions can be found to solve problems linked to the numbers, as it was mentioned before, in so far softwares can now taken into account the true name attributed by the farmer to a given animal, even if the data processing consider only numbers. Nevertheless, the officers involved in animal recording systems have to be competent in the technical language but also familiar in the local language of the farmers and in confidence with them. It is an important point to take into consideration within the training programme of the officers and recorders.

However, it is a too short a view to only consider cultural aspects of traditional societies in developing countries as a matter of resistance to the diffusion of the technical progress. Several additional reflections can be expressed which provide elements for a deeper understanding of the relations between the local farming societies where livestock are playing a major cultural role and animal recording systems considered as a support for the introducion of technics from industrialized countries and cities.

Firstly, it is obvious that operations of animal recording systems have to be carried out according to mimimun educational conditions and that means that all the farmers cannot be concerned with. It means to select only a part of them. This can be considered as a limitation of the efficiency of recording systems. This remark is of importance and needs special consideration. In fact, one has to outline that despite it is a multipurpose tool, animal recording system is not dedicated to be generalized to all the farmers for it is not a farming technics providing per se a better efficiency and improvement of animal production systems as it is the case of feeding, health control, reproductive technics.... It is before all a tool for better diagnostic of the true situation of animal husbandry in a given area, for better knowledge of the possible ways of evolution of the farmers and better adressing their needs for development, and for demonstration of better organization at the local level. We also have to remind that in the case where animal recording systems are to support breeding programmes, only a part of the farmers are involved in it and produce the improved animals for others farmers. So, it does not matter if animal recording system is limited to some farmers, in so far as other categories of farmers could indirectly benefit from the recording process through a better address of the extension actions.

At a second degree, attention has to be paid to situations where only a part of the farmers is primarly concerned with progress adapted to on-farm situations. Sociologists observed that this gap can provide preeminent social role to people playing the card of the technical development in traditional societies which are moving toward development and integration in a logics of production for marketing. It means that the introduction of technical progress in local societies can encounter at the same time resistance and interest. If the proposed changes mean to destroy the existing systems or are outside the cultural references of the people, they will be rejected. But they are also able to meet interest if they are considered by the farmers as an acceptable way of evolution of the existing systems. From the point of view of development, the goal is to identify technics and evolutions which can be accepted by a large number of farmers, and it is a basic goal for animal recording systems.

Thirdly, humility attitude has to be respected. The possible ways of evolution of in-field animal production systems are not so easy to identify in so far, as it was mentioned before, all animal production systems in developing countries are not firstly dedicated to market production, but can have other functions in relation with religious and social events or have a saving role in order to face future uncertainty (see 2.2.3). More generally, we have to consider the social consequences of the introduction of new farming technics in animal production systems closely related to the societies as it is the case in transhumane and nomadic large extensive systems. The success could mean the disappearance of these specific human societies, and as a matter of fact also a break in the ecosystems balance of fragile environments.

Finally, in respect to the role of recording system in the assessment and selection of local germplasm, we cannot be aware about the issue of its property. This question has to be carefully discussed considering the respective role of the farmers in breeding original germplasm for several generations in specific context of constraints, resources and objectives, and of the support of the national foundation and organization for assisting them, in front to possible international interests. This discussion can be initiated taking into consideration the evolution of the human challenge about keeping biodiversity at the world level (Hammond and Leicht, 1997; Hodges, 1997).

6. Cost and evaluation of animal recording systems

For any group or organization involved in an animal recording programme, or planing to build a project including it, a first elementary question surges: “How much are the costs?” and a second one: “Is it possible to diminish the cost by simplifying the recording system?” And finally: “What is economic interest for an animal recording system?”

As an illustration of the weight of these questions, it can be mentioned here the facts reported by Turner and Parker (1984), about the cost of an animal recording system directly taken in charge by farmers involved in New Zealand Group Breeding Schemes. Some participating farmers “naively” discovered that the management and the recording and breeding operations of the open nucleus flock, common to the group, has to be paid by them, and that the sires coming from this sytem can cost as highly and even more than those they previously purchased from elite farmers. In these circumstances, some farmers left the scheme with the consequent failure of some Group Breeding Schemes as remarked by the authors.

6.1 What are the costs of an on-farm animal recording system?

This approach needs basically to make an inventory of the material means necessary to carry out an animal recording system.

6.1.1 Components of the cost

An exhaustive list of the types of components involved in an animal recording system is proposed in Annexe 1. The table can be filled at the level of a functional unit size for carrying out the recording system, for instance at a regional level, or within a farmers organization, or at a national public institution. The example (Annexe 2) is given here from the situation of the sheep recording system carried out in Morocco by Association Nationale Ovine et Caprine (ANOC) in marginal areas (Ait Bihi and Boujenane, 1997). Such a table could be also used for providing a financial estimates to state or private institutions which would initiate an animal recording system. It could also provide a basis for a comparative evaluation of the cost between the existing systems if needed.

If the breeding programme also involves testing station, or open nucleus herd/flock, or frozen semen and artificial insemination center, the cost includes initial investment plus maintenance and functionning operations, in which the reembursing and interests of the capital for investment could be included.

6.1.2 Factors of variation of the cost of the components

The global cost could largely vary in respect to the respective cost of the components which are variable among the various countries, in respect to the living costs rate, to the relative amount of the appointements and also to the cost of material which needs importations from developed countries which, as vehicles and computers, or even specific material for animal recording as ear-tags or weighing machines.

Bearing in mind the role of the computer processing in the organization of animal recording systems (see 5.1 and 5.5), differences between countries can also come from the current facilities or not to have close relation with active informatics (computer, software, and human expertise).

The type of recording system (see 4.) is also a factor of variation of the cost of an animal recording system. Particularly, for a given animal recording system, all the topics of the Annex 1 may not be necessary. Comparisons can be easily made of the cost of the various strategies of animal recording and breeding. For one side, we can consider what is called the "minimum animal recording system" and on the other side, we have the most complete and sophisticated systems associating testing station and artificial insemination to on-farm recording.

6.1.3 Indices for comparisons

Indices can be obtained from the global cost (gC) calculated from the list of the Annex 1:

* the cost per individual recorded animal (iC)

This index can be obtained by dividing the global cost (gC) of a given animal recording system by the number of recorded animals (nRA), bearing in mind that the meaning of this index is only valuable when the recording system has passed through the preliminary period and is carried out in routine period.

$$iC = gC / nRA$$

* the individual cost expressed in respect to the commercial value (cV) of the animal

$$R1 = (iC / cV) \times 100$$

This percentage measures the financial effort for animal recording in respect to the economic value of the recorded animal.

* then in respect to the value of the all products: meat, milk, wool

$$R2 = (iC / p) \times 100$$

p = price of meat kg. or price of milk litre, or price wool kg, depending of the recorded trait considered as the main one.

This percentage (R2) has a particular value in permitting comparison between systems at the international level, without taking into consideration currency exchange rates. For instance, we could express the cost of individual recording in equivalent of weight of meat, or litter of milk... The value expressed in reference to milk, meat, or wool quantity can also be used for measuring the relative contributions of the various partners to the global cost: farmers, commercial company, regional authority, state...

But we have to pay attention to the fact that this index is mainly adapted to situations with specialized and intensive animal production systems - for milk or for meat or for wool. In contrast, in the developing countries, the basic situation is that of multipurpose production systems: meat + milk + draught and labor (and wool and hair). In this situation, the global value of return from one animal could be difficult to appraise in monetary terms. We can only retain here from these remarks that the ratio cost/production value, expressed in unity of milk, or meat, or wool production can provide an index for comparison without the direct influence of the currency fluctuations between countries.

These indices were calculated in reference to the Moroccan example in sheep recording (Annex 2). The average cost per recorded ewe (iC) is estimated at 9 DH per head. It represents approximately 0.6 to 0.9% of the commercial value per ewe (R1), or 2.0 to 2.6% of the commercial value per lamb (R1'), or still the value of 160 to 180 g of lamb meat (R2). This type of evaluation permits to estimate the investment rate set by the animal recording system to be put into relation with the expected progress (see 6.3.). In the Moroccan case, it is remarkable that the two largest sources of expenses are linked to vehicle (depreciation, fuel and management: 25%) and to appointments and traveling expenses (45%) due to the large distances to cover in the countryside, the both representing 70% of the global cost. Certainly, it is an usual pattern for expenses of animal recording systems in any situation in developing countries with large distances and extensive conditions. It is hoped that this type of evaluation be achieved in various national situations.

6.2 How to diminish the cost by simplifying the animal recording procedures

6.2.1 Choice of record frequency

a) Principles: a fundamental principle is on the basis of the recording system organizations for breeding purpose: *how to obtain a non-biased estimate of the whole production or performance of an animal without daily measurements?* Its means to make the choice of records frequency. In this respect, for instance monthly recording in dairy animal or still measurements of the live weight of the lambs every 3 weeks, can be considered as current and acceptable procedures.

However, the pressure for increasing the simplification of the recording procedure has two roots:
- to search for cheaper procedures with the same objective and information production;
- In fact it means to make more with less money;
- to obtain better adjustment of the recorded traits to the objectives.

This last consideration opens the way to a come-back to the objectives pursued by the respective actors having interest for animal recording system: individual farmers, farmers organization, technical and economic framework of the production systems, or official authorities (regional, national...). This discussion on the objectives can be complex if considering that are not only the breeding objectives on individual animals concerned but more largely development purpose and strategy of engaged contacts with the farmers are considered.(see 3.3)

b) Modalities: in fact, the choice of the frequency and of the recorded traits have to be always a compromise between the expected precision of the assessment and the cost. Particularly, one can search to have less charges for the appointments, and its means that every officer is able to record more animals, more herds or flocks... during one month or one year.

The lower cost can be also obtain in a better share of the fixed investments (as rent of housing, price of vehicles, computer systems, etc) among a greater number of animals when the recording system attain the routine phase. If the recording procedures are managed by officers, it will be of interest to evaluate the reasonable number of farms that can be monthly followed by each of them. It is clear that this number is related to the frequency of the records carried out at the farm level. In fact, it can be chosen that for development purpose, there is a need for monthly contacts between farmers and recorders.

6.2.2 Issues of simplified procedures

Whatever the result of this optimization, several research studies are available in the literature which support the interest in and the possibilities of more simplified procedures.

The example of dairy animals is interesting to discuss even if it is achieved in intensive dairy sheep dedicated to the Roquefort cheese in France. The basic idea was that it was not necessary to collect the two daily milkings. Alternate evening/morning monthly records are sufficient and more efficient than an complete record per two months, evening and morning. Better efficiency of the estimation of the daily yield is obtained, if the record of one milking, evening or morning, is completed by the knowledge of the total milk production of the herd obtained in the two daily milkings, evening + morning, in the bulk. The same procedure can be follow for the estimation of the milk composition. In Lacaune dairy sheep this proposal (Flamant and Poutous, 1970) was made at first in order to increase the efficiency of the pure breed selection scheme, but it generalized achievement in the recorded flocks demonstrated also the value of the knowledge of the bulk yield for management help and the global efficiency of the flock production. (***)

In fact, in these efficient breeding schemes, the organizers and framework of an animal recording system have to pay attention to the fact that the introduction of simplified procedures in a routine system can be considered, by the farmers for instance, as inefficient. This aspect has to be taken into consideration and needs explanation. It has its place in the training programme for the officers and the farmers, if necessary with the participation of scientists who can provide objective arguments, for example demonstrating that it is efficient to record the milk yield of more dairy daughters cows per sire bull with less individual precision in order to improve the estimation of the breeding value of the sires. In developing countries, the authors usually favorable to on-farm recording system consider desirable to have less precise recorded traits, but on larger number of animals for breeding purpose and on a larger number of farmers for development purpose. This fact also needs explanation and training from scientists towards politician and financers. It is clear that these simplifications are more and more easier to achieve with the assistance of computer facilities.

A good optimization of the animal recording system could also include the participation of the farmers to the recording operations: the birth registration in a specific booklet is clearly relevant to the farmer, and can also include observations on the conditions of the birth, on the mother and the young animal. The farmer can take charge of the milk recording in so far as the recording system is considered more as a help to the management of the herd than an official one for genetic indexing purpose. But it is clear that this choice cannot be made in situation with low literacy and technical level of the farmers.

6.2.3 Money for station or for on-farm recording?

Beside the simplification of the recording measurements and the issue of the frequency, other source of expense has to be considered: the need or not for creating testing stations or open nucleus herds/flocks. To make complete instruction of this critical point, it is recommended to refer to the conclusions

(***) For the estimation of the growth rate in sheep production for instance, preliminary French studies argumented for a 3 weeks frequency, in order to estimate the daily growth individual rate from 10 to 30 days which expresses the maternal milk ability, and then from 30 to 90 days which expresses the growth potential of the individual lamb. This registrations are completed by the birth declaration made by the farmer: date of birth, number of born lambs. The evolution was processed in regard of the too high cost of the procedure in regard to the need of increasing the number of flocks and animals recorded. Firstly in admitting that the 30-70 days growth rate was sufficient for estimating the individual growth potential, that means a reduction of one passage in the flock during the lambing period. Secondly, in considering that the need for a precise evaluation of the lamb growth rate is more needed in meat breeds but less important than the estimate of the maternal productivity in a large number of breeds. Consequently, the recording procedure can be limited to the birth declaration, with the number of born lambs, then with weight control at larger frequency, with two records per lambs between the birth and the slaughter or selection for breeding animal. (Bodin *et al.*, 1995) of Croston *et al.* (1980) who consider that, even if testing stations authorize more complete and accurate records, this advantage is limited by the capital expense it needs. This issue has to be carefully examined in developing countries with low level of available investment, in contrast to the political attractiveness of such realization, larger than the organization of only on-farm recording. And if capital should be available, calculation has to be made about the interest of the use of this financial facilities for extension of on-farm recording system to new farmers.

6.3 Estimation of economic efficiency and appraisal of the interest of animal recording systems

6.3.1 Methods for estimating the economic efficiency of recording systems for breeding purposes

Animal recording systems which are active since a long term can be submitted to an evaluation of their economic efficiency, considering the estimated overall cost and the response obtained. An approach of the estimated overall cost can be at first performed by describing the successive steps of the evolution of the recording and breeding system: number of animals and herds/flocks involved, evaluation of the genetic progress. For the new systems, it is useful to get from the organizers an expense\income estimation of the recording operations, as suggested by James (1986), taking into account the successive years, the planed enlargement of the number of the farmers concerned, and the expected rate of progress for the production. For instance, Callow *et al.* (1986) demonstrated that the new "Sheeplan" scheme they designed was not only technologically more efficient but also will provide financial benefit to the New Zealand sheep industry. This type of estimation is useful for providing arguments for the people or institutions which have to pay to cover part of the whole cost of the recording and breeding system.

Question is asked about the estimation of returns from the expected genetic progress in the long term, from 10 to 20 years after starting the breeding programme. In this situation a first issue concerns the possible changing of the market conditions with heavy consequences on the economic situation for the farmers, that could modify the interest of the chosen objectives in the origin of the programme. The response to this embarrassing question could be the choice for criteria which can be considered as of permanent interest, for instance: adaptation to constraints of the environment, resistance to diseases, mothering ability. But it is well known that these functional traits are difficult to select for and that they could be in a negative genetic correlation with productive traits as milk yield, growth rate, of immediate economic interest for the farmer (Groen *et al.*, 1996). Flamant *et al.* (1995) also propose to pay more attention to the diversity of the animal resources in respect to the possibilities it offers for rapidly changing of the herd/flock genotype in response to new economic interests. Illustration is given of the interest of local breeds in the case of rural areas in the Mediterranean where the orientation toward tourist activities in relation with specific quality products or leisure and landscape could be more interesting for the farmer than the only milk or meat production with specialized breeds. In these conditions, conservation of the biodiversity and acceptance of the usefulness of non specialized breeds are of importance to face these rapid changes and evolutions (Flamant, 1997).

Another question to discuss is related to the method of estimation of the economic efficiency of one given breeding programme, in respect to returns and expenses. James (1986) examines the significance of two types of combinations between returns (R) and costs (C): the profit equation P = R - C or the ratios Q = C/R or Q = R/C. The profit equation seems better when considering the evaluation in the short term (10 years) and the ratios are better for estimations in the long term (25 years). But the consideration of the long term stimulated research on the interest of the "discounted cash flows procedure", used by Poutous and Vissac (1962) on dairy cattle and by Hill (1971) on beef cattle. James (1986) and Ponzoni (1986) consider that despite the better precision and theoretical interest of this last method, the results are similar to the comparison cost vs. income year per year.

These estimates can also be practically used for chosing the best breeding objective considering the need for better optimization of the expense (Pearson, 1982). But we have also to have in mind that coming back to the situations of low input systems in developing countries, the genetic progress of the performances of individual animals cannot be obtained outside a global goal concerning the improvement of the efficiency and productivity of the whole production system (Poivey, 1987).

6.3.2 Examples of financial efficiency of breeding programmes

All the examples deeply studied on breeding programmes carried out in developed countries, as those by Poutous and Vissac (1962) on the on-farm progeny-testing of dairy bulls in France with artificial insemination or by Hill (1971) on a project of beef cattle testing station, prove their high economic efficiency in the long term.

It is interesting to outline that de Groot (1996) arrives at the same conclusion in India with an on-farm performance recording programme on local goats, with high technical means, and considers that taking into account the initial investments and the current yearly expenses and the expected genetic gain in milk yield and body growth, the first net benefit year is reached on the 10^{th} year.

However, the effectiveness of such results have to be submitted to critical view in low-to-medium input systems, where the first limiting factor could be the investment availability. In this situation, it is not sufficient to demonstrate the long term economic profitability of a breeding programme. It is necessary to adapt the choice of the breeding and recording procedure to the financial possibilities in the short term resulting from arbitration of the public governemental funds, in respect to other needs for development of the society and of the economy.

6.3.3. Efficiency of animal recording system with goal of global development

Considering the use of animal recording not only for breeding purpose but for global development progress, the conclusions reported before need to be reoriented for the efficiency of the animal recording system has not to be appreciated independently of the global programme.

In this type of situation, animal recording is only one of the tools used in support to development programme. Consequently, the relation cost\benefit cannot be estimated by isolating the animal recording system from the whole context. The evaluation has to take into account the interest of a bottom-up strategy in contrast to a top-down strategy. Particularly, considering animal recording system as a privileged tool in order to better inform responsible of the development about in-field situation of animal production systems, ways of evolution acceptable for them and their effective evolution within a global projetc of development, we cannot estimate the result in only the recorded farms but in the whole project better adressed with the support of the data coming from the recording system. It is particularly true during the first step of establishment of the recording systems.

If further developments of recording systems are carried out toward breeding scheme, we have also to consider that there is no total independence between the efficiency of a breeding scheme on local breed and global development. Lessons coming from the observation of the evolution of well organized breeding scheme achieved in France in dairy sheep, (Flamant, 1991) show that the long term genetic objectives where supported by short term objectives in intensifying the production systems, considering the fact that the accompanying techniques for breeding purpose in the long term where also immediately favorable for the profitability of the systems. In these situations, we observe that animal recording system could not be only an observatory of the evolutions but also a motor for. It was also observed that in the most achieved breeding programmes on local breeds, the network of the various actors contributing to the recording and testing operations, can be the basis of a social organization taking in charge the objectives and the means of local development projects. This remark has to be linked with the reflexions achieved about the human aspects of animal recording systems (see 5.2).

7. Requirements and conditions of implementation of animal recording systems. Final recommendations

7.1 Basic requirements

From the various experiences of animal recording systems carried out in India, de Groot (1996) observes that there is a need for:
1. a clear definition of recording purposes;
2. a good institutional environment and backup;
3. a long-term perspective in planning and also for generating financial and human resources to ensure the continuation of the activities.

De Groot (1996) also defines the conditions required for a sustained success: (i) relative independent administrative status of the organization, (ii) continuous financial support from Government, (iii) vision and capacity of the staff.

The choice of the objectives for animal recording system is very needed in respect to finally 3 possible functions:
- animal recording system as observatory and diagnostic of the in-field situation;
- animal recording system as a platform for monitoring management improvement and a "lead technology" for development;
- animal recording system as a basis for breeding programme, on-farm or on-station.

There are relations between these three types of objectives which are not independent. Figure 3 illustrates these relations, and also the possible progression from one objective to one another.

As a system of collecting information, animal recording can be used as a platform for development and can have in this context various functions:
1. for observation and diagnostic purpose, animal recording has a specific contribution in the appraisal of livestock farming systems, in complementary with other types of information at the herd/flock level, combined with information on the local context;
2. as mean of entry at the farm level, animal recording system has a catalytic effect in supporting development programmes, farmers being considered as central actors for any technical action;
3. if breeding programme is considered as an objective for development, animal recording system provide basic information to achieve it.

7.2 "Minimum" animal recording system

Considering the generally low financial capacity of the State in developing countries, it appears very useful to describe the "minimun" standard of animal recording system to achieve, having in the mind its multipurpose function, and particularly the capacity of such technology to induce in the short term phenotypic progress before long term genetics progress, or to be an accompanying tool for developmental strategy.

Under this principle, animal recording system has to be adapted at the same time to the goal of increasing the productivity of the animal production systems but with reasonable financial expenses and requirements adapted

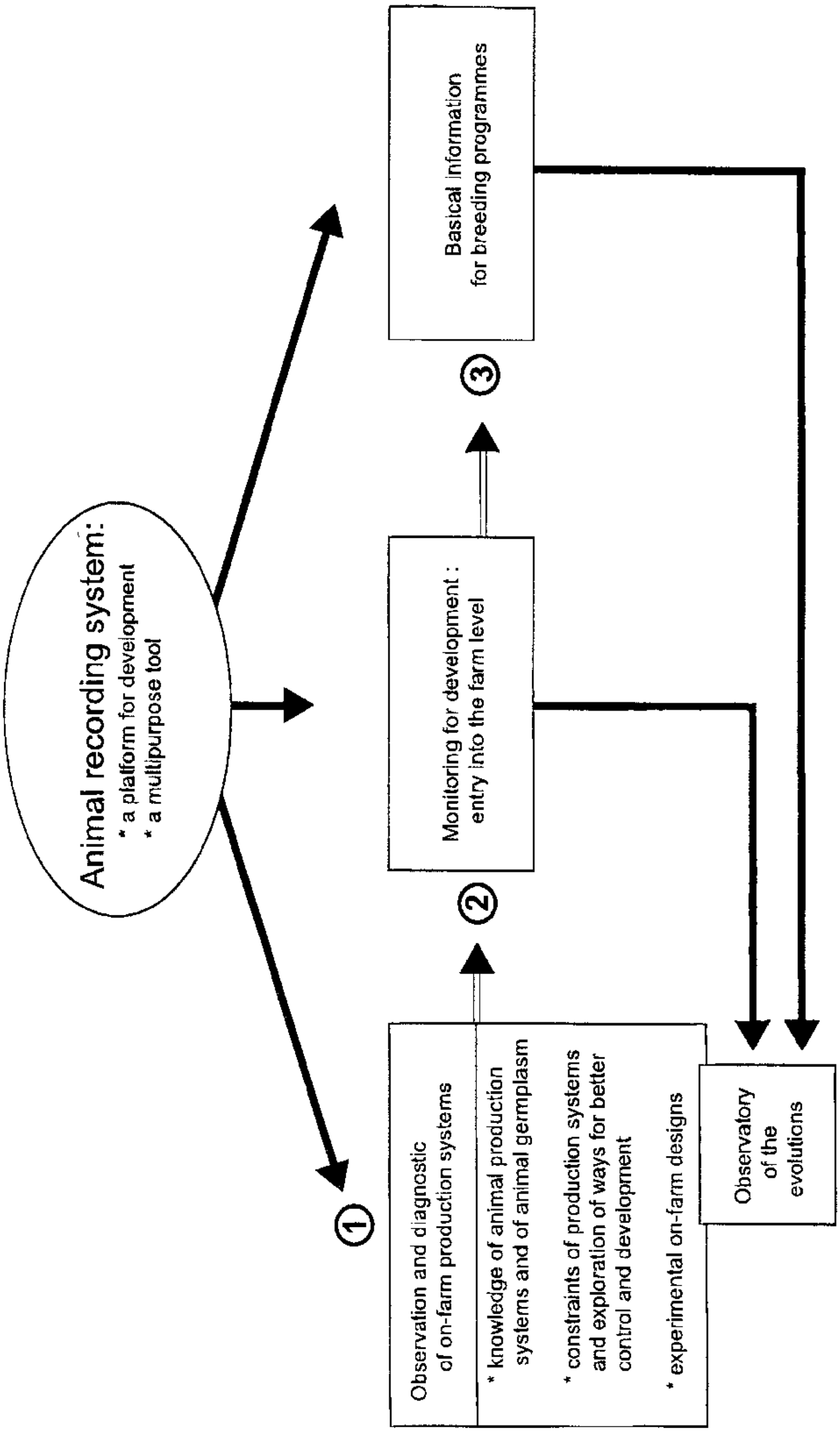

Figure 3. Animal recording system: multipurpose tool, various functions and progressive ways of implimentation.

to the conditions of the national economy and to the possible supports coming from international organizations. It is stressed that this desirable “minimum” can include various components, the nature of which depending a lot on the particularities of the local production systems, respectively: the nature of the animal products (milk, meat, wool, energy by draught and obviously mixed of all the possible products), the biological characteristics of the species (cattle, sheep, goats, horses and others), the type of the production systems (pastoral or intensive, sedentary or transhumant or nomad) and also the place of animals in the social organization (village keepers, religious aspects, social prestige...). So it is difficult to describe here a precise “minimum” animal recording system precisely adapted to every of these conditions. This is the job of any organization, which has the willingness to engage in such endeavor, to design this minimum in the context of its specific animal production systems.

However, it is possible to underline some principles from conclusion of the before chapters. They are summarized as follow:

1. on-farm recording on a sample of 10-15 to 20-25 units, representative of the diversity of the situations observed in a given local breed and territory (almost one thousand animals in the total);
2. individual marking of the animals, but individual names can be used in some situations and even the description of the color pattern in diversified cattle no standardised populations;
3. monthly recording, without assistance in material providing difficult to transport (weighing machines for cattle for instance), that means metric measurements;
4. possible local use of micro computers for immediate registration of the data and checking of the number of the animals;
5. adoption of standardized form and software at national level;
6. production of regular lists of results;
7. training programmes for officers, recorders and farmers.

These seven points have to be investigated and discussed at the local and national level, in respect to the characteristics of the project, and namely to the expression of the official interest for the developement of animal recording system (see 3.1).

In the situation where there is an existing station, it is useful to organize in priority an on-farm recording scheme around the station and linked to it, in order to make closer the activities of the station and the reality of the animal production systems. It is particularly interesting in the case of dairy herds engaged in crossing schemes from central station or artificial insemination center with European or North American breeds (see 4.1 and 4.3).

The creation of a station cannot be envisaged at the local level only after the phases of on-farm diagnostic and in accompanying monitoring management improvements, for demonstration and test of solutions, if the objectives and the role of this station for development purpose are well identified and discussed.

Finally, a ram/bull center can be imagined in a further step, in so far as breeding objectives and adaptation traits are clearly identified from the knowledge of the livestock farming systems.

7.3 Role of the State and of national organization

State and national organization have a specific role to play for achieving animal recording systems. Examples can be given of self-organized recording systems by the interested farmers as in New Zealand and Australia (Cf. Group Breeding Schemes. see chapter 4), but the need for continuous effort and long term perspective mentioned before cannot be meet without a public engagement.

Authors outline that it is only at a national level that it is possible to conceive, organize and manage an information system which provides the framework for any local action in the field of animal recording and farm monitoring. Such a system could be now more easily achieved through computer and software facilities, and in adaptating monitoring programmes designed by research as illustrated for instance by de Freitas et al (1997) in the case of Brazilian dairy herds.

The needed actions and obligatory contribution from State can be listed as following:

1. basic need for research in order to built methodology for on-farm observation, models for decision making, models for animal breeding, and in adaptating efficient solutions evolved in other conditions;
2. organization of information and processing network for animal recording, including computer center, standardization of forms used by officers and farmers, and building of software adapted to the situation of livestock farming systems;
3. creation of specific institutions and stimulation of collective organization taking in charge animal recording systems, assistance to the farmers and training programmes for technical framework, officers and recorders;
4. financial support in view of long term benefit.

7.4 Main snags to pay attention

In final, considerations can be made about the main snags to avoid in the achievement of animal recording systems.

As a matter of fact, this report highlights convergence of interests involving animal recording systems, and valorizes the usefulness of this multi-purpose tool. However the reality can be also a clash between various types of interests from the various actors involved with various and divergent objectives. It is why we also need to identify here and discuss possible sources of misunderstanding between various actors involved in the social system established by carrying out animal recording systems.

It is firstly possible to describe a "black scenario" in which the computer and the information network begins the finality of the animal recording system. The animal recording system is above all dedicated to supply the computer system. This situation is founded in the constraints of the management of the whole data network in which the computer center is the most technically sophisticated and so it only defines the rules to be followed by the other actors in the recording systems whic may be unaware of the constraints and needs of the other actors of the network.

In a second "black scenario", recording system is firstly designed for breeding purpose from traits of individual animals and does not accept to include and to process information at the herd/flock level. The origin can be technical, related for instance to the availability of software adapted to this purpose.

Other criticisms can also expressed towards a "blind" use of animal recording system:

- There could be limited confidence in the interest of animal recording system, from people closely involved in local development process in so far as they give priority to the need of understanding the management and decision system of the farmers, or in firstly diffusing basic techniques for the improvement of animal production systems and consider unuseful the knowledge of the variability of the individual animal performances.
- In contrast to the former remark, prejudices have also been taken against limits of the use of quantified data. It could have for consequences orientations towards exclusively improvement of the level of the strictly recorded traits. We have to pay attention to the fact that the improvement of the productivity of individual animals is not the unique way for higher livestock productivity and income at the farm level.

In the practical achievement of a given animal recording system, possible conflicts can also occur between top-down strategy from national decision-makers and bottom-up strategy privileging poor small farmers.

And finally, human issues have to be discussed in respect to questions about the consequences of introduction of new technics on the future of traditions and local societies.

The above "crititicisms" are mentioned not for objective to provide negative opinion about animal recording systems. Their purpose is to enlighten the challenges of good implementation of animal recording systems into a more global and social organization of the development. It is expected here that the tool which is an animal recording system will not begin the unique objective but will remain only a tool. This important issue has to be taken into account in the training programme of people involved in animal recording systems.

8. Conclusion

This report is concerned with the largest number of farming animals over the world (approximately the 2/3 world population), kept in developing countries, but of which the contribution to the global world production is relatively low (only 1/3 of the meat and milk world production). It means that till now animal husbandry was unsufficiently taken in charge by development procedures adapted to the specific conditions of the majority of the world. Extensive range systems are not able to meet the increasing needs of humanity for animal protein, but the intensive model, evolved in developed countries, cannot be carried out in conditions where public and private financial means are not available. In these conditions the largest ranges of future progress have to be prospected in low-to-medium animal production systems in so far as the means used and the objectives defined be founded on the knowledge of the specific qualities of the local animal germplasm and on the identification of the ways of evolution of the farming systems acceptable by the present populations and societies involved in animal production systems.

It is why despite difficulties and limiting factors for carrying out animal recording systems in the context of most developing countries, this report stresses the need for voluntary on-farm procedures, even associating poor small farmers. Theoretical basis for this approach are now available, considering that animal production system is “a dual entity”, as well a biotechnical system as a decision making and management system.

Examples from the available litterature aim to cover a large range of situations for animal production:

- new specialised animal production systems in small to medium herds mainly dedicated for milk production in the surroundings of the cities (periurban systems), and linked to the milk marketing towards the close consumers; or new animal production systems associated to the need of draught animals for the development of cropping systems;
- traditional mixed farming systems in small to medium herd/flock for largely diversified production in village conditions;
- large extensive farming systems in range land conditions - ranching systems or nomadism and transhumance.

Litterature and experiences are convergent to consider now the possibility to carry out animal recording systems for multipurpose development use, associating records on individual animals to information from the herd/flock management and from the farming system within its social and economic local environment.

Computer systems and software are also now available and have to be considered as no bypassing means, for processing diversified and complexe information in direction of various goals:

- present state and diagnostic of the local on-farm situation and of its possible way of evolution;
- basis for experiments;
- help for various types of development and assistance actions: feeding, veterinary, breeding, organisation of marketing...

It should however be dangerous to see animal recording system as a new miraculous stick, suitable for rapid turning in advantage difficult situations of populations in the countryside. It was firstly illustrated in this report the need for progressive approach and for the respect of successive steps in order to success. Its potential interest does not justify the possibility to be unaware of possible snags coming from the difficulties to manage a complexe human network associating various competences and interests which could also be proved their capacity to clash.

Finally, a lot of experiences through the world proved the effectiveness of on-farm animal recording so long as there is search for adapted objectives and procedures to the local context, continuity of financial official supports, good level competences of the technical framework. Probably, the first important interest of animal recording system is the possibility to have a better knowledge of the true conditions for animal production at the farm level. Animal recording system carried out in a small but well choose sample of herd/flocks could be of first utility in order to better adress the need of a larger population concerned with the same goals, constraints and resources, and receptive to the same way for evolution. Nevertheless, this efficiency in the long term does not permit to avoid a serious local or/and national consideration and questions about the way chosen for the evolution of the farmers and village societies in relation to the technical and economic changes. The original association between traditions and modernity is under the hands of the responsible of the development programmes as well as in those of the farmers and their families and villages.

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Annexe 1

Material components of an animal recording system

1. marks of the individual animals: ear-tags, ink...

2. instruments for recording:
   - milk recording tubes
   - weighing systems
   - for young small ruminants
   - for mature small ruminants
   - for calves
   - for mature beef cattle
   - meter for metric measurement
   - automatic registration system
   - contention system and of sorting of the animals

3. pre-printed documents
   - birth daily registration booklet at the farm level,
   - printed forms for officers

4. informatics
   - individual computer
   - farmers
   - officers
   - central computer system and software

5. paper for editing the results, post, and divers

6. vehicles, fuel and maintenance

7. staff and employees:
   - appointments
   - travelling expenses

Annexe 2

Example of the cost of sheep recording system in Morocco (Association Nationale Ovine et Caprine - ANOC).
Cost in Moroccan Dirham (DH) (1 US$ = 9.53 DH)

1. animal identification (ear-tags and tattooing)	16.000 DH
2. instruments for recording (dynamic balance, 50 and 100 kg.)	3.000 DH
3. pre-printed documents for manual data acquisition	7.000 DH
4. Informatics: computer (annual sinking)	6.000 DH
5. Listing, Post, divers	10.000 DH
6. Vehicles	
- annual sinking	18.000 DH
- fuel and maintenance	19.200 DH
7. Staff and employees	
- appointments and traveling expenses of recorders	30.000 DH
- employee for computer data acquisition	15.000 DH
- appointment of the responsible of recording system (*)	20.000 DH
Total	**144.200 DH**

(*) 20% of its monthly time

<u>Calculation of indices</u> (see 6.1.3.)

- gC (global cost) = 144.200 DH
- nRA (number of Recorded Animals : 16.000 ewes (140 flocks)
  iC = gC/nRA = 9 DH
- cv (commercial value per ewe) = 1.000 to 1.500 DH
  R1 = (iC/cV) x 100 = 0,6 to 0,9 %
- cv (commercial value per lamb) = 600 to 800 DH
  R1' = (iC/cV) x 100 = 2,0 to 2,6 %

Goal-Led Livestock Recording Systems for Low To Medium Input Production Systems

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1. Introduction

1.1 Background

The major objective of this paper is to outline the principles underlying good recording schemes and then to use this outline in a process aimed at developing guidelines for any new scheme, with particular emphasis on low to medium input systems.

Interestingly, considering the widespread use of recording in livestock work, there seems to be very little literature which can be used to address these questions. Key publications dealing with livestock recording are listed in the Bibliography. This paper, therefore, draws on a combination of the limited literature and other experiences of designing, running and evaluating livestock recording schemes in both developed and developing countries and involving livestock systems ranging from intensive to low-input.

Although this paper is primarily about the development of livestock recording schemes for low/medium-input livestock production systems it will be based on the set of principles which can be applied to any livestock system.

1.2 Recording in perspective

Livestock recording can be viewed as an imposition on the normal routine of the livestock farmer; it is an additional task which has a cost but at the same time may have an additional value. The ultimate question about any livestock recording scheme is therefore about the additional benefits to the livestock farmer in relation to the additional costs (i.e. is it worth doing). It follows that the rationale for any recording scheme is based on economic (in its widest sense to include monetary, social and cultural value) rather than technical decisions. This may seem an obvious and basic idea but few recording schemes are assessed in terms of their economics before they are designed and implemented. This is true whatever the type of livestock recording scheme considered. It may be that the value of the recording process accrues to different players in the scheme, farmers, governments, merchants, added-value companies etc.

The two major determinants of a successful livestock recording scheme are two non-technical factors, these are the physical constraints of the livestock system being recorded and the financial returns likely from a given recording set-up. The physical constraints which determine if a recording scheme is likely to be successful include the accessibility of the animals when needed for recording, accessibility of the farm to recording agency staff, if the required infrastructure is in place etc. In intensive livestock recording schemes it is assumed that the pay-off for expensive according procedures makes the recording worthwhile. But even in this situation the recording of certain desirable characteristics may not be economical to the breeders concerned. One example of this can be found relating to the use of X-ray computed tomography and its ability to measure the live animal composition of species such as pigs and sheep and the limited use of this technique in commercial livestock breeding. The technique has been shown to be successful in improving genetic gains but its uptake has been extremely. Therefore any recording scheme is a compromise between what is desired and what is physically and financially possible. This is true whatever the species, system and likely level of inputs.

1.3 Classifying and implementing livestock recording schemes

There are a number of criteria that could be used to classify livestock recording schemes. These are listed in table 1. A number of these criteria will be developed later in the paper and used to discuss the characteristics of different schemes.

Table 1. Possible criteria for classifying livestock recording schemes.

Classifying criterion	Examples
Purpose for recording	Management decisions, genetic improvement
Production intensity	Intensive, extensive
Level of recording	One herd, all herds, males, particular progeny
Operating methods	Farmer recording, agency recording, research
Legal requirements	Statutory information, farmer’s choice
Species or species subgroup	Cattle, beef, dairy, sheep, breed, herd
Level of integration with other activities	Extension, AI, veterinary input, policy development

It is a common belief amongst planners, managers and agencies that if livestock recording is required as part of a project (the word project is used throughout this paper in its broadest sense) then it will probably be possible to find an existing scheme and import it into the new situation. This belief has been supported by a number of companies/individuals who have developed livestock recording software and attempted to market it widely. However, there are a number of reasons why this has not turned out to be successful in practice. These include:

- Even within apparently similar livestock enterprises, different variables need to be recorded in different situations.
- The physical situation of the recorded enterprises.
- Infrastructure differences.
- Different cost structures.
- Reports are often required in different formats.
- Hardware/operating systems differ.
- Poor documentation of programs makes amendment difficult.
- Required analyses differ.

Even with the move towards a more common hardware and operating system world-wide (IBM-compatible PC and Microsoft Windows) these problems are still apparent and lead to very inefficient and costly development procedures. Even recording methods applicable to low-input systems, perhaps based on cards, record books and calculation sheets, have some of the same problems.

It is a major contention of this paper that recording schemes are not portable to any great extent, and that in any new situation a new scheme will need to be developed. Consequently the design of most schemes should start from first principles, which should allow for local variation in physical and human infrastructure, market conditions and, most importantly, objectives.

In order to overcome these problems this paper proposes that livestock recording should be approached in a logical manner, using a set of principles outlined in this paper and aimed at developing the necessary technical expertise to handle the recording scheme at local level ('local level' means at the most appropriate level for the individual scheme). This is a fundamental approach that is not always found in practice. It is also the reason why this paper is not prescriptive, in the sense of providing an easily applied set of recording schemes for every situation. Almost all aspects of any livestock recording scheme will be dependent on local factors and recording schemes must be designed to be appropriate for the situation in which it will be used. It is of little value to try to change the local circumstances to fit an imposed recording scheme.

As outlined above, recording schemes must be viewed in terms of their real benefit to the individual farmer, not the researcher, government official or commercial company. In fact most successful recording schemes are farmer-originated and arise from a perceived need at the farm level by those intimately concerned with the day-to-day running of the livestock enterprise. Many failed recording schemes are the result of an imposed system which had no net benefit to the farmer.

1.4 Products

The most commonly recorded species, world-wide, is probably the dairy cow and the most common product from it is milk. However, there is a much longer list of species farmed by the human race and the products from this list of species is numerous. Table 2 lists the major farmed livestock species and table 3 the major products from these animals (FAO, 1995).

Table 2. The major farmed species of livestock world-wide (FAO, 1995).

Mammalian species	Avian species
Buffalo	Chicken
Cattle (all *Bos* and *Bibos* species)	Domestic duck
Yak	Turkey
Goat	Muscovy duck
Sheep	Domestic goose
Pig	Guineafowl
Ass	Partridge
Horse	Pheasant
Dromedary	Quail
Bactrian camel	Pigeon
Alpaca	Cassowary
Llama	Emu
Guanaco	Nandu
Vicuna	Ostrich

Table 3. The major livestock products world-wide (FAO, 1995).

Meat	Milk
Wool	Hair
Skins	Pelts
Eggs	Dung
Traction	Wealth
Security	Cultural value
Blood	

In theory recording schemes can be applied to any species for any product and the objectives achieved. However, in practice this is rarely carried out. Considering the list of products above then organised schemes involving formal recording are found for only meat, milk, hair, skins, wool and eggs. This is because the cost of putting a scheme into operation is not recouped in many species/product combinations.

2.0 Types of livestock recording schemes

There is a wide variety of different types of recording schemes found in livestock production and its associated industries. Although this paper concentrates on those directly associated with the individual farmer, or group of farmers, a wider range of schemes that can be found within a livestock industry are listed, for completeness, in Table 4. Recording schemes fall into four main categories according to their purpose. These are categorised here as schemes relating to genetic resources, enterprise management, farming systems research, government policy and a miscellaneous set of other schemes.

This paper will concentrate on the first two categories, genetic resources and enterprise management, which are the schemes commonly operated at the farm level for the benefit of individual farmers. In the following section the requirements of a recording scheme to achieve a primary purpose will be described using a medium-input meat sheep system as the example, in order to illustrate what is required. The primary characteristics of all other species/purpose schemes for low and medium input systems will then be summarised in order to give an idea about the key aspects in which they differ.

2.1 Animal genetic resources recording systems

2.1.1 Breed/national population structure

This type of recording is designed to define the breeding structure of a particular population at national level, although more local schemes may be required. They usually take the form of a survey and may cover one or several breeds, as the goal of the work dictates.

Example 1

Although the Ministry of Agriculture, Fisheries and Food carries out an annual census of all farms in Britain there is no information collected on a regular basis of the size and distribution of sheep breeds and crosses. Information is available from breed societies about the number of registered sheep in each breed (for which there is a breed society) but this is not a true picture of the number of purebred sheep of each breed in the country.

In order to obtain a picture of the breeding structure of the sheep industry a postal survey has been conducted on three occasions (1971, 1987 and 1996). In these surveys a 10% random sample of all sheep farmers in Britain were sent a one-page form asking for details of their ewe and ram numbers, by age, and the mating pattern of their different breeds. The forms returned were used to estimate the size and mating structure of the different breeds, in combination with census and other information from various sources (MLC, 1988 and as yet unpublished data).

Table 4. Types of recording schemes found in a livestock industry.

Genetic resources	Breed/national population structure Breed characterisation Population screening Pedigree information Genetic merit for performance
Enterprise Management	Phenotypic group performance, inventories etc. Resource use (Grazing use/Feed use) Farm management budgeting, accounts, costs, prices, margins Farm health records
Farming systems research	System comparisons Economic evaluations Baseline performance for production systems Market/abattoir/milk outlets prices, costs Breed comparisons Problem identification Indigenous knowledge systems
Government Policy	National/regional/local - value/economics/costs/returns/prices National/regional/local - census, inventories National/regional/local health schemes
Others	Veterinary practice records Product distribution companies records Wool company records Carcase classification/ other abattoir data Milk laboratory (Cell counts/ milk quality) Breeding stock production company AI/ET company Environmental impact assessments Indicators of sustainability

This is a relatively cheap way of obtaining information but depends on a number of factors which may not apply in all situations. These include a reliable postal service, the willingness and ability of farmers to answer and return the form, reliable mechanisms for cross-checking the data and estimating the complete population size. A more costly method for collecting the same type of information is by visiting a random, or structured sample of farms, and interviewing farmers. Whichever method is used a key criterion for success is to keep the number of questions to a minimum, commensurate with achieving the goals of the survey, and to make sure that the data summary and analysis system can cope with the data collected, within a sensible time span.

2.1.2. Breed characterisation

Breed characterisation usually takes the form descriptive and numeric information used to uniquely identify the characteristics of a given group (breed) of animals. Because phenotype is a product of genotype and its environment, it is essential to combine performance data with information on the production system under which the animals are kept. Apart from the value of the information as a breed description, it is more likely to be used for management purposes and breed substitution choices.

Example 2

Hill breeds of sheep in Britain are regularly sold from the mountainous areas, where they originate, to less harsh upland farms after 3 or 4 lambings. In their new environment these ewes may be kept for a further 3 or 4 lambings. Their lambing performance differs in the two different environments as shown by flock recording occurring under both sets of conditions. Such breed characterisation involves the measurement of key performance variables from a group of flocks over a number of years (Croston and Pollott, 1995).

2.1.3 Pedigree recording

Pedigree recording involves the recording of matings and birth events of individually identified animals in order to ascribe parentage to offspring. It is commonly used by breed societies but is also the basis for genetic improvement by selection. A number of different mating procedures can be used to ensure that the actual male mated to a female is known. This can involve group mating with one male, individual mating of each female with a known male or the use of artificial insemination with semen from a known source. Supervised births with correct mothering or individually penned females at birth is the second part of this process.

Example 3

Any breed society flock book is a useful example of pedigree recording output. e.g. Suffolk flock book.

2.1.4 Genetic value of performance traits

Recording the performance of individually identifiable animals in contemporary groups is the most common means of achieving genetic improvement. If at least one parent of each animal is known, and the known parent has several offspring, then the genetic evaluation of animals is possible. If no parental information is available then the use of this information is limited to screening a population for superior phenotypes, perhaps as the basis for building up a nucleus population from a variety of sources. This type of recording is usually carried out as part of a selection scheme to improve one or more traits in the selected population. Superior animals or their relatives are often used more widely in the population to improve production levels of the population at large.

Example 4

Several sheep recording schemes of this type operate world-wide. European schemes have been reviewed by Croston *et al.* (1980).

2.2 Enterprise management recording schemes

Livestock enterprises, like the farms on which they are kept, are an economic enterprise, just like any business. There are a number of features of the livestock enterprise that need to be recorded in order to help the business function more efficiently. Financial records are an obvious necessity in this respect. In addition certain key physical features of the enterprise should be recorded since they are crucial to the levels of performance necessary to achieve profitability.

2.2.1 Phenotypic group performance, inventories etc.

Keeping track of the number of animals in the herd and the changes that occur during the year is a fundamental requirement for good livestock management. The number of breeding females, the number of offspring born and reared and the number of animals dying are typical key variables in this type of recording scheme. In addition the collection of a certain amount of data on key physical performance traits can be of enormous benefit. The amount of milk produced, the time taken for a meat animal to achieve marketable weight, the weight of that animal at sale, the number of eggs produced per day or year are typical of the key variables that can be recorded and used as management information to improve the enterprise.

2.2.2 Resource use

Efficient and profitable livestock enterprises are based on the effective use of a large range of inputs which are turned into saleable livestock products. By monitoring the use of these inputs and using that information to improve their conversion to outputs farmers can increase their profitability and hence success. The major input in all livestock enterprises over which the farmer has control is livestock feed. This may take the form of grazed material, both sown and natural, forage, or purchased feed. Records of the quantities of feed purchased and fed to particular groups of animals are fundamental in this respect. In controlled grazing situations the use of grassland by livestock, the number and type of livestock grazed, the length of time grazed and the use of fertiliser can be used to monitor grassland use. If forage is removed from such pastures then further records can help to monitor forage production.

In most livestock enterprises feed is the major proportion of variable costs. However the use of fixed assets such as labour and capital equipment can be important in some situations and so their use should be monitored in order to improve efficiency.

2.2.3 Financial records

In many livestock enterprises the amount of money moving in and out of the business is significant and the prices paid and received for inputs and products is crucial to profitability. Recording of certain key aspects of the financial side of the enterprise is therefore critical to good management.

Financial margins, income minus costs, are a basic measure of financial success in any business. Thus records of all costs associated with the enterprise are essential. These will include purchases of new animals, feed, medicines and the many small items needed to manage a livestock enterprise effectively. In the controlled grazing situation the cost of sowing and maintaining the pasture, fertiliser, fencing and any costs associated with forage production are required. The costs of all capital expenditure needs to be recorded and apportioned to the various livestock enterprises realistically. Comparable prices of inputs from alternate suppliers may be useful in order to manage bills more effectively in the future. The income received from the sale of products needs to be recorded.

The financial figures collected form the basis of the farm accounts which provide an overview of the profitability of the whole farm business. This is a necessity for the individual farmer in order to manage his business more effectively. In many cases these records are a legal requirement for tax and other governmental purposes.

2.2.4 Farm health records

The control of livestock diseases is crucial in all livestock enterprises. Records of the occurrence of disease and any treatments administered can be useful to take. In addition the use of prophylactic measures in the herd should be noted and used as a management aid. In some cases this may be a legal requirement and the incidence of certain diseases may need to be notified to particular government authorities.

3.0 Principles of goal-led livestock recording

The difficulties of transposing an existing recording scheme to a new situation have been discussed above. The designers of new schemes can learn much from schemes currently in operation but must create a more appropriate scheme for their own situation. There can be no general list of what needs to be recorded or what mechanisms should be used in a new situation. In order to achieve an effective new recording scheme a checklist of principles may be of value. These are outlined below.

3.1 Livestock recording - a tool, not an end in itself

Although livestock recording schemes very soon become a major task in any project and take up a great deal of time and resources it is of prime importance to be constantly reminded that livestock recording is *not* the purpose of a project but just a means to an end. It is critical, therefore, that everybody concerned with a project involving recording are aware of this and are constantly reminded of it. Data is only being collected in order to service a more fundamental question about the livestock or system being recorded. If this view of livestock recording is encouraged in a project, then many of the problems found with recording schemes may be overcome.

3.2 Defining the objective/goal of the project

If livestock recording is viewed as a process rather than and end in itself it follows that the objective or goal of the project is concerned with questions other than how the livestock will be recorded. This is the most important aspect of any project, to keep the goal in sight. Once the goals have been clearly defined then any livestock recording process can be devised to meet those goals and considerations of cost-effectiveness and physical infrastructure then become important. Defining the goal is the most critical part of the process to get right at the outset.

It is crucial to involve all parties associated with the project at this early stage, including farmers, data collection agencies, extension agencies as well as those designing and operating the scheme. Ownership of the scheme is a key concept and involving all parties at this early stage will help in the planning process, orientate the scheme to what the client really needs, avoid costly changes later on and give all stakeholders the feel of controlling the project. This should include a clear understanding of the roles of the various parties in the project.

3.3 Steps to achieve the project's goal

Any project will require a number of tasks to be performed in order to meet its goals. Once the goals have been defined, the project can be broken down into these tasks. One or more of these tasks will involve livestock recording (in the context of this paper) and it will now be possible to focus in on those tasks and to devise an appropriate recording scheme.

3.4 The role of livestock recording in goal achievement

The major role of livestock recording is to provide information on which some form of management decision can be based. More specialised livestock recording may be required for research purposes where the main goal is to answer a question, test a hypothesis or characterise a particular aspect of livestock production. Whichever is applicable, some form of data will be collected which will need to be analysed appropriately to provide answers to these more specific questions.

3.5 Collecting data to achieve goals

Collecting data for its own sake or the 'if-it-moves-record-it' syndrome is a common error in many recording schemes. If the project is focused on the questions that need to be answered, it then becomes easier to think in terms of the minimum amount of new information that needs to be collected in order to complete the steps in the tasks mentioned above. This is a vital attitude to develop when operating recording schemes. The temptation to 'just record these few extra variables because someone might be interested in them one day' is always great but rarely, if ever, turns out to result in useable information. Either no one ever gets round to using the 'extra' information or else if they do, then there is always another few variables that would have been useful to collect in order to achieve the objectives of the secondary project.

3.6 Planning the use of the data collected

It is a common facet of many research projects and livestock recording schemes, sometimes for valid reasons, to design the data analysis system after the data has been collected. This should be avoided if at all possible. Often the need for certain variables, or their superfluity, is only realised at the analysis stage. Designing the analysis system in advance will help focus the mind on what is really required at the recording stage. This step should also include designing the way in which the results are presented. Often reports are needed for farmers, sponsors or other clients and a good understanding of what they need, well in advance, will help to focus the scheme on the essential requirements of the data collection. Another important aspect of this stage of the planning process is to decide when reports are going to be required from the system. Working backwards from the results stage towards the data collection stage will help in the planning of the most costly part of the scheme, data collection.

3.7 Planning data collection

Once the objectives of the recording scheme are clear and how the data will be analysed and presented is understood, much of the groundwork will have been carried out. At this stage a clear idea of what actual aspects of the livestock enterprise need to be recorded should be possible and so the data collection procedures can be planned. Think about how the data will be collected and the implications of this process for all the players in the scheme. This should include a realistic estimate of the costs of the data collection process, which should be looked at in relation to the likely benefits. It is often worth reconsidering the goals of the project at this stage, in the light of the cost/benefit analysis carried out.

3.8 Resources for data collection

When planning the data collection processes it is essential to develop a realistic idea about the resources required. These include both the human and physical resources. In many situations the cost of both the human resource and the travel to farms is very high and is a critical factor in determining the cost-effectiveness of a project. Recording procedures need to be planned to optimise the costs in relation to the returns expected. This does not always mean developing low-cost procedures, if the benefits are great. Whilst it is common to find the costs of the recording agency accounted for, at this stage, the cost of the farmer's time is often overlooked.

3.9 Motivating the key players

Motivation of the key players and the maintenance of morale are often a forgotten but essential part of many livestock recording schemes. Many common problems that could arise later may be minimised by involving all participants as early as possible. Including all parties in the planning and development process is an essential element of this. Giving people a sense of the objectives of the recording process, and providing regular feedback on how the project is developing or what the results found so far show is an important aspect of keeping morale high and the continued success of the project.

3.10 Feedback and evaluation

Whilst it is often costly to change a scheme, once it is working, it is better to modify it to achieve the goals set than to persist with unrequired procedures. It is essential to plan and incorporate feedback mechanisms into the scheme.

3.11 Design the recording and analysis system

Critical features of any recording system are that it should be simple to use, relevant to goals of the project, it should contain the maximum amount of validation and cross-checking of data. The reports should be easy to understand, relevant to the user and provide the means to achieving the goals of the project.

3.12 Minimising errors

It is common to find errors occurring in recorded data due to poor recording procedures. Data errors can be minimised by reducing/eliminating copying of data, using computers at the point of data collection, using prelists of animals expected a certain events, checking data at source and many other simple but effective procedures.

3.13 Testing the system

The new recording system will need to be tested, perhaps as a pilot scheme, and any feedback incorporated into modifications ready for general use. Once again it is essential to involve as many of the players as possible in this process, both to engender ownership of the system and to develop an improved recording system.

3.14 Using the recording system

Once the system is prepared and in use it is essential to keep the system under review. Keep an open mind about modifying any stage of the system in the light of how it operates in practice. Build feedback mechanisms into the system and use them to maintain morale and interest of the stakeholders, as well as to develop the most cost-effective recording system.

4.0 Characteristics of genetic resource recording schemes

In the next two sections recording schemes will be classified according to primary purpose (genetic resources - Section 4; enterprise management - Section 5) and species/sub-species group. Cross-tabulation of these factors will be developed and an indication given in the tables of where similar characteristics of the recording schemes apply to a number of cells in the table. For each cell in the classification which has an entry the main issues relating to the recording schemes will be outlined.

Table 5. Sections containing comments by species and primary purpose for genetic resources recording in low and medium input systems.

Species/Product	*Population survey*	*Breed characterisation*	*Pedigree identification*	*Breeding value estimation*
Cattle/Buffaloes milk	Section 4.1	Section 4.2 and 4.4.1.2	Section 4.3	Section 4.4 and 4.4.1.2
Cattle/Buffaloes meat		Section 4.2 and 4.4.1.1		Section 4.4 and 4.4.1.1
Pigs		Section 4.2, 4.4.1.1 and 4.4.1.5		Section 4.4, 4.4.1.1 and 4.4.1.5
Poultry-meat		Section 4.2 and 4.4.1.1		Section 4.4 and 4.4.1.1
Poultry-eggs				
Sheep/Goats milk		Section 4.2 and 4.4.1.2		Section 4.4 and 4.4.1.2
Sheep/Goats meat		Section 4.2. and 4.4.1.1		Section 4.4 and 4.4.1.1
Sheep/Goats wool/hair		Section 4.2 and 4.4.1.4		Section 4.4 and 4.4.1.4

4.1 Population surveys

Rationale Farmers need to know where different breeds can be obtained.
Planners need to know what resources are present, where and in what quantities.
Geneticists need to be able to plan breed improvement in the most cost-effective way.
Conservationists need to know which breeds are in danger and where they are.

Although population surveys operate at the farm level they are of little direct benefit to the farmers being surveyed. This makes them more difficult to carry out because the co-operation of farmers is essential in order to collect the required information, and to ensure that the information collected is accurate.

4.1.1 Definition of a breed/cross

One of the key areas in breed population surveys is the definition of breed and cross types and the standardisation of nomenclature throughout the survey. Training of survey staff to use the same definition at all times is a very important aspect of such surveys. The question then arises as to how the definitions are arrived at in the first place. In some situations breed societies will define what is an acceptable description of their breed but it is more common to find a lack of documented breed/type definitions. In this instance it is important to build up a set of working definitions based on the farmers' own perceptions married with those of local veterinarians and extension workers. Care must be taken to note the many local variations of breed names just as the breed definitions must encompass any variation in breed characteristics.

Often it is crucial in these surveys to use the farmer's knowledge of the parents and grandparents of their stock in order to correctly assign breed\cross names to any given stock.

4.1.2 Definition of livestock types to be surveyed

Surveys commonly ask questions about the productive state, age or purpose of stock kept on individual farms and count stock in individual classes or groupings of classes. These need to clearly defined and verifiable at farm level, during the course of the survey. Only in certain specialised situations are stock kept for a single purpose, so various combinations of purposes should be allowed. Again local knowledge about the use and description of livestock is essential when defining groups which will be recorded

4.1.3 Sampling issues

Clearly the objective of population surveys is to find out the number and distribution of certain classes of animals in a given geographical location. Counting every animal will give the complete answer to whatever questions are posed for which the survey is carried out. However, this is always the most expensive option and so some form of sampling is commonly practised. The question arises about the size of sample used to estimate the complete picture and what should be the structure of the sample.

There are many texts written about sampling in surveys. The important points as far as livestock population surveys are concerned relate to the sampling from within meaningful groupings of farms and balancing this against the cost of gathering the information.

4.1.4 Timing of the survey

Animal populations are not static and so it becomes important to fix a time when these type of surveys are carried out. Ideally all records should be collected on the same day but this is usually impractical due to the constraints of manpower. Tying the survey to an event may be useful in some instances e.g. mating time in a seasonal breeding species. However, it is more likely to accept some variation in numbers from location to location as part of the sampling error of the survey.

4.1.5 Animals to be recorded

Surveys are basically about counting animals in certain categories so all animals selected for sampling should be recorded but according to the predefined categories, as discussed above. These categories usually comprise breeding females, breeding males, young offspring (sometimes by age group) and replacement breeding stock not yet mature enough to breed.

4.1.6 How the scheme is operated

Surveys of this type are usually one-off activities, even though they may be repeated at various time intervals. They are best co-ordinated centrally with any number of tiers of staff between the organisers and the farming population. Needless to say the fewer the tiers the better but a balance should be struck with local knowledge which is often invaluable in such surveys.

Data is checked locally but collated centrally, most likely with the aid of a specifically written computer programme. The size of the task is commonly underestimated and the manpower and computing requirements are often great. This type of survey is often of least direct value to the farmer and consequently results in poor feed-back mechanisms.

4.1.7 Integration with other activities

Surveys are often planned to be carried out by local veterinarians or technicians in conjunction with routine visits to farms, villages or dip tanks. This at first sight appears to be an advantage, particularly since the cost of travel is a large component of the cost of these surveys. However, there are a number of reasons why this may not be such a useful approach. These include the time required to complete the questionnaire may be incompatible with the other tasks, there may be a problem meeting the right people to help with the questionnaire, not all animals come to dip tanks and so some may be missed from the survey.

4.1.8 Variables recorded

Counts are the most common variables recorded in surveys.

4.2 Breed characterisation

Rationale. Farmers need to know the relative performance of their possible breed choices.
Farmers need to know how breeds perform under different conditions.
Planners need to know breed performance in different systems.
Conservationists need to distinguish one breed from another.

Breed characterisation is a descriptive process aimed at understanding what features of a breed make it different from other breeds of the same species. In this sense it is of little value to the individual farmer. However, where some choice between breeds is a possibility, at the farm level, then the information gathered as part of the breed characterisation process could be useful. As pointed out above, breeds need to characterised in all environments where they are found, since all animals are the result of their genotype as modified by their environment. In this case breed characterisation should always be carried out with some form of environmental or system characterisation, at the same time. This makes the characterisation process more complicated than it first appears and some form of rationalisation of the environments in which the breed is found is necessary.

Clearly, each farm on which the breed is found represents a different environment but it would be too expensive to record animals on them all. The grouping of farms on a climatic, agroecological zone or other relevant basis provides a starting point for a more realistic approach to characterisation. In many areas farmers operate similar systems of production and so geographical location may be a useful means for selecting farms. However, differences in the level of intensity of production, disease challenge and other management factors may require different sets of characterisation data for each situation.

Characterisation should cover both the visual appearance of the breed and key measures of performance, under the described environmental conditions. This makes breed characterisation a longer process than a single farm visit to inspect and describe the outward appearance of the animals in a breed. It will involve some form of measurement over time to record performance data and may require information on features of the breed which are not immediately obvious on inspection. These may include disease resistance, climatic stress tolerance, ability to cope with particular feeding regimes etc.

4.2.1 Animals to be recorded

All ages and both sexes of the breed being characterised need to be considered in the characterisation process.

4.2.2 How the scheme is operated

Since there is no direct payoff to the farmers of breed characterisation then funding must come from outside the farming system to support it. This inevitably leads to an agency of some type devising and running the scheme, using fieldstaff to collect the information.

4.2.3 Integration with other activities

The collection of breed characterisation data may be carried out in conjunction with some of the enterprise management and genetic evaluation schemes described in other sections of this paper.

4.2.4 Variables recorded

Any and every feature of the breed which distinguishes it from other breeds of a similar type need to be recorded. These include external measurements of body dimensions, descriptions of colour, shape, coat characteristics, horns, humps etc. In addition performance data will need to be collected for the main traits of importance for the breed. This will vary by the types of products for which the breed is kept and is similar to the list described in Section 4.4.1.

4.2.5 System and environment characterisation

The importance of recording the characteristics of the environment and production system under which the breed characteristics are recorded cannot be stressed enough. No genotype exists outside a physical environment and the expression of any genotype, in the form of a living animal, can only occur within a particular set of climatic, geographical, nutritional, managemental and health conditions. These factors are the major aspects which should be used to characterise the physical environment in which the animals perform. It is impractical to carry out valid trials in all possible environments with all possible breeds to determine which factors affect performance significantly, and hence determine under what different combination of factors any given breed should be characterised. The more usual approach is to record animal performance within the environments in which they are found and then to consider the range of important physical factors which affect the animal's performance. In many situations there is a gradual change in a particular factor e.g. altitude, rainfall, and so some arbitrary division between environments will need to be defined in order to arrive a workable definition of a 'different' environment. In other situations differences are clear cut. The presence or absence of a disease vector is clearly identifiable and so make defining environments easier.

4.3 Pedigree identification

Rationale. Farmers can have some faith in genetically transmitted characteristics from specific parents.
Farmers know that the package of genes described as a breed remain together.
Farmers can avoid inbreeding problems.
Geneticists have the means to estimate breeding values of relatives .

Pedigree is an essential part of several aspects of genetic resource work and is designed to provide a way of knowing the parentage of a particular animal, and hence to trace its line of descent or lineage. This may be used to mate animals from certain families with known or perceived characteristics, to avoid increasing inbreeding too rapidly or as a basis for the genetic evaluation of individual animals. Often this type of recording is operated by a breed society who use it to maintain breed type, if used in conjunction with some elementary form of breed characterisation. In modern breed societies pedigree identification is secondary to performance characteristics of the animals in the breed.

Animal identification systems are crucial to pedigree and performance recording schemes. A system of unique, easily read and foolproof identification is required e.g. ear tags, branding, tattoos, electronic tagging, are just a few of the possible systems in place.

4.3.1 Animals to be recorded

In its basic form pedigree recording is concerned with the identification of the sire and dam of a particular individual. Thus matings need to be identifiable and birth events traceable back to a particular mother. In addition some form of individual animal identification is necessary (see Section 6).

4.3.2 How the scheme is operated

In most cases it is up to the individual farmer to arrange the management of his/her herd in order to be unequivocal about the parentage of any offspring. In certain rare circumstances this may be backed-up by other methods, such as DNA 'fingerprinting', or blood tests based on other criteria. When AI is used then an AI technician may provide evidence of a particular mating, particularly since the technician should have details of the male who's semen is being used. Either the farmer may maintain his/her own pedigree register, or it is quite common to find breed societies operating a herdbook system.

4.3.3 Integration with other activities

Pedigree recording is often associated with performance recording for genetic evaluation purposes, and the use of AI. Recording of the birth events are often part of the farming routine and so the mothering of the offspring is often controlled.

4.3.4 Variables recorded

Identities of the sire, dam and offspring are the usual variables recorded.

4.4 Breeding value estimation

Rationale. Farmers can choose parents of the next generation on an objective basis.
Farmers can improve the physical performance of their herds.
Breeding companies can sell animals with predictable performance.

4.4.1 Trait-specific recording issues in genetic value schemes

The traits recorded as part of schemes designed to estimate genetic value can be categorised generally across species. In these types of schemes the recorded traits may be the traits trying to be improved or they may be linked to other traits which cannot be measured directly. In the same way traits may be measured on relatives of the animals under selection. Only the particular features of the various species will mean that some traits are treated differently in the different species. This section describes the different traits and aspects of them which are common to all species.

4.4.1.1 Meat

In animals kept for meat production the traits of major concern are linked to growth, carcase composition, conformation and meat quality. Growth is commonly measured as liveweight at a given age, or series of ages, or the difference between two or more weights and expressed as weight gain per day. These measurements are relatively easy to take provided that an appropriate weighing scale is available. Weighing large animals in remote areas tends to be difficult. This has been overcome by use of a tape measure with a graduated weight scale on it. However, the relationship between heart girth (the commonly used dimension to estimate weight with this tape measure) and weight may vary from one breed to another.

Interest in the composition of the live animal, and hence its potential carcase, and a desire to select fast-growing animal which lay down lean rather than fat has resulted in measurements on the live animal which may be linked to carcase characteristics. These include various estimates of fat and lean on the live animal taken with relatively sophisticated equipment (ultrasound, x-ray computed tomography, velocity of sound etc.) or as visual/externally assessed scores. The measurement of conformation is a variation on this since it is believed that animal shape can be related to composition.

Carcase characteristics may be recorded on a sample of related sacrifice animals. These could include carcase weight, joint weight, lean/fat/bone content of sides or joints, fat/muscle depths, meat colour, visually assessed scores for fat and conformation and measures of meat quality assessed on cooked samples by trained or consumer taste panels. Aspects of meat quality such as colour, drip loss and toughness may be recorded under laboratory conditions.

4.4.1.2 Milk

The most commonly measured characteristic of animals kept for milk production is lactation yield, or some component of it which is highly correlated to total yield. This is commonly achieved by taking periodic daily measurements of milk and multiplying them up to estimate total lactation yield. More recent developments have been aimed at using test-day yields rather than estimated total lactation yield as the trait of interest. Suckling of milk by the young adds a complicating factor to the use of milk yield. Measurement of milk consumed directly by the young is impossible to record accurately under farm conditions, hence in most species where this is common milk records during suckling are disregarded in milk yield calculations. However, in many dual-purpose situations, where the young suckle for large proportions of the lactation, there exists a very unsatisfactory situation with respect to accurate milk yield recording. The influence of the farmer, through his/her management decisions on length of time the young is allowed to suckle can cause very inaccurate and even misleading estimates of milk yield to be made. One further complication in milk yield recording is the variation in milk-letdown to milking between different breeds and crosses.

Interest in the nutritive value of milk has resulted in milk composition becoming an important aspect of dairy animals. Fat and protein yield and/or proportion may be recorded from a sample from individual lactating animals under laboratory conditions. Characteristics of the animal under milking conditions such as milking speed and milk letdown are other factors considered important in some recording schemes. Traits correlated with manufacturing quality of the milk are also traits of interest in some recording schemes.

In many dairy industries the use of AI is widespread and so the genetic merit of males is of vital importance. Since milk recording can only occur in females a males will commonly be evaluated in terms of his daughters' performance. This is a more reliable estimate of his breeding value for a number of reasons; daughters are often more numerous than other female relatives, daughters actually express half the genes carried by the male (on average) and daughters are more likely to be evaluated under a wide range of farm conditions, providing a better estimate of breeding value.

Because of the importance of milk in many societies, the range of products made from milk and the almost instant financial returns from the sale of milk, a considerable number of sophisticated milk recording schemes are found. However, these are usually associated with easy access to markets for milk, sizeable herds and high yielding animals which can benefit from the sale or use of high value males.

4.4.1.3 Eggs

In poultry species kept for egg production, several measures can be recorded to provide useful information on which to base management or genetic decisions. The number of eggs laid in a given time period or the frequency of lay are common measures of performance. Where eggs are sold by a particular payment system then size, measured or graded, or weight may be important characteristics to record. Measurements of egg quality may include shell colour, blood spots, yolk and albumen characteristics depending on the market or selection criteria being used.

One of the critical aspects of egg poultry recording is the matching of the egg with the bird that laid it. A number of systems have been devised to accomplish this, including the use of individual cages to house the birds or the use of trap nests. Under low-input systems this is not so easily achieved since control of laying may be non-existent.

4.4.1.4 Wool/hair/pelts/skins

One of the most important aspects to record on animals kept for wool is the quantity of wool harvested. This usually measured as a weight but the size of skins and pelts may be of importance. Since skins and pelts are only available from the dead animal then close relatives may be recorded to provide information on animals kept for breeding. Several quality features of wool/hair may be of importance to record. These include fibre diameter, fibre type, crimp characteristics and staple length. Various systems have been developed to described fibre diameter, or its associated qualities, to circumvent the more time consuming and costly measurements required to give precise measures of quality.

In many respects wool improvement by genetic selection is one of the most readily achievable goals in livestock breeding. Often traits are highly heritable, readily measured on all individuals in the population and genetic gins per year can be high. However, these factors may be offset by poor market prices for the product on a fluctuating world market, with competition from man-made alternatives. In many industries breeding schemes for wool are limited to males only or even non-existent.

4.4.1.5 Reproductive performance

In all recorded farm animals various measures of reproductive performance are important. The most common measure is the number of offspring born/birth event, often referred to as litter size. In species with very low litter size then the frequency of births may be a more important measure of reproductive performance. The incidence of barrenness and other reproductive disorders can be important in some situations. Components of the breeding interval such as birth to weaning interval or birth to rebreeding interval may be of more interest in these situations. If this is so then the recording of event dates becomes important. A further useful measure may be the length of reproductive life and the occurrence of any reproductive disorders.

In males semen characteristics such as motility, viability rate and volume could be important traits.

Reproductive characters are generally found to have a low heritability, so genetic improvement is often ignored. However in several species some families are more prolific than other, major genes for ovulation rate have been identified and the phenotypic variance is high enough to offset low levels of additive genetic variance in selection schemes.

4.4.1.6 Health traits

All livestock are susceptible to diseases. Some record of which diseases and conditions an animal is susceptible to is important. The traits measures may be of an all-or-none nature (e.g. susceptible or not) or may be more continuous (level of resistance). The advances being made in molecular genetics are likely to have the greatest effect in the short term on animals with identifiable disease resistance genes.

4.4.1.7 Functional/ Type traits

A number of traits relating to the shape of form of the animal are recorded in some species. These may relate to movement, shape or posture or be associated with longevity, productive lifespan or other non-quantifiable but important characteristics.

4.4.2 Contemporary groups, population size and structure

The recording of livestock in order to estimate the genetic value of individuals always requires that the measured animals are kept in contemporary groups. These groups should be large enough to give an accuracy to the genetic value estimate which is commensurate with the use to which it will be put. Issues of group size and genetic linkage are more related to the genetics of the traits measured than any particular aspect of recording. It is not possible to estimate genetic values in situations where contemporary group sizes are small (say <3), where knowledge of at least one parent is lacking or where parental groups are small. Under such circumstances it may be possible to identify animals with good phenotypic performance and use them as the basis for a nucleus breeding scheme.

There are a number of techniques that can be used to improve a population with a poor structure in order to make recording and genetic evaluation worthwhile. These include the use of AI, village bulls (or other species as appropriate), ram circles, nucleus breeding schemes and sire-referencing schemes.

4.4.3 How the scheme is operated

The nature of selection schemes for genetic improvement means that the recording effort has to be co-ordinated and sustained over a long period of time in order to show any appreciable results, if at all. There are many examples where this has been done on an individual herd basis but the economies of scale are particularly advantageous in these types of schemes. Consequently it is common to find an agency, of some description, operating the recording process on behalf of participating farmers. This agency will not only provide recording services but also carry out genetic evaluations, or link with another organisation with the necessary means to do them.

4.5 Level of inputs and genetic resources recording schemes

No mention has been made in this section about the effect of the level of inputs on the way in which genetic resource recording schemes are run. This is because these schemes are neutral to the level of inputs applied or the level of intensity of the livestock enterprise. Many factors have already been mentioned as having an effect on the way schemes are run, particularly the physical and economic circumstances within which the various schemes operate. For example, the reasons why very few genetic selection schemes are found in small-holder livestock enterprises are often related to factors such as herd size, accessibility, costs of the scheme, etc. rather than the level of inputs, which in many cases run at a relatively high level.

5.0 Characteristics of enterprise management recording schemes

Table 6. Sections containing comments by species and primary purpose for enterprise management recording in low and medium input systems.

Species/Product	*Physical performance*	*Resource use*	*Financial records*
Cattle/Buffaloes - milk	Section5.1 and 5.1.1	Section 5.2	Section 5.3
Cattle/Buffaloes - meat	Section 5.1, 5.1.2 and 5.1.3		
Pigs	Section 5.1 and 5.1.3		
Poultry - meat	Section 5.1 and 5.1.3		
Poultry - eggs	Section 5.1 and 5.1.4		
Sheep/Goats - milk	Section 5.1 and 5.1.1		
Sheep/Goats - meat	Section 5.1 and 5.1.2		
Sheep/Goats - wool/hair	Section 5.1 and 5.1.5		

The main purpose of enterprise recording schemes is to provide the farmer with information which can be of used to make the farm business run more efficiently. Since farming enterprises are heavily dependent on many biological processes, their utilisation and manipulation, then much enterprise recording depends on the recording of appropriate biological aspects of the enterprise. In many ways this is similar to recording for genetic value estimation, described in Section 4.4. However, in the case of enterprise recording the level of recording is often less detailed and a greater variety of factors are recorded about the enterprise. This is a result of the fact that in any given livestock system the benefit:cost ratio for enterprise recording schemes is likely to be lower than for schemes designed to estimate genetic value. In addition, once a basic set of enterprise recording schemes is in place then the marginal value of extra variables recorded is very low.

In most cases the primary recording operations are carried out by the farmer with specialist techniques only being used where laboratory, veterinary or abattoir information is either cost effective and/or a statutory requirement. Advisors may collect the information from the farmer and add value to it by further processing, but this adds a considerable cost element to the recording system. This cost may be borne by any of several players; the farmer, the advisory organisation, veterinary practices, different levels of government, and commercial companies being the most likely.

The use of sophisticated recording techniques, such as computers, is less of a necessity than for genetic resource recording schemes, can help to make the recording more useful. A well organised paper record system can be just as useful and probably more cost effective.

5.1 Physical performance recording

Rationale. Farmers need to know how well the biological features of their livestock are working.
Farmers and advisors can compare their current groups with previous groups.
Farmers and advisors can compare herds on different farms.
Farmers and advisors can set realistic targets for new groups of animals to achieve.
Planners can estimate expected output at regional or national level

Physical performance recording schemes are usually designed to provide details about the main biological aspects of an enterprise which influence profitability. This will vary according to the type of livestock product which is important in any given enterprise. Although the value of any individual animal may be high in some types of enterprises, e.g. large ruminants, this is not so for all species. However, the recording of individual animal’s performance in this type of recording scheme is partly dependent on its own value but also on the value of the output and the likelihood of a high benefit:cost ratio from recording. Thus the recording of an individually identified dairy cow’s milking performance is more likely to be carried out than the recording of an individual identified sheep’s wool production.

The most basic set of records will be summaries of contemporary group performance for certain key variables, depending on the species and type of product being produced. This may take the form of counts of numbers of animals produced, eggs produced etc. or may be based on measured variables such as the average milk per cow, wool per sheep, liveweight per bird sold etc. The exact type of record kept will vary by species, product, location-specific factors and likely benefit:cost ratio of recording. Basic to all enterprises are records of the number of animals present and the number of productive animals at key events e.g. birth, weaning, sale etc.

In this section individual animal recording refers to data collected on individually identified animals which is recorded against that animals identity for management purposes. Clearly many animals are individually measured but the data produced may only be used to produce group\herd statistics.

5.1.1 Females kept for milk production

In most situations milk is a high value product and is produced in relatively large quantities, compared to other products from the same species. It is, therefore, essential to be able to identify the animals which are under-performing and replace them with new animals which are likely to be better producers. Hence, in bovine herds some form of individual cow recording is common. In other species this may be less common. Estimates of lactation yield are basic in this situation with information on milk quality being important only in very special circumstances (e.g. where differential payments based on milk quality are high). Lactation length is a key feature of lactation yield in most circumstances and species.

Reproductive performance is a crucial aspect of dairy systems since the proportion of time that females are in-milk will be a key determinant of profitability. Thus the interval between births and its components (weaning to first service; first to successful service etc.) are important variables in many situations.

5.1.2 Females kept to breed meat animals

Individual animal performance recording is less detailed in this situation, compared to milk animals, with the most crucial measure needed on individual animals being litter size, barrenness and rearing ability. Contemporary group counts and basic performance measures are the most likely variables to be recorded. Counts are best expressed on a meaningful basis (e.g. number of lambs reared per ewe mated, piglets born per/sow/year). Performance measures may take a similar form (e.g. weight of calf weaned per cow).

5.1.3 Meat animals

Individual animal performance recording is unlikely for meat producing animals. However, data on growth (liveweight difference over a given time period), shape and carcase characteristics are often of value. Hence variables such as weight for age, average carcase weight, time taken to reach marketable condition are typical variables recorded.

5.1.4 Egg production

Counts of eggs produced and aspects of egg quality, including weight\size, are commonly recorded aspects of egg producing enterprises. Summaries of such data by on a per bird or per house basis are basic requirements of such poultry enterprises.

5.1.5 Wool production

The weight of wool produced and the quantity produce in different quality categories provide the basic measures required for wool producing enterprises. These are commonly expressed on a per animal shorn basis to enable useful comparisons.

5.2 Resource use recording

Rationale. Farmers need to manage natural resources in a sustainable and efficient manner.
Farmers need to know how well their stock are performing using key inputs.
Farmers and advisors can use measures of resource use to improve performance.
Planners need to know levels of resource use and input/output relationships.

In low to medium input systems the level of inputs is, by definition, is less than in intensive systems. However, the efficient use of inputs is still crucial and will affect profitability. In addition such systems will use a number of natural resources, which will need to be managed in a sustainable manner. Recording of these resources is, therefore, important.

5.2.1 Aspects to be recorded

The major resources used by livestock farmers are land and feed (including water) with labour and capital being of importance. Land is related to feed in the sense that most land is used as a source of feed, in the form of grazed material or forage.

Purchased feed (or feed transferred to the livestock from another enterprise on the farm) is often the most straightforward to record. This will take the form of the quantities of feed purchased and then fed to particular groups of animals. Simple summaries of the amount of food fed per animal are basic to this type of recording. Further details relating to the chemical composition of the feeds may be of value if suitable laboratories are available and rationing systems are a practical and cost effective proposition.

5.2.2 Grazing

The monitoring of grassland production and grazing use has a key part to play in many livestock production situations. Simple recording of grassland area, numbers of different stock types grazing the grass and the length of time grazed can be used to estimate a variety of measures of grassland output. These can then be used by farmers and advisors to improve grazing management and improve resource use.

5.3 Financial

Rationale. Farmers need to know if their enterprise is profitable.
Advisors can use financial data to help improve economic performance.
Planners need to know the economics of alternative livestock systems.
Tax authorities need to know farmers incomes.

Financial recording is a subject in its own right, often being dealt with by accountants and auditors. However the simple use of financial records can aid livestock production considerably. Records collected include the cost of all inputs and the value received for all outputs, which can then be used to compute gross and net margins, either on a per animal basis or, where land is a limiting factor, on a per hectare basis.

6.0 Concluding remarks

Livestock recording is a complex subject with many different facets, depending on the species and type of recording necessary. Key determinants of the efficacy of any system are the physical situation of the enterprise to be recorded and the likely cost:benefit ratio to the farmer. Questions about the detail of what a particular scheme should consist of depend more on local factors than a set of global blueprints. A series of steps have been outlined which should help planners and scheme designers arrive at viable livestock recording schemes.

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Private and Public Organisational Aspects/Roles in Animal Recording & Breeding

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Executive summary

- development of livestock recording, management and improvement systems has typically involved substantial public sector investment and activity in all countries. Such investment is under increasing pressure for a range of reasons, and so there is urgent need to a) clarify beneficial or essential public roles in such systems, and b) develop approaches to management of systems involving public and private roles for often numerous groups and/or individuals
- developing a framework for such analysis from traditional political ideologies will be of little benefit: a framework is suggested here which focuses on objective program design, management and evaluation/ monitoring parameters
- this framework can be applied to any livestock recording, management and improvement system, with the proviso that initial analysis and ongoing evaluation will require recognition of the full range of ways in which livestock are involved in and contribute to local ecosystems and economies
- an analogous framework can be applied to the supporting knowledge systems, and doing so will help more effective utilisation of a critical resource, namely skilled practical animal management and improvement knowledge
- from the suggested framework analysis, a clearer assessment of which goods and services are most appropriately treated as public and/or private can be made, allowing for evolution of the balance of these as management and improvement proceed
- development of an international approach to livestock resource management based on the suggested framework is clearly a potential role for FAO, and one which would assist with improving the flow and management of international aid and investment funds to livestock resources, particularly those in low-to-medium production systems which are otherwise likely to be increasingly starved of financial and knowledge inputs.

1.0 Introduction

1.1 what are public and private policy issues?

This document outlines key policy issues that arise in the course of initiating, managing and evaluating, livestock recording programs, particularly for low-to-medium input production environments (LMIP). In so doing, it explicitly assumes a value at least partly independent analysis of such programs, both to enhance internal auditing of such programs by their managers, owners and other stakeholders, and to clarify and facilitate potential roles for organisations such as FAO in assisting development of optimal management of livestock improvement programs.

It is assumed that livestock recording systems are initiated at least partly for genetic improvement purposes, and so utilises various parameters of genetic improvement programs as an objective basis for evaluating investment in livestock recording. Note that recording may begin as part of a more general "industry improvement program" (in the Western sense) or agricultural development program, and this will certainly affect decision-making about the improvement program, but for the moment, I will concentrate on the genetic improvement component of livestock performance recording.

In the wider senses, recording of performance is of enormous value simply for management decision-making, both for the individual farmer and also for the industry or country as a whole. Indeed, it is for this reason that herd recording of dairy cows has been almost universally subsidised in Western countries until recently, and hence modified the investment conditions for genetic improvement significantly. I will return to this issue of support for, and cost of, information, later in this document.

Focussing on genetic improvement in this way is built on the belief that no livestock production system (or particular breed or stock) can survive in a world of limited resources without:

1. genetic improvement in some combination of production efficiency and possibly product quality, and
2. maintenance of the ultimate resource for such improvement, namely genetic variation.

Note that this applies to all stocks, whether managed in intensive high input systems or filling a scavenger role in village ecosystems.

It is further assumed that both livestock products and knowledge of methods of genetic improvement are traded commodities with markets for both, in the broadest sense of the term "market", and that public and private policy are made and evolve in market environments. This may not be either accepted by all players, or not be explicit, but this assumption will be used here because it provides a clear and widely understood basis for thinking about situations involving management of costs and benefits.

The title of this document could suggest some comparison between private and public planning, investment and management systems: such comparisons are widespread and typically corrupted by ideological positions. They can however be avoided for this document by adopting a very pragmatic approach to developing policy, one that attempts to be simple, clear, and to recognise that almost all human activities are affected by both individual and collective concerns. Animal genetic improvement is no different: what is important is to recognise how individual and collective behaviours, rules, patterns and so on affect definition and achievement of optimal management of genetic resources.

The expertise I draw upon to develop some important questions concerning public and private policy for livestock recording and improvement is in the development and management of genetic improvement programs within a number of livestock species in one small-medium economy, namely Australia. Within that number there are species in which management is as intensive and corporate as any in the world, ranging through to others in which exchange, ownership and planning are certainly pre-modern, if not feudal in many of their properties.

Clearly, other disciplines are relevant to the topic of this discussion paper, such as policy analysis, development economics, and comparative sociology. These approaches may be beneficial for later consideration of the topic of this paper, but I contend that an initial establishment of the key policy questions will simplify any such refinement of analysis.

To summarise, the purpose of this document is to outline a framework specifically aimed at clarifying public and private roles in development and management of livestock recording and improvement programs, and for auditing the performance of such programs.

1.2 What does “private” and “public” policy mean?

A simple basis for answering this question lies in a definition of “public goods”, which take several forms:

1. goods which cannot be supplied to anybody without being available to all (or at least many), and their individual users can’t be made to pay for them (or pay completely) - national defence, and law and order being examples;
2. goods which can be but are not usually charged for (for instance highways, bridges, weather forecasts, and public libraries);
3. goods which can be supplied in a market way but which many governments choose to supply to their citizens free or at below cost, such as education, health services, and public transport (Stretton and Orchard, 1994).

Thus public goods are those for which there is some amount and form of collective funding, and for which planning and so on are at least in principle developed by public organisations.

Importantly, this definition includes items that provide a framework or foundation for other activities, law and order, and the existence of regulations concerning commercial transactions and the form and amount foreign investment and ownership in any commodity, being prime examples. That these are public goods, and that community and private behaviour and life is impossible without their existence has long been recognised (Smith, 1776).

From this, public policy can be defined as: "The decision-making on planning, supporting, managing, evaluating, and developing programs that deliver public goods, and the implementing of those decisions".

By contrast, private policy seems appealingly to restrict this definition to private goods - goods whose value is partly or completely retained by the person or firm producing that good (in which sense a profit is a good). More importantly, access to the goods generated by a private investment program will be restricted as much as possible to those who fund and carry out the investment program, subject of course to public constraints such as taxation.

At this point, it should be noted that some authors strongly support the view that there is no product, service or good which cannot be managed, provided or created completely in the private sector, and indeed that private sector investment will invariably deliver better results for investments of almost any kind (including scientific research and development), with the possible exception of goods that are effectively community values, such as law and order, and an integrated system of exchange. The "soft" version of this position suggests that governments or the public sector may have a role in removing market distortions or corruptions, but the "hard" version holds that even these minimal public activities are unnecessary or more likely counter-productive (Kealey, 1996).

While this position may in fact be true, the more important point is that all current livestock improvement programs throughout the world rely on public investment for at least some of their resources, so that livestock recording and improvement is everywhere a mixed system: the balance within these systems may however be changing. This balance, and whether and how that balance should or is changing is addressed here.

In this context, the question underlying this document becomes more like "how to manage public and private investments in a mixed system to ensure optimal management of genetic resources?" This will include identifying those components of livestock recording and improvement programs more likely to attract private investment and those requiring public or collective involvement, and establishing the best possible basis for evaluating the performance of the program, whatever its balance of public and private involvement.

This question in the non-animal improvement specific sense, is at the heart of political debate (and sometimes conflict) throughout the world. As such, there is an enormous literature at all levels on the subject: it is far beyond the scope of this document to address that literature. It is hoped that by focussing on well-understood aspects of animal breeding theory and practice, combined with some simple but hopefully sound assessment of the flow of resources into and out of such programs, the need to explore and review this literature will be avoided.

Genetic improvement theory assumes a sound public good framework, so that conditions are favourable for investment in genetic improvement, and that the individuals or firms making the investments will seek to maximise some parameter(s) of the investment.

For investment in any technology or process, the following conditions must be met:
- potential investors must have a clear understanding of how to adopt and use the technology,
- they must have clear information about the technology and its alternatives,
- they must have clear signals about the likelihood of achieving improved (appropriate) returns for an improved product or process,
- they must have an adequate capital base from which to fund the investment.

We can now examine the technology of livestock recording and improvement in these terms, and begin by identifying the functional elements of the technology of livestock improvement.

2.0 The technology of livestock recording and improvement

2.1 Knowledge and its application

The foundation of all animal improvement programs is the identification of genetically superior individuals or groups of animals. This has 3 essential components:
- definition of “superior”
- assessment of performance for the traits that determine superiority
- some form of prediction of genetic superiority from the observed phenotypic superiority

Note that in very simple systems, the 2nd and 3rd steps may be the same. The second step establishes the need for animal identification and recording, while the first and third are where genetic knowledge is applied.

Having identified genetically superior animals, they will then be used preferentially as parents of future generations.

In this definition, identification, measurement and control of mating can be considered as "simple" components of the knowledge system that supports genetic improvement, while the definition of superiority and the prediction of genetic superiority are more complex components. Typically in Western, "scientific" improvement programs, these components rely on trained professional input.

How are these components applied in livestock improvement programs? Almost invariably, some stratification of the population into genetically active and "commercial" sectors occur, partly because humans rely on the fact that animal populations can produce surplus offspring and so not all animals are required to be parents (and hence there can be selection). This stratification is enhanced wherever:

a) the simple (identification and recording) and complex (definition and prediction) components involve real financial costs,
b) differences in level of animal performance result in differences in market value (whatever form that market may take).

Almost invariably, some animals, families, flocks, herds or other restricted groups become the most significant source of future genes for the population - the nucleus or stud. In some circumstances this separation may not result in any difference in genetic merit: for example in some village livestock populations there may be favoured animals or families, but there may be insufficient control over mating to stop other animals or families contributing genes.

Where there is any form of nucleus, the remainder of the population may simply be harvested for its products, or may be further segregated into multiplier and commercial sectors. (Such systems will be referred to here as "nucleus-multiplier-commercial" or NMC systems.) This higher degree of organisation implies some stability of human social structure over time.

Animal breeding theory shows that such multi-tier systems offer advantages in terms of economising on recording effort, essentially by utilising potentially high (usually) male reproduction rates to produce large numbers of commercial progeny from a small nucleus, or a small nucleus plus multiplier. In these terms, stratification of this type is effectively inevitable.

More importantly for the economics of livestock improvement, having an NMC structure can allow very high levels of investment in recording and selection in the nucleus, provided that these costs can be spread over a large enough number of commercial expressions, and provided that enough of the benefits of those commercial expressions is captured so that that the investment required for successful nucleus operation can be maintained.

This structure can be evaluated through a number of simple parameters:
- numbers of parents in the nucleus (males and females) and mating ratios, and hence effective population size Ne and inbreeding rate;
- genetic selection differentials achieved in the nucleus, and hence rates of genetic gain;
- cost of recording in the nucleus, and any recording costs applied elsewhere in the system;
- lag time between tiers of the structure, and hence the rate of dissemination of genetic improvement from the nucleus into the commercial population.

More simply, the key elements that determine overall system efficiency are:
- appropriateness of objectives in the nucleus sector;
- selection intensity, accuracy of evaluation and generation length, and hence rate of genetic gain in the nucleus;
- efficiency of transmission of genetic gain deriving in the nucleus - which depends essentially on migration rates between sectors, multiplication rates within the multiplier and commercial sectors, and generation lengths in the multiplier and commercial sectors.

Design considerations for such systems have been extensively developed and discussed (Bichard, 1971, James, 1977) including systems that incorporate upward migration of genetic material (termed open nucleus systems). Since these sample a larger population, they can generate higher rates of genetic gain and reduced inbreeding, although for practical application appropriate cost-benefit evaluation must include greater costs than for closed systems.

This document is not intended to review nucleus:NMC animal breeding and production systems, rather, to highlight that they are a model of some value for thinking about investment in livestock improvement.

Such systems:
- concentrate recording effort (cost) in as small a proportion of the total population as inbreeding and reproductive constraints allow;
- use hierarchical multiplication to spread these costs over as large a commercial population as possible;
- allow differentiation of the management system appropriate to the level of the system;
- where open nucleus, allow animals to be moved to the level of the system appropriate to the predicted level of genetic merit. This point is critical; NMC systems are based on placing animals within the overall hierarchical structure where the return from the effort invested in estimating their genetic merit will be maximised. Note that this does not mean estimating all animals' genetic merit with equal accuracy

(animals compete for places in either the next tier up, or to be parents of the next generation, according to the prior expectation of their likely genetic merit and their performance within their current cohort).

What relevance does this have for the management of livestock recording and improvement systems? The relevance lies in seeing a number of analogies between the estimation and dissemination of animal genetic merit and its subsequent commercial application to produce livestock products in livestock NMC systems, and the generation, dissemination and application of animal breeding knowledge. This knowledge is a critical "raw material" of the actual livestock system, and the argument here is that its management can be developed and evaluated using the principles of NMC systems.

2.2 The Nucleus, multiplier, commercial sector of animal breeding knowledge systems

Using this model, animal breeding and production systems are backed by a complementary knowledge system, with 3 key components:

Nucleus: generation of knowledge and knowledge tools for describing and manipulating genetic variation. This includes models for describing genetic variation (additive, non-additive, molecular etc), theory and tools for variance component estimation and prediction of genetic merit, approaches to developing breeding objectives, and theory and design of breeding programs for all combinations of achieving genetic gain and maintaining/managing genetic diversity.

The "core business" of this sector is knowledge generation.

Multiplier: customisation of nucleus-derived knowledge to specific industry situations. For example, in meat-sheep breeding in Australia, this customisation includes development of breeding objectives reflecting the costs and prices associated with sheep meat products/traits, estimation of variance components for growth, carcase, wool, reproduction and fitness traits of sheep in Australian production systems, development of prediction tools and recommendations, and breeding program design at the breed and farm level.

The "core business" of this sector is knowledge customisation.

Commercial: application of the customised knowledge through performance recording systems, breeder and commercial producer training and advisory programs, and likely integration with industry improvement programs.

The "core business" of this sector is knowledge application.

The “commercial sector” of this knowledge structure is the primary point of intersection with animal industry value chains, which typically consist of breeding, production, processing and retailing sectors, with considerable within- and between-industry and country variation in most parameters (financial constraints and structures, differentiation and integration of sectors, etc) of these value chains.

The value of this conceptual framework for evaluating the joint management of the connected genetic knowledge and livestock industry systems lies in several aspects:

- familiarity - most animal breeders are familiar with the NMC model;
- simplicity - allowing individual knowledge and actual livestock activities to be accurately placed within their respective frameworks;
- suitability for analysis of performance - the framework provides an excellent basis for understanding why particular investments (of time, people, resources etc) are made at any point in the system, and most importantly for the proposed policy document, for understanding the likely risks and returns associated with such investments, either individually or more frequently as components of overall public and\or private investment programs.

Using this framework, several features of this knowledge system can be highlighted which are specifically relevant to the aims of the policy document:

2.3 Location

- The nucleus of animal breeding knowledge systems is a dispersed one, with elements in a small number of almost entirely European and North American universities. This is certainly true for quantitative genetics theory and most of the theory of its application, and also appears to be true for the growing sub-discipline of applying molecular genetics technologies to livestock breeding.
- The customisation level (the analog of the multiplier level) is also dispersed, this time in the two dimensions of space (countries, states within countries, and sometimes organisations within those areas) and species. This level is where management and technical support of national evaluation programs are “located” (although they may involve multiple physical sites).
- The commercialisation level is the stage of actually doing genetic evaluations, indexing, advising breeding program managers and farmers and so on, is located. Clearly, this level exists for each industry for which some form of evaluation system exists, and includes the day-to-day activity of those private organisations that conduct their own internal evaluation programs.
- Nucleus breeding programs in developing countries, often located on government research stations, represent a particular form of the commercialisation level of the knowledge NMC, with some activity at

the customisation level. Alternatively, the customisation activities may take place within universities within developing countries, or through collaborative projects with developed country universities or research institutes.

• Several authors have examined the components of national evaluation/ improvement systems (Brascamp, 1994; Garrick, 1997; Banks and Kinghorn, 1997) and identified one apparent distinction that is relevant to the present discussion. Particularly in the pig industry, 2 forms of organisation are evident: the vertically integrated company which typically employs its own geneticists whose duties may include definition of breeding objectives and parameter estimation, and the alternative where separate breeding organisations, groups or farms have products evaluated via industry- or government-funded evaluation systems. Here parameter estimation and breeding objective definition (customisation activities in the NMC model) are almost invariably carried out by independent research personnel, leaving breeding program personnel to respond to the results delivered by the evaluation system.

A critical point to highlight here is that the knowledge system nucleus is essentially restricted to Western universities and research institutes is although it is dispersed within that “location”. Clearly, it important to examine what resources are required to maintain this nucleus, to ask whether its physical and cultural location cause any problems, and to examine the nature and effectiveness of its integration with the customisation and commercialisation levels of the knowledge NMC.

2.4 Supply of resources

Given the knowledge NMC, there are 3 broad types (levels) of human resource

• **Theoreticians** - those involved in improving methods of parameter estimation and breeding value prediction, and in breeding program design.

• **Applied livestock improvement scientists** - people with graduate and (increasingly) post-graduate training in quantitative genetics whose work focuses on applying theory to a particular species.

• **Breeding program managers and advisers** - often with less formal quantitative genetics training (although in Western countries this is increasingly not the case), and often with more interest in practical aspects of breeding programs and animal husbandry, and typically more “people-oriented”.

These 3 categories correspond to the nucleus, customisation and commercialisation components of the NMC, and will be identified as the 3 primary knowledge system roles.

There are in addition, 3 other types of human resource that contribute to effective improvement programs, and which will be referred to as the 3 primary implementation system roles:

- **System managers** - where this role exists, it is typically supported in some way by industry or government funds, and aims to integrate the components of the entire knowledge NMC to achieve maximum return on industry/government funds. This is not a clearly defined or necessarily recognised role, and where individuals perform this role or something closely related, they may come from a range of backgrounds.
- **Field staff** - this role may in practice overlap with that of program managers and advisers, and will typically include much farm-level coordination, data collection, inputs to animal identification and breeding. Again, this role is performed by people from a broad range of backgrounds but typically with sound animal husbandry and people liaison skills.
- **Farmers** - in most multi-owner livestock NMC's, farmers do not perform the roles identified here to breeding program managers and advisers or field staff. This is perhaps an over-categorisation, as it is clear that where appropriate rewards and training systems exist, a proportion of livestock owners will invest in developing measurement and program management skills. This tendency is enhanced where the improvement program is supported by decision-making aids, either in the form of software tools or simple rules well-extended.

The primary knowledge and implementation system roles are:

Knowledge system roles	Implementation system roles
Theory development (nucleus)	System management
Applied livestock improvement science (customisation)	Field staff - data collection
Breeding program management and advising (commercialisation)	Farmers/livestock managers

The supply system for these human resources depends heavily on the existence of education systems that support some specialisation and which are internationally linked. As with the livestock NMC, the knowledge NMC acts to spread the costs of the nucleus over as large a number of commercial operations as possible, and as with the livestock NMC, provided that the evaluation system is appropriately integrated, students with high levels of talent should be moved to the most appropriate nucleus. This has been a part of international training in animal improvement for many years.

So, for the core animal improvement knowledge skills of variance component estimation and the prediction of genetic merit, an international dispersed nucleus has existed for many years. However, unlike an animal improvement NMC, selection of candidates for the nucleus usually takes place within the culture in which the customisation and commercialisation levels exist, and there is no obvious system evaluation (see later in this section).

International links exist at the customisation level, although they are not as tight as at the nucleus but strengthening through increasing use of the world-wide web and through congresses such as the World Congresses on Genetics Applied to Livestock Production.

At the commercialisation level, links have been weaker, although progressive breeders and farmers, program managers and advisers usually have greater awareness of international developments within at least their own industry than the "average" farmer, adviser or manager.

Different cultures will differ in their retention rates of graduates to various levels of the educational system for animal improvement knowledge, but it should be possible to estimate numbers of entrants to each stage to support the NMC for its 3 primary knowledge roles and 3 primary implementation roles.

Clearly (both from practical experience and from the analogy with the livestock NMC), numbers of individuals will be smallest for the nucleus, next smallest for the customisation level, and highest for the commercialisation level. Can we estimate numbers for each?

Animal improvement systems within Australia provide an example reported in table 1.

2.5 Commentary

- This simple and approximate analysis is specifically not intended to suggest any optimality (rates of genetic improvement vary considerably between and within these industries, even within this 1 country which has a history of investing considerable public funds in animal improvement R&D).
- This analysis suggests that within Australia, there are approximately 100 animal improvement professionals servicing 5 major industries with net farm-gate value of c. $10 bn Aus (or c. $8 bn US). In addition there are some 3 000 breeding program managers/owners. Assuming a 5% recruitment rate, 5 new improvement program professionals and c. 50-60 new breeding program managers/owners are likely per year.

The foregoing provides a model for understanding and characterisation of the human resources required for sustainable livestock improvement programs. It is worth briefly noting 3 key parameters of such systems, each of which is important in diagnosis of the performance of the system, and raise some key questions before moving on to address specific policy areas.

Table 1. Animal improvement systems in Australia.

Role	Beef cattle	Dairy cattle	Wool sheep	Meat sheep	Pigs
Number of people in:					
Knowledge system:					
Nucleus		⇐ ⇐ ⇐ 10-15 ⇒ ⇒ ⇒			
Customisation	5	2	2-3	1-2	1-2
	15-25	5	5-10	3-5	3-5
Commercialisation					
Implementation system:					
System management	-	1	1	1	0.5
Field staff	-	15	-	-	-
Breeders/farmers	1,5	3*	> 1 000	600-750	15
Industry size:					
# breeding females	500	1 000 000	2 000 000	250	40
% evaluated	30-40	90	10	75	30-40
Approx. net worth	$3 bn	$1.5 bn	$4 bn	$1 bn	$1.2 bn
Approximate rate of genetic gain (δ_I/yr)**	0.1-0.15	0.15	0.05	0.15-0.3	0.1-0.25

*Australia is serviced by 1 local breeding cooperative, 2 importers who do limited progeny testing, and by direct importation.

**these estimated genetic trends include importations in some cases, and cover only the genetically active/performance recorded sector of the total breeding population

Note

- these are all estimates of net person-years. Some individuals perform mixed roles within this classification. This reflects the fact that the classification of roles developed here draws on observation of the operation of a number of industries which show some variation in how this range of roles is provided.
- the distinction between wool- and meat-sheep is cultural, somewhat arbitrary, and is breaking down.
- the estimates of net worth are approximate, and are farm-gate values.

The 3 key parameters are the integration between tiers of the knowledge NMC, the typical source and expectations behind investments into such systems, and what might be the basis of public and private evaluation of livestock improvement systems. These will be briefly discussed, before completing this section with some comment on the evaluation of the livestock and knowledge NMCs, and important philosophical questions concerning the evolution of livestock improvement systems and the possible effects of this on public and private policy.

2.6 Integration

The most successful applications of NMC systems appear to be in intensive industries, where they have accelerated inherent trends to vertical integration through ownership (or franchising). This highlights the commercial importance of very tight integration through the NMC system. By analogy, investment into the knowledge NMC will be most effective where there is very rapid and effective communication of information up and down the NMC. BLUP-based evaluation systems seem to be highlighting and accelerating this integration by information/ communication at least in western countries.

This aspect of knowledge systems has been addressed elsewhere (Blum, 1991; Blum et al, 1990; Rogers et al, 1976) with some attempt made to identify essential elements of successful agricultural knowledge/extension systems (AKS). In simple terms these comprise research, extension and utilisation. Rogers et al (1976) suggested 8 elements critical to success of AKS':

1. a critical mass of new technology;
2. a research sub-system oriented to utilisation (the nucleus and customisation components in the model presented here);
3. a high degree of user control over the research utilisation process;
4. structural linkages amongst the research utilisation system's components;
5. a high degree of client contact by the linking sub-system;
6. a "spannable" social distance across each interface between components of the system;
7. evolution as a complete system; and
8. a high degree of control by the system over its environment.

Blum et al (1990) reviewed the AKS' of Israel and the Netherlands, and suggested 8 additional critical elements:

1. the existence of specific knowledge policy to which farmers have direct input;
2. deliberate coordination of the knowledge generation and exchange process/system;
3. involvement of all media (including farmers themselves) in knowledge exchange-this includes allowing or encouraging "up and down" flow of information (an open nucleus system in the terminology of the model proposed here);
4. a higher educational level of users enhances the effectiveness of agricultural knowledge exchange;
5. informal linkages (including social ones) are as important as the formal ones;
6. linkages are most effective in small or regional systems;
7. advisers should be professionals, actors in the system should be professionally independent;
8. cooperation and involvement by all actors enhance system success.

For multi-owner public systems, many of these elements are subject to public analysis and influence.

There is considerable overlap between the "research-extension-utilisation" model of Agricultural Knowledge Systems proposed by Rogers and others and the "NMC" model proposed here: the principle difference lies in classifying knowledge activities as nucleus (theory), customisation (fine-tuning the theory for a particular species in a particular production system and environment), and commercialisation (extension, utilisation and implementation). The outstanding feature of the work of Rogers and others in the present context is the focus on integrating factors and their importance. This is the direct analog of dissemination techniques in livestock NMC's: the lag between successive tiers in a NMC is the single most controllable cost for a livestock improvement program, and in principle minimising this lag is critical to profitability.

A specific issue concerning integration that has been explicitly studied in the livestock improvement context is the genetic correlation between the nucleus environment and that of lower tiers. In simple terms, if the genetic correlation between the expression of a trait in the nucleus environment and elsewhere is not 1, then genetic improvement generated in the nucleus yields less than equivalent improvement elsewhere and there is a danger a) that the balance of improvement between traits will be wrong, and b) that investment made in the nucleus will yield sub-optimal return.

In the animal breeding case, studies suggest that the critical level of this parameter is 0.8. Clearly, there is no obvious equivalent critical point for the knowledge NMC, although cultural (and other) mismatch between individuals/firms in different tiers has clearly been recognised as a problem in implementation of improved animal breeding methods before:

- via "scientists", field staff and farmers being unable to communicate with each other,
- via these groups being socially isolated from each other,
- via the effect of Westernisation of goals and lifestyles of students moving to western countries for higher graduate and post-graduate training.

As described here, this is as much a problem of inefficient "gene flow" between tiers as of different objectives and/or environments in the different tiers: the problems are both widespread and similarly reduce the return on investment in the knowledge system.

2.7 Source/ expectation of investments

Typically investment in the knowledge NMC has relied totally on the public sector for the nucleus, most often through universities. Investment into the multiplier (customisation) and commercialisation (application) sectors has usually relied more on industry specific funds - a specific form of public funding.

This package of investments then generates value which accrues through the value chain of the specific industry for which the performance recording/genetic evaluation system has been developed. Most often, profits from livestock NMC's (and hence from the supporting knowledge NMC's) accrue at or near the consumer end of the livestock value chains. This will be through lower (in real terms) prices for livestock products - benefiting consumers, and retained or increased market share for large processing and/or retailing operations.

This overall pattern of investment reflects several beliefs (and resulting policy views):
- that the knowledge NMC and its direct application through industry performance recording and genetic improvement programs is inherently uncertain, requires long time-frames to generate detectable cultural and financial change, and produces only small and risky returns to any individual participant (Smith, 1978);
- that knowledge itself is not a commodity whose generation and application can or should be satisfactorily modelled, analysed or managed in the ways applied to more standard commodities.

Thus investment in knowledge generation and customisation, and in many circumstances in its application, have been viewed as so unlikely to attract private investment that substantial public investments have been made over considerable periods of time.

This approach has begun to alter within the last 2 decades in Western economies for a number of reasons:
- so-called economic rationalist political ideologies have been predominant, effectively questioning most forms of public ownership and investment;
- as communities have become wealthier, more attention and hence more public money, has been directed towards policy issues such as environmental degradation and maintenance of health care systems;
- increasing globalisation has placed public and private improvement systems into more competitive markets, typically identifying superior foreign product(s), forcing greater and greater local attention into the application component of the knowledge NMC and heavier reliance on the global pools of knowledge nucleus and to some extent knowledge customisation talents.

A simple example of this is provided by the simultaneous global diffusion of both North American dairy cattle genetic material and of North American-trained animal breeding graduates and post-graduates.
These changes qre affesting the ability and propensity to invest of the traditional source of much of the funding for livestock improvement systems, and bringing into clearer focus the basic reasons for such public investment, which have typically included:
- food security concerns;

- preventative health policy, aimed at ensuring consistent supplies of cheap, local food products particularly those such as milk seen as having almost strategic public health importance;
- political views regarding access to improving technology for farmers (passive public support for farmers);
- deliberate alteration of the terms of access to such technology to maintain lifestyles for farmers, rural and countryside amenity value, and clear desire to counter rationalisation of farm numbers and resultant urban unemployment, various forms of active public support for farming.

Finally, as the effectiveness of improvement programs has improved, there has been a clear modification in public expectation of breeding programs. Many (western) consumers are somewhat averse to "high-tech agriculture", and this trend is mirrored by the growing attitude that breeding companies that earn substantial profits from sale of genetic material are hardly deserving of public support.

Further questions that will be briefly discussed here are:

- Given a satisfactory method or framework for evaluation, can we suggest both appropriate individuals/groups to assess system performance, and ways of "curing" the a system diagnosed as performing sub-optimally from this model?
- Does evolution of technology and of the "livestock improvement business" affect these recruitment rates?
- What characterises a mature livestock improvement business, and is public funding/support for such necessary or appropriate?

These will be discussed in this order, since evaluation is in this case simpler than diagnosis, has a clearer basis in theory, and establishes the basis for addressing both other questions identified here, and those addressed in the remainder of this document.

2.7.1 Analysis and Evaluation of a) The Livestock Improvement NMC

Evaluation of investment into a livestock NMC is straightforward and routine. The primary measure of success is rate of genetic gain, expressed either in index units (ideally currency units), or to facilitate comparison across species and industries, in units of index standard deviations.

Clearly, this component of the evaluation can use the simple expression for genetic gain:

$$\text{Rate of gain R (index units/yr)} = \frac{(\Sigma\, i_i \,.\, r_{IT}\,)\,.\ \ \sigma_I}{\Sigma\, l_i}$$

where: i=standardised selection intensity
rIT=correlation between Index and True Breeding Value
L=generation interval
sI=standard deviation of Index

Breeding program managers, advisers and research scientists typically investigate the "settings" of each of the components of this response formula and their joint optimisation in both theoretical studies and increasingly in year-to-year management of breeding programs under their control or influence.

Secondary evaluation measures several parameters affecting commercial returns and sustainability:

- Rate of expression in commercial animals. This is a compound parameter, comprising genetic lag between nucleus and other tiers in the livestock NMC (which in turn comprises time lag to commercial expressions and number of commercial expressions per recorded/evaluated animal), and market penetration in the breeding sector (usually the nucleus of the livestock NMC). The latter is typically expressed as the proportion of dams of sires undergoing evaluation, or the proportion of commercial sires (sires delivered/sold to the commercial sector) undergoing genetic evaluation.
- Numbers of new sires entering the population and their relatedness. These are the primary determinants of effective population size and hence of the rate of inbreeding. For populations either closed or unlikely to be open to importation, this affects capacity to maintain rates of improvement into the medium- and long-term.
- Rate of financial return to the nucleus sector. This does not directly affect company/community return from the improvement program, but may be a limiting factor, either through insufficient funds to support the costs of high-performing programs, and/or insufficient incentive for personnel involved in managing the program to pursue improvements.
- Appropriateness of breeding objectives is also critical to sustainability of the improvement program. It is not really however a diagnostic (except in the sense that one can check that the Index being applied is the one that maximises correlation between Index and True Breeding Value for the known objective). Rather, it requires that economic analysis of the industry be as rigorous and comprehensive as possible. Determining whether this is/has been the case is somewhat subjective. Attempts have been made to develop theory for establishing multiple lines with multiple objectives (Smith, 1978, Howarth and Goddard, 1997): these however are both incomplete and are based on using a diverse portfolio approach to counter uncertainty regarding the future, rather than "real-time" or a posteriori evaluation of objective(s) being applied.

  In this area then, as with the area of predicting growth of new core knowledge, we are left with no obvious way of dealing with uncertainty about the future. Perhaps the diverse portfolio approach warrants further investigation in both areas.

In addition, program cost parameters which should be considered include:

- cost of obtaining each performance record(s) for individual animals;

- cost of processing data to produce breeding value estimates (per estimate), this should include reporting costs;
- amount and cost of advisory input to both data collection and selection and mating decisions;
- total number of performance records and breeding value estimates per year;
- where possible, any public support for any of these costs should be identified.

A series of specific diagnoses can therefore be suggested:

- Rate of gain, in index standard deviation units, either as estimated (where BLUP methods are used) or predicted (from selection, accuracy and generation length parameters, where population is non-pedigreed).
- Design parameters: selection intensity, accuracy and generation length for each pathway (where pedigreed records are maintained in a database, each of these can be directly calculated).
- Rate of expression in commercial population: the diffusion rate or rate at which genes of new animals are expressed in the commercial population (where separate).
- Numbers of new sires entering nucleus: this is easy to determine whether the population is pedigreed or not, but where pedigree records are kept in a database, more precise measures of the rate of inbreeding can be calculated.
- Return to the nucleus: average prices for seedstock animals, and relationship between estimated merit and price received.
- Appropriateness of breeding objectives: the primary evaluation here can only be checking current (or recent) prices for all traits/units in the objective with those used in the actual breeding objective. Also, current population statistics should be used to check realised discounted expressions per sire (or breeding female, or whichever livestock unit is used) for cases where there are distinct cohorts of animals contributing to total discounted expressions, and these differ in their expressions of traits in the objective.
- Net investment in the program, and net return. In most circumstances these will be over a specific period of time in order that the flow of returns from individual selection decisions can be fully accounted. Where costs are broken down to publicly-, privately-, individually-and collectively-funded, both the net investment and the net returns can then be apportioned accordingly.

The suggested overall framework for the evaluation of livestock improvement programs including some diagnostic steps is reported in table 2.

Table 2. Framework for evaluation and diagnosis of Livestock Improvement Programs.

Parameter:	Measure
Rate of gain:	
primary measure:	Predicted/estimated gain
secondary measures	Selection intensities in nucleus Accuracy of selection in nucleus Generation length in nucleus
Appropriateness of breeding objectives:	
	Current/recent prices for traits in objective function
Sustainability (genetic sustainability):	
Inbreeding accumulation	Numbers of new sires per year/calculated rate of inbreeding
Measures of financial performance:	
Variable costs	Cost of recording for each trait Cost of processing per breeding value estimate Cost of advisory inputs, to recording Cost of advisory inputs, to selection and mating
Fixed costs	Net investment in design, parameter estimation, system management, and training
Net performance	Net investment, total fixed costs Net investment, total variable/recording and processing costs, and total advisory costs
Financial return - to nucleus	Real price trends for seedstock Relationship between seedstock estimated genetic merit and price
Financial return - to system	Discounted commercial expressions per nucleus animal (number) Price trends for commercial traits
Net return:	
	Net present value of gain over 5, 10, & 25 years Net present value of program over 5, 10 & 25 years

This technical and financial evaluation of livestock improvement programs is in principle straightforward, and there is no reason why any improvement program in any species could not be evaluated following this simple outline. Most features of the evaluation will be common, but with some scope for recognising aspects unique to particular species and industry structures.

In this latter context, it is appropriate to note that financial evaluation may well be more difficult in practise where it is hoped to compare public and private programs (and indeed, some private programs may resist any disclosure of program performance at all).

Differences and similarities across species will be highlighted by use of rate of gain in index standard deviation units as the primary technical evaluation. Clearly, average price for nucleus animals, net investment and net return will be heavily influenced by the value of the product(s) of the particular species and hence the value of individual animals.

2.7.2 Analysis and Evaluation of b) The Knowledge NMC

Similar analysis of investment into the knowledge NMC is not so straightforward, and even where carried out may be confused by competing and conflicting attitudes to valuing knowledge and varying reasons for public and private investments into such systems.

As with the technical and financial evaluation of public and private livestock improvement programs, it will often be difficult to obtain accurate information on investment in human resources within the private entities in the knowledge NMC. This really approaches the crux of the public:private policy issues regarding investment in livestock improvement: eventually public support for such programs must be justified, and to be justified it must have measurable livestock improvement results and quantifiable investment in human resources.

I have attempted a human resource assessment for a number of Australian livestock industries: this is however only the first step in managing that particular total investment portfolio. Allowing that there are in some cases no obvious analogies with the livestock NMC, we can nevertheless move through the main evaluation stages suggested above:

2.7.2.1 Rate of gain

There is no clear analogy here, whereas rate of genetic change can be quantified and valued (in both prediction and estimation phases), it is not so immediately obvious how rate of generation of new knowledge can be similarly handled. This is not to say that qualified observers cannot judge whether a particular method (for variance component estimation or breeding value prediction), result (for a particular parameter for a particular trait), or design innovation (in breeding program design) is really new and genuinely adds new knowledge. Indeed, this is the basis of use of citation indexes and (with almost certainly less value and accuracy) in assessment for career progression via simple paper counting. The main concern with use of citation indexes would be that appropriate stratification by subject was included, so that the rate of generation of new knowledge within a particular subject area could be assessed.

One aspect of the knowledge NMC which is simple to assess and which is analogous to the "Accuracy of selection" measure in the livestock NMC, is that it should be defined whether breeding value estimates (where used) are within-unit, within-year or across-unit and across-year. The capacity to allow across-unit comparisons significantly adds to the power and effectiveness of a livestock improvement program, but brings specific requirements of the recording and data processing systems.

More generally, there is not such a clear relationship between new knowledge about genetic improvement and genetic improvement itself, as there is for example between changing genetic merit and changing phenotypic merit. So, whereas high rates of change in estimated genetic merit translate readily into high rates of change in observed phenotypic merit, it has not been the case to date that rates of knowledge generation for animal improvement, and rates of animal improvement themself, have been particularly closely related. Indeed, one of the key issues for this paper is really how to improve that translation of knowledge into practical effect.

Part of the problem with including "rate of gain" in knowledge as a component of evaluation of the knowledge NMC is that livestock improvement has a substantial store of "knowledge capital" which has been accumulated through the 20th century, and in particular since World War II, almost as if there had been a protected nucleus operation, which has only really begun to be harvested since the 1960's.

A possible argument here is that in fact further investment in the knowledge nucleus (core knowledge and core knowledge workers) is not justified, since well-managed improvement programs are reliably predicted to continue improving for the indefinite future, and that sufficient knowledge and software tools exist for the customisation process to be successfully applied to any species of livestock.

The other problem is that whereas genetic theory provides means to estimate duration of genetic progress, and we can confidently expect improvement to continue in most species for at least several decades, we have no corresponding theory for the generation of new knowledge. It should be stressed that this applies more specifically to the knowledge nucleus areas of study: in customisation it is essentially easy to specify how much effort (money and time) will be required to obtain what number of genetic parameter estimates and breeding objective definitions, and in application, relatively little new knowledge is ever required.

A clear distinction can therefore be drawn for evaluation purposes between:
- "harvesting" of existing knowledge, which is fairly simply evaluated both via its results, rates of genetic gain in a particular population, and via measurement of activity such as parameter estimation, breeding objective definition and so on, and
- generation of genuinely new "core" or nucleus knowledge.

For the moment we will note the problems in this component of evaluation of knowledge NMC's, and move on to examine prospects for other aspects of that evaluation.

2.7.2.2 Numbers of new "knowledge workers" entering the population

As with actual animals, there are 2 components to this. Firstly, each individual can only do so much "knowledge work", with different limits in different tiers of the knowledge NMC. Advisers can only satisfactorily "service" a finite number of farmers in the course of a year, research scientists can only generate so many genetic parameters estimates, and so on. Thus, depending on the number of owners or animals, and of animals, it is possible to estimate required numbers of "application workers", and given normal rates of attrition, ideal numbers of new trainees per industry per year.

Secondly, the influx of new knowledge workers brings revitalisation, slightly (and occasionally radically) new approaches, and continuing capacity to train further new workers. This latter aspect is more akin to the inbreeding aspect of recruitment rates in livestock improvement programs. Typically, this is addressed by a combination of scholarships and/or subsidised training for junior workers, together with the incentives provided by whatever employment prospects exist within the knowledge NMC.

This evaluation should usually be straightforward, (numbers of students in various forms of agricultural and/or technical training can be determined, as can recruitment rates to public and private sector livestock improvement programs and organisations).

2.7.2.3 Rate of financial return to the nucleus

As with the evaluation rate of gain in the knowledge vs the livestock NMC, this is not straightforward for the knowledge NMC, and again this is based on difficulties with valuing knowledge. In this case, the specific problem is that different cultures vary in both their capacity to identify, and then their readiness to specifically reward, knowledge innovators. Again, this reflects the lack of a simple and reliable theory of knowledge generation and valuation (by contrast with the existence of such theory for generating and valuing genetic change).

Even in cultures where good/great teaching has been valued, this has not necessarily meant rewarding the source of new knowledge, but rather its transmission, and further it is certainly the case that social and financial rewards even for teaching have diminished in many countries during the last 3-5 decades.

The problem here is however not one of evaluation: it is straightforward to identify returns to personnel working in the knowledge nucleus. It is harder to know whether these rewards are in fact sufficient or appropriate to ensure satisfactory rates of generation of core knowledge into the future, again because of the absence of any satisfactory theory of knowledge and growth.

Clearly there are problems with direct evaluation of the performance of the knowledge NMC itself. Does this present serious problems? The main reason for wanting such evaluation is to improve diagnosis and cure of under-performing livestock improvement systems. Given that a simple approach to their diagnosis has been presented, clearly much can be done before detailed objective analysis of the knowledge NMC becomes necessary, and even then it is relatively straightforward to assess human resource investment and to identify shortcomings in the customisation and application sectors of the knowledge NMC.

Extending this point, a comprehensive survey of the performance of livestock recording and improvement programs as outlined here will very rapidly identify those sectors where limited or ineffective access to the knowledge nucleus is hindering performance.

3.0 The technology of livestock recording and improvement

3.1 Summary and recommendations

- The first step in optimising public and private investment in recording and improvement systems is sensible evaluation of the amount, type and location, and result(s) of such investment.
- A simple framework for evaluation of livestock improvement programs across species has been suggested. FAO should establish a database for those programs with which it is involved, recording the parameters outlined here for both the livestock system, and as far as possible, the supporting knowledge system.
- Wherever possible, other systems/programs should be included in the database, which will both expand the bases of comparison and highlight any systematic differences (both qualitative and quantitative) between the different classes of program: FAO-involved, independent but with governmental involvement, independent but with industry involvement, and private.
- Performance of the livestock system is the primary measure of performance of the supporting knowledge system, and if the approach suggested here is followed, it will be straightforward to identify deficiencies in the knowledge system that are limiting performance of the livestock program.

The remainder of this document links this simple and essentially technical "functional analysis and evaluation framework" with a series of policy issues.

This approach has been taken in the view that policy decisions for livestock recording and improvement must be grounded in objective evaluation of those programs first, and choices about access, funding, support and so on, second. This is clearly a value judgement, and one that is prevalent within the community of western animal breeding scientists in particular, and particularly recently, western economists and other technocrats. I believe it is relevant to discussion of animal improvement systems fundamentally because such systems have always relied on valuing of animals and animal products by individuals and communities. Such valuing assumes differences in performance, and more importantly differences in the results of different selection decisions: differences that individuals and groups attempt to predict and capture.

Accordingly, an underlying market-based model is acceptable: the public and private issues arising are not those concerning effectiveness of the recording and improvement system itself so much as those concerning access to the system, funding for it, and access to/distribution of its products and profits.

4.0 Specific policy issues arising from the functional analysis and evaluation framework

4.1 What are the consequences of focussing on "Low-to-medium input production environments (LMIP's)?

It can be initially tempting to ascribe to livestock production systems in LMIPs characteristics that inhibit analysis using a simple framework as described here:

- animals may (appear) not to be traded in any cash economy and so are hard to value;
- surpluses of livestock or livestock products may be rare or intermittent;
- ownership may be highly communal;
- animals may function as part of a waste-management or recycling system rather than a surplus generation and harvesting system, and so on.

These and other characteristics that apparently differentiate such systems from those in which livestock improvement technology has been successfully applied are however analogous to the features of ecosystems different from those first studied by western ecologists: the nodes and channels of energy flow may be quite different in say a tropical rainforest from those of a temperate grassland. These differences may lead to the initial conclusion that no common principles apply: there is still however energy input, flux, dissipation and so on, and the underlying principles of analysis that support analysis and understanding of an ecosystem will still be valid.

In the same way, while the specific features of recording and improvement in an LMIP may be unique, the underlying principles will still include:

- differences in performance with some genetic component and differing value for some decision-maker(s);
- selection amongst the animals and resulting manipulation of mating and reproduction;
- some cultural process for supporting this human activity and ensuring that it continues.

If this view is accepted, then the main challenge in developing and evaluating policy for recording and improvement systems in LMIPs lies in careful and accurate analysis of the system, rather than in the simplistic response that the fact of operating in an LMIP means that broad-target, western-style systems will be necessary and must be funded and managed from outside the LMIP and the people who live within it.

Another aspect for consideration here is whether agency response to an LMIP (and agency may be either local government and/or foreign aid agency) is to encourage/support modification of the physical environment. This may change the underlying conditions of the livestock system, and mean that the basis for valuing livestock changes. Such modification of the environment is of course often one of the results of successful management of such systems: as farmers accumulate some form of profit from their livestock or other activities, some of that profit may be invested in improving feed supplies, disease control or whatever. This invariably changes the demands placed on the livestock and hence both the breeding objectives and the favoured breeds/strains or individual animals.

This type of change has already meant the disappearance or decline of many breeds within western agriculture and there is no reason to suppose any different result elsewhere. This raises in itself a fundamental policy issue: is the current low-to-medium input accepted as inevitable or will some way be sought of modifying the bio-economic ecosystem? If the latter, then should anyone be concerned with the fate of breeds/strains suited to the existing system? Further, is there a real likelihood that humans will tend to leave the LMIP system if they have any choice?

There is a high likelihood that this issue will become more and more relevant in the next few decades as food supply and security become more and more central to world trade and political debate. It seems highly likely that there will be more and more international investment in food production, and this will certainly not be restricted to working within the constraints that apply to local farmers and/or traditional farming systems.

Given that in this sense LMIP livestock systems are often integral to traditional cultural systems, the real issue for public policy debate here (both nationally and internationally) may rapidly become "whether and how traditional lifestyles should be preserved?"

Thus the suggested answer to this first question is a two-fold "no":

- the same framework for analysis and evaluation of livestock recording and improvement can be used for LMIPs and for higher input systems; what may change are the specifics of how valuing is done, how selection decisions are supported, and how results are distributed (for example), but rates of gain and rates of inbreeding can still be estimated;
- answering "yes" would imply that inputs cannot and/or will not change, but while the farmers/people within an LMIP livestock system may be unable to modify the inputs there is now very little chance that the system will remain isolated from the rest of the world. While internal profits may not be sufficient to modify the system, external ones almost certainly will. This prospect raises far wider social questions than those which simply focus on livestock production.

The approach taken to answering this question quite simply broadens the arena for the public policy question to something like "should governments attempt to change the conditions of access to markets for individuals\groups where most players are relatively poor (in capital)". Typically, the answer has been "yes", and various forms of assistance have been developed, which have been widely applied within western agricultural systems over a long period of time. Incidentally, state funding of research stations and cooperative/nucleus breeding programs should be recognised as methods of changing the conditions of access to both knowledge and seedstock markets.

The difficulty that arises sooner or later if this approach is taken is to decide the point at which the assisted group is no longer sufficiently relatively poor. A further difficulty often highlighted by supporters of less interventionist approaches, is that such modification of market access does not seem to help individuals or companies survive or compete when conditions change: for these individuals or groups to remain involved requires a new set of modifications to market access conditions.

4.2 What are the consequences of different forms of ownership: public (through government), cooperative and private on investment in livestock production systems?

I suggest that the answer here is again two-fold:

- different forms of ownership have no effect on the applicability of the functional analysis and evaluation framework outlined here;
- different forms of ownership may however have real and important effects on propensity to invest in innovation, marketing and other aspects of managing the livestock system, and will clearly almost certainly have different effects on the distribution of any profits.

The most obvious effect of various forms of public/collective involvement in livestock production (indeed, in agricultural production) has been to maintain more individuals physically involved in the production process itself than where private ownership has operated. This has not necessarily meant higher or lower rates of genetic gain or better or worse preservation of genetic material.

In some cases it is argued that this result is in itself desirable (by for instance reducing urban unemployment rates). Becoming too deeply involved in this debate is beyond the scope of this document, but two simple observations can be made:

- the analysis and evaluation framework suggested here encourages a focus on the primary livestock (and in particular, genetic) aspects; rate of gain in commercial traits and preservation of the capacity to make such gain and to respond to changing circumstances. If public policy decisions are made which affect these adversely but maintain employment/involvement, then the capacity to support employment within the livestock system will suffer. To avoid this, decision-making will often become as centralised as in any private conglomerate, with almost as damaging a set of social consequences;
- livestock recording and improvement are only unrelated to innovation in a world of constant environment and population; normally they inevitably mean change in the circumstances of the humans involved, and this typically means reduced direct employment.

In general then, the functional analysis and evaluation of livestock systems are not changed by their form of ownership. What is likely to change is the degree of management complexity as more owners' interests must be explicitly addressed, and the means and availability of investment funds, particularly to support innovations in areas such as new measurement technologies (although there is no strong evidence suggesting that either private companies or public institutions are necessarily more or less likely to make such investments successfully).

This conclusion is probably also true for different political systems. As with the suggested effects of different forms of ownership, the basic functional analysis is not changed whether capitalist or socialist systems are being considered: what certainly may change is the environment for investment, the skill etc with which this investment is carried out and managed, and the way in which returns from investment are handled. Genetic improvement has been successfully implemented in a range of political cultures but has been most clearly documented and has accelerated most rapidly since the introduction of BLUP systems in countries and industries with access to large breeding populations and reasonably effective markets for seedstock/genetic products. Importantly, the effectiveness of such markets has often been enhanced by public investment in independent genetic evaluation systems, although some authors have suggested that such independence is only necessary to support genetic improvement until a significant proportion of production is managed within vertical and horizantal alliances.

4.3 Does the purpose of the Recording/ Breeding system affect the public and private organisational roles - genetic improvement or genetic conservation?

There has been a tendency for greater public investment to be necessary for programs aimed at genetic resource conservation. In general this reflects either lack of private sector interest (ownership, development etc) in breeds no longer viewed as commercially competitive, or more general lack of development activity in a livestock sector which particularly when coupled with increasing pressure of land and feed resources for livestock production inevitably fragments and reduces livestock breeding populations.

These problems clearly underpin the global livestock genetic diversity program, the question here is more specific. Given that private sector involvement in livestock populations will require return on investment and usually aims to maximise that in the short to medium term, then we can expect less private investment in programs solely aimed at preservation/conservation.

This highlights the question of purpose for such programs, and supports the pragmatic position in which populations are selected for conservation effort that are already locally economically important, or have sufficient numbers such that appropriate genetic improvement will make increasingly attractive for private involvement in management and development.

In this view, public involvement can aim to “save” endangered populations, establish the basis for their continuing improvement, and aim for increasing private involvement (farmer, cooperative, company) in the medium to long term.

Successful management of such populations will then depend on exactly the same performance parameters as any other:
- the rate of genetic improvement in the breeding objective, properly defined;
- the management of inbreeding and of access to new sources of genetic variation.

In such cases, public roles become clearer:
- identification of candidate stocks;
- assessing the existing genetic structure so that initial sampling can be optimised;
- initiating some form of recording in order to support selection;
- and having some input to the mating program such that inbreeding is minimised.

Once this has been implemented, the challenge remaining is to decide at what point, and how rapidly to reduce public support for and involvement in the program. This is addressed in a later question. The conclusion here is that all livestock management and improvement programs should be seen as having “conservation” and “improvement” components, that simple measures are available with which to assess performance for both, and that as such programs develop the likely involvement required from the public sector will change. In short, the distinction between “conservation” and “improvement” programs is blurred and the balance of the two aspects will change as a livestock population management program proceeds.

4.4 Should performance recording and livestock improvement programs have a clearly stated objective?

Framed this way, there can only be 1 answer to this question. Given the time, resources and modification of livestock populations that can be expected from all sound recording and improvement programs, it is essential to have both objectives and performance targets objectively defined.

Having objectives and targets clearly defined and assessed maximises the chance that successful programs will make the transition to economic self-sufficiency, and that under-performing programs will be rapidly diagnosed and targeted for intervention.

From the functional analysis that is used in this document, the objectives should include:
- clear definition of the breeding objective for the population;
- definition of initial set of traits for recording;
- definition of models and methods for initiation of reporting for management and genetic evaluation;
- definition of targets for numbers of recorded animals, numbers of selected animals, and hence targets for rates of genetic improvement and for maintenance/increase in effective population size (and hence stabilisation or reduction of rate of inbreeding);
- definition of targets for numbers of commercial animals expressing genetic improvement, where there is a distinction between “nucleus” and “commercial” animals;
- statement of method and audience for reporting of a) genetic evaluations and b) performance against stated objectives/targets.

Establishing this framework for evaluation, and in many cases maintaining it, will require some disinterested public input. Given that this framework defines the starting conditions for livestock recording and improvement, and a solid basis for continuing monitoring and evaluation of such programs, this points to the value of public activity as establishing a platform for recording and improvement and an independent structure for monitoring continuing performance.

4.5 Who is responsible for development and maintenance of the genetic technologies used in the performance recording system, and what does this responsibility imply in terms of amounts and duration of public support?

The most useful starting point for answering this question is the definition of public goods given earlier. Where an effective market exists for livestock or their products, then performance recording is almost invariably justifiable on the basis of management diagnosis and animal improvement. If so, then recording costs themselves should not require public support.

Expert advisory inputs, large scale research, and overall program monitoring and management will remain more as public goods, until such time as individual business units have grown in scale to the point where annual revenue is in excess of 20-50 times the cost of these R&D and management items. (As an example, net farm gate income of the Australian meat sheep industry is some 600m$Au, and for this industry expert advisory input, technical support and program management cost c. $0.5 m or 0.1% of turnover). If this estimate of core system costs is valid elsewhere (other than simply Australia), then industries or livestock populations that cannot generate in excess of $500m income will require some public intervention.

This discussion suggests different categories of program costs, in line with the functional analysis outlined earlier (the NMC system for supporting knowledge). At this time in the Australian meat sheep industry, all direct program costs are met by industry (so in strict terms entirely privately), with a distinction between fixed costs (program management, expert advisory input and research support) being met by industry levies and more recently by membership costs which are relatively similar for all breeders and commercial producers, and recording and delivery costs, which are essentially per animal.

This model aims for complete industry ownership, totally private funding, but with a mix of overhead (management, technical and advisory support etc) and variable (recording and reporting) costs. The Australian meat sheep industry and its the evolution in funding method is reported in table 2.

The model outlined addresses the direct costs of livestock population recording and improvement programs. The major indirect cost not included is the education and training of operatives at different levels of the knowledge NMC. Here there is the clearest case for continuing public involvement, whether through investment in education generally or through more specific measures such as scholarship programs for all levels of training. Even within the knowledge NMC, it is possible to view the Nucleus costs as being public goods, and the skills/knowledge requirements of the Multiplication and Commercialisation sectors as being more private. Within the model examined above (the Australian meat sheep industry), the Knowledge Multiplier (customisation) costs (program management and supporting research) have been met through generic

Table 2. The Australian meat sheep industry and its the evolution in funding method

Item	Period/phase	
	Establishment	Direct ownership
Period/duration	1989-1996 (7 years)	1996 - ?
Funding for Overheads *(Management, technical support, research)*	Industry levies - largely from commercial production plus government R&D matching (up to 2.5% of turnover)	Direct membership of industry owned company
Funding for delivery: *(Recording, data processing and reporting)*	User pays - breeders pay per animal evaluated	User pays; breeders pay per animal evaluated
Triggers for phase change:	a) proportion of nucleus recorded (75% for terminal sires, 33% for maternal breed animals) b) maturity of system information (across-flock and year evaluations for all breeds, breed specific indexes, structural traits evaluated) c) premiums for recorded seedstock (25-33% margin for each Index standard deviation superiority) d) legislative (R&D Act) requirements	

levies on production and are now being met through membership of an industry company, while Commercialisation costs (delivery) have been and remain on a direct user pays basis.

The challenge that remains within this model is for industries\countries\livestock populations to be aware of, and maintain effective knowledge nuclei and effective links between those nuclei and the Multiplication and Commercialisation sectors.

Summarising this point, for both the livestock and knowledge NMCs, nucleus costs are most readily identified as public, commercialisation as private, and Multiplication costs as moving through a transition from typically initially public or at least collectively funded to more direct industry/farmer/private ownership.

4.6 Who is responsible for collection, analysis and dissemination of the information products of the performance recording system?

The simple answer for this is that this responsibility lies with the program/ system management, and is indeed an integral component of the design of the system, and should be continuously monitored for effectiveness (cost, accuracy, speed, simplicity, relevance and so on being critical).

Similarly, reporting system/program performance should be an explicit responsibility of the program management.

The exact methods used for collection, analysis and dissemination will depend on the traits involved, the culture and geography of the country and industry involved, the educational level of farmers and advisors, and is obviously a central “design” issue for the program.

In terms of public/private roles, the initial design and management of these aspects of the program will be within the Multiplication (customisation) sector of the knowledge NMC, and hence likely to at least initially involve public/collective funding. As the system develops, there is no reason why these design issues cannot be more and more directly included in delivery, and hence more and more directly funded by the users (farmers and producers).

4.7 Where (as is usually the case) multiple agencies (public and private) are involved, what are the stated/ effective reasons for that involvement?

The answers to questions 5 & 6, together with earlier discussion, suggest that the following reasons will be important:

- public agencies will often be involved where farmers do not have, or are believed not to have, sufficient skills and or funds to support the decision-making required particularly for the livestock nucleus;
- public agencies may be involved to help small farmers remain in the breeding and/or production business, by reducing the cost of technical knowledge and/or recording and/or genetic evaluation;
- public agencies may be involved for national strategic reasons, food security, regional employment, general development and so on;

- private agencies will almost invariably be involved in order to profit; this does not mean such agencies are not contributing to the public goals such as those suggested above (indeed much public policy discussion throughout the world is now concerned with using the profit motive to improve delivery of previously public services.

The latter point highlights the 2 key issues about private involvement in community development issues (which is what livestock recording and improvement have typically been viewed as):

- private investment will seek private goods and services ie those where individuals or firms can capture value from their supply, and this has classically been the argument for public involvement in areas such as basic research, expensive research, general extension and so on;
- there is widespread political argument in favour of the view that private sector delivery is almost invariably more effective and/or efficient than public sector. As privatisation has proceeded and begun to be analysed, more attention has been paid to the characteristics of the market for the goods or services whose delivery privatised (for example, Tittenbrun, 1996).

These studies point to the value of preserving a public role for analysing market characteristics, identifying approaches to enhancing market efficiency, and in particular questioning the existence of supposed “natural monopolies”.

In terms of the issue of livestock recording and improvement, the analysis presented here suggests that nucleus knowledge may be the clearest example of a public good, and that as one moves towards to commercial end of the “knowledge chain”, knowledge and system/program design become more and more private goods and services.

This points to specific and valuable public roles in livestock recording and improvement:

- identifying sources of, and perhaps assisting with access to, appropriate knowledge nucleus workers or teams and products (i.e. software);
- working with farmers/industry to establish the framework for knowledge customisation;
- developing with farmers/industry a suitable framework for evaluating performance of the recording and improvement system;
- applying independent analysis to the markets for livestock seedstock, animals and products and the corresponding knowledge products and services to identify market distortions and inefficiencies;
- from the basis of such analysis, working with farmers/industry to remove such distortions and inefficiencies.

4.8 (a) What training structures/systems are in place for personnel within the knowledge and livestock NMCs? How are these funded and evaluated?

This is not so much a question for discussion here, so much as an important component of the public analysis role suggested under 7. This discussion paper is pointing to development and management of the basic knowledge generation and dissemination systems as being a “public” role in most circumstances.

This does not mean that the public sector should be seen as the permanent provider/manager of this component of recording and improvement systems, but that initial evaluation of the knowledge NMC should be independent of individual sectors and/or firms. Such analysis can then highlight alternative ways of funding continuing research, training and knowledge dissemination with the suggested aim being to move to such knowledge management being treated as being a standard component of the “business” of that industry or livestock population.

As with the livestock NMC, evaluation of the knowledge NMC is critical, certainly initially this will be an important public role.

4.8 (b) How and on what terms do elements within the knowledge and livestock NMCs have access to capital?

This is really a financial version of 8 (a), and is an area that has been explored widely and for a number of decades within the discipline of development economics and elsewhere. Again, the point is not to develop answers (or analysis) here, but to stress the importance of analysis of terms of access to capital for the development and management of both the knowledge and livestock NMCs.

This analysis should include identification of alternative strategies for modifying access both knowledge and financial capital: cooperatives are a widespread and potentially highly successful way of reducing costs of entry to numbers of small players such as farmers.

In this context, existing laws governing cooperatives and other financial and legal structures can affect the ease of establishment and likelihood of success of alternative forms of operation within both the knowledge and livestock NMCs. Initial analysis and planning for recording and improvement systems should take this into account.

4.9 What processes of system evaluation are available, and how can they be used most effectively in continuing system management?

One of the key messages of this discussion document is that a simple framework exists for the evaluation of livestock recording and improvement systems and their associated knowledge NMCs. The elements of this framework are standard within the breeding program design literature: what is perhaps new is the suggestions that:

- The framework should be routinely applied to all livestock recording and improvement systems.
- It forms a simple model for developing analogous evaluation of the knowledge systems that support livestock recording and improvement.

- It can be applied to LMIP systems including those where some/much of the value of livestock and their products are outside any obvious cash economy (including for example scavenger animals, which may not be traded but which have a clear and definable role within for example a village ecosystem).
- It is robust to evolution of both the livestock and knowledge NMCs and is applicable to systems initially devoted to conservation or improvement separately.

The framework is sufficiently simple that it could be readily applied to either national or international databases monitoring both livestock programs and the supporting knowledge NMCs. As with other forms of evaluation, this would improve allocation of resources within both systems and particularly help international aid and development agencies diagnose and respond to problems within both systems.

4.10 When is a livestock recording and improvement system mature, and what effect(s) does this have?

Two indicators of system/program maturity can be suggested:
- The system has become self-supporting; it is generating sufficient income to fund its own management and has the appropriate internal mechanisms in place and operating to do that.
- Rates of innovation, within both the livestock and knowledge NMCs, have stabilised (note: not that they have stopped).

The effects of such maturing will probably include:
- Reduced or zero need for public involvement, in the sense of support\input from taxpayers outside the livestock industry/system (note that cooperative or collective involvement may be integral).
- Under current trends of globalisation, almost certainly horizontal and vertical alliances across national borders.
- Larger effective scale for most operations in all sectors of both the livestock and knowledge NMCs; however it is achieved, maximising the number of animals expressing each new unit of both knowledge gain and genetic gain is one of the two ultimate determinants of livestock population/industry success.
- Unfortunately for many circumstances, this usually means a period of contraction of employment prior to growth in both livestock and knowledge work being dependent on income from the livestock system\program.

4.11 Does the public role ever disappear?

The answer to 10 above suggests that in strictly functional terms, the public role (suggested as initial analysis, development of the basic framework for livestock recording and for continuing evaluation of the performance of the livestock and knowledge NMCs) could indeed decline as livestock systems/programs approached maturity. This is probably generally unlikely for 2 reasons:

• True maturity probably requires a truly perfect market for all components of both livestock and knowledge NMCs; this situation has not been reached even in highly integrated poultry and pig industries in Western countries which still rely on the public sector at least for a supply of both trained graduates and access to developments in core knowledge.
• There is a continuing tension between the desire for economic efficiency (as expressed in the desire for cheaper and higher quality food) and the desire for food safety, environmental safety, and the increasing world-wide concern about the availability of employment.

At the very least, these latter point to a continuing public role (both within and increasingly across national borders) in modifying the environment and conditions for private operations.

On this basis, it seems likely that both public and private roles will continue and have to coexist within livestock and knowledge NMCs.

4.12 Is there a role for agencies such as FAO?

At best, such agencies are an international version of traditional public service organisations within countries, providing disinterested analysis, modifying conditions of access to suit particular community expectations, providing otherwise limiting resources, and so on.

Given this view, there is clearly a role for FAO such areas as:
• Collating basic information (the DAD-IS Global Database).
• Suggesting a framework for development, evaluation and management of livestock NMCs, and initiating a database for this purpose.
• Conducting assessment of global livestock recording and improvement knowledge resources, and particularly in helping match global aid and investment funds with such resources and the areas requiring their application.
• Disseminating the continuing evaluations of recording and improvement systems (this could be in conjunction with agencies such as INTERBULL).

These roles might simply be summarised as providing at least the beginnings of a global livestock recording and improvement system with integrated supporting knowledge NMC.

5.0 Conclusions

Discussion of public and private roles in livestock recording and improvement systems addresses issues common to the much wider issues of the roles of public and private sector activity generally. In livestock industries, there have typically been the specific issues of concern for the viability of small farmers and of public availability of scientific knowledge of animal production and improvement, and to these have been more recently added concern for genetic viability of many locally and internationally important livestock populations.

Rather than work through the potential minefield of ideological differences concerning public and private policy generally, management of mixed systems, and so on, this discussion document provides a simple functional analysis of the critical elements of livestock recording and improvement systems and their associated knowledge generation and dissemination systems.

The underlying message is that there are many simple analogies between the two, and that we can draw on animal breeding program design models to suggest a simple and logical framework for developing, managing and evaluating both the livestock and knowledge systems.

Without such a framework, discussion of public and private roles is effectively meaningless: with such a framework it is relatively simple to assess the state and performance of any potential or existing recording and improvement system.

This framework can be applied to LMIP systems: what may be special about these is the exact role(s) played by a particular breed or strain in a particular system. What will not change are the basic parameters of what traits contribute value and are amenable to genetic improvement, what information or records will allow effective genetic selection and improved management diagnosis, and who makes what decisions about mating structure and so determines medium- to long-term genetic viability.

It is suggested here that the clearest public role is to establish this framework for each individual situation, and following this is minimise distortions and inefficiencies in the markets for livestock, their products and the knowledge required for their management and improvement. Public involvement beyond this is problematic, not so much because it may not be of value but because it may be increasingly hard to reduce reliance on public support despite reducing availability.

This problem will likely be minimised by having a clear framework for evaluation of the livestock and knowledge systems, which will highlight both problems with either system, or just as importantly successes such as improvement in average animal performance, increases in rate of genetic gain, increase in effective population size, or improvement in rates of dissemination of knowledge and skills.

The discussion here is unavoidably simple; many issues are raised in passing and it is possible that the need for skilled and sensitive local and global analysis and understanding has not been stressed sufficiently. This is probably the second area where high quality public involvement will be of great value, and points to a critical facilitating role for FAO and related agencies. Establishing an international framework for, and system of, analysing and evaluating livestock and knowledge recording and improvement systems will almost certainly improve access to and allocation of knowledge resources for managing livestock recording and improvement.

Such a framework will reduce the chance local breeding populations will be unnecessarily swamped or replaced by imported stocks, and improve the chances for effective international utilisation of livestock recording, management and improvement skills.

Without that framework, many systems will not be managed to the level necessary to maintain and enhance livestock production in a range of environments, and will lose the base of genetic variability with which to respond to both changing circumstances and the need for constant improvement which all livestock production systems will increasingly face.

Clear, simple and practical information is essential in improving livestock production in all environments and political systems. Applying that principle to the development and evaluation of livestock recording and improvement systems themselves will most simply allow public and private roles to be identified and to evolve to suit the animals, the production systems and the communities in which they exist.

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Fundamental Considerations of Measurement, Analysis and Interpretation in Designing Performance Recording Systems in Animals

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1.0 Introduction

In traditional husbandry the measurement of production has played little part, with assessment of animals usually being made by subjective evaluation of performance. Such evaluation may be fairly accurate when flocks or herds are small and closely supervised because under such conditions individual animals are very well known to the people concerned. However, when groups of animals are too large or husbandry systems are not suitable for detailed individual knowledge of animal performance, measurement provides the only possibility for comparison among different animals or groups. Measurement is particularly important when animals are to be compared and the animals involved are not all known by those who must make decisions on choices between them. Even when there is good personal knowledge of animals in a particular population, that knowledge may not be generally available and may not be in a form convenient for analysis of differences in profitability of various management procedures or for planning breeding programs. Therefore even in low or medium input farming systems it may be desirable to institute performance recording in order to improve general management or genetic improvement.

The rational management of an animal population of any type may be regarded as involving the attainment of the goals of the owners of the population in the most efficient manner. One way of approaching this ideal is to identify the desired goals in terms of measured performance. Goals of the managers may be considered to consist of inputs and outputs, with the aim being to maximise the difference between the value of inputs and the value of outputs. Unless inputs and outputs are quantified their comparison is necessarily somewhat arbitrary. While it is possible to manage a population to obtain a satisfactory outcome without measurements, it is likely that some use of measurements will improve flock or herd productivity. When national or regional goals are concerned, it seems that only a degree of performance recording would allow their pursuit. With the growing realisation of the importance of sustainable agricultural systems there will be increasing pressure to quantify the effects of different husbandry practices.

Both for normal management and for genetic improvement programs there are similar considerations to be taken into account in formulating a performance recording scheme. The measurements to be taken and the recording and analysis systems implemented must be relevant to the goals of the overall program, they must be practical and cost effective, and they must be acceptable to farmers. Normal management may be seen as the taking of decisions in order to maximise the profitability of existing resources, while genetic improvement may be seen as providing improved animal resources for the future. Strictly speaking this is an arbitrary distinction, since some management decisions, such as a decision to reduce stocking rates to avoid overgrazing, will have impacts on future productivity, and some management procedures will affect genetic improvement. However, in a broad sense this distinction between optimising use of existing resources and providing better animals for the future can be seen as the major difference. Given that there is overlap between the two types of performance recording schemes, and that a specific scheme may serve both purposes, this discussion will not treat the two types separately. As the requirements for a breeding program may often be more stringent, the major emphasis will be on planning of systems for this purpose, but except for some special requirements for genetic improvement which will usually be obvious the principles apply equally to both management and breeding recording systems. For example, records may be used for making management decisions, or for providing information required by government bodies but not used in management. This would in many ways be analogous to the distinction made below about reasons for performance recording in breeding programs. In fact, there is in general a close analogy between the information used to make decisions for selection and to make management decisions. Farmers and their advisors concerned to identify problems leading to sub-optimal rates of growth or reproduction will need the same kinds of data on growth rate or breeding success as will breeders concerned to increase rates of genetic improvement.

Broadly speaking there are two main reasons for measuring performance in breeding programs: the provision of information on which selection decisions are to be made, and provision of information which may be of value but which is not intended for use in selection decisions. There are good reasons for making a distinction between these purposes, as will be discussed in due course. The more important purpose is to aid in making selection decisions, and this will be the main focus of the present document.

2.0 Choice of traits

There are in principle very many measurements which could be made as part of a performance recording system. Since there are costs associated with every measurement, it is only those traits whose measurement makes a cost-effective contribution to genetic progress which can justifiably be included in such a system. How can such traits be chosen?

2.1 Importance for breeding goal

In a strict sense, choice of traits can be made only after extensive investigations have been made. Before it is possible to assess a contribution to genetic progress it is necessary that genetic progress be defined, and this can logically be done only after a breeding goal has been defined (James 1982). The definition of a breeding goal is a decision to be made by the owner of the breeding population in question, and is in some sense arbitrary, but in recent times there has been extensive discussion of how this might be done in a structured way (e.g. Amer and Fox, 1992; Smith, James and Brascamp, 1986; Brascamp, Smith and Guy, 1985; Ponzoni, 1986; Goddard, 1997). Essentially it appears to be an emerging consensus that the approach recommended by Amer and Fox (1992) can be used as a basis for the definition of goals, though in practice there may be difficulties in a rigorous application of the method because of market distortions for political or other reasons. It is also recognised that there will always be considerable uncertainties in such definitions because the goals will not be achieved for many years, by which time conditions may have changed, so that it may be that breeders who best guess the future may be more successful than those who derive their goals in the most logical manner but guess the future badly. Nevertheless it remains true that only in relation to a defined goal is it possible to assess the contribution of a performance recording system. In the same way, for a management oriented system it is only when the crucial decisions have been identified that the value of performance recording in making those decisions can be assessed.

In making such an assessment it is important to keep a clear distinction between traits which are to be improved because they are part of the breeding objective, and traits which are to be used as selection criteria, which may include some or all of the traits in the objective, but may also include traits which are of no intrinsic value but because of their correlations with important traits can be used to effect genetic improvement. As an example of the distinction between these traits, we may cite feed intake of grazing animals as a component of the breeding goal in most, if not all husbandry systems, but it is one which would not be routinely measured as a selection criterion because of the impracticability of such measurement. On the other hand, a measurement of backfat thickness at a specified location is of minor importance in itself, but may be a valuable selection criterion because it has a strong correlation with the total amount of fat in the carcase after slaughter. In designing a performance recording system it is not sufficient to identify economically important traits and decide to measure them, as indicated by the example of feed intake of grazing animals. But the identification of economically important traits can lead to the search for correlated traits which may be used as selection criteria for improvement of characters which are too difficult or too expensive to measure.

Before reliable choices can be made it is also necessary that accurate estimates of genetic parameters are available, and these will often be lacking. Indeed, in some cases a good reason for embarking on a performance recording program is to obtain data for the estimation of such parameters. Accurate estimation of genetic parameters requires quite extensive data sets even with modern software such as DFREML (Meyer, 1989) or VCE (Groeneveld and Kovac, 1990) which is capable of extracting information from field data in an efficient manner. In the first stages of a recording program, then, it is likely that the necessary information will not be available. The way to proceed in this case is generally taken to be as follows. For most traits there are estimates available in some populations, even if they are not closely related to the population of interest. A literature survey will give some guidance as to the estimates to be expected in the population of interest. Of course, it is a truism that the heritability of a trait is defined for a particular population in a particular environment, but experience suggests that if no better information is available, a value taken from a literature search is better than nothing and may even be better than a very inaccurate estimate from a small amount of data taken from the relevant population. Similar remarks apply to genetic correlations, which are notoriously difficult to estimate accurately, so that in some circumstances the use of a phenotypic correlation as an estimate of a genetic correlation is justified. In making such guesses from literature reports it is wise to note that variances and covariances have often been found to differ substantially between environments with low inputs and high stress levels and environments with high inputs and low stress. Populations of animals adapted to such different environments are also likely to differ in variance structures when maintained in the same environment. If possible guesses should be based on estimates for broadly similar environments.

In the long run there is no real substitute for estimates from an appropriate data set, but decisions must often be made in the short run. For the moment we shall assume that a breeding goal has been defined and a range of potential selection criteria have been identified, following which a set of estimates of genetic parameters for the traits in the breeding goal and the selection criteria have been assembled.

The information obtained in this way can be then used to assess the contribution each trait to be used as a selection criterion can make to genetic progress. A simple way to approach this problem is to use selection index methods, as done for example by Ponzoni (1986). Once the breeding goal has been defined, the response to selection using an index which includes all potential criteria can be predicted from selection index theory. It is then simple using freely available software to check the effects of dropping certain criteria from the index on the response to selection. If a criterion can be left out of the index with a negligible loss of response we must question the value of measuring the trait, recording it and using it in the prediction of breeding values. If the omission of a trait from the index leads to substantial loss of response we would be reluctant to remove it from the criteria to be used even if it were expensive to measure. A survey of possible selection criteria by this method can be very informative and give rapid insight into the relative importance of different criteria in a breeding program.

So far we have been considering selection within a population, where continuing genetic improvement is being sought. Measurement is also important for selection between different populations, and may be especially important because the various populations may be familiar to different groups of people. However, measurements in themselves are of little value unless they are made in comparable conditions (ideally in the same environment) and are relevant to breeding goals in the same way as in selection within populations. For this purpose it may be that individual breeding values are of lesser importance than the mean breeding values of the different populations, and the considerations involved are not identical in the two cases.

2.2 Practicability

It has already been mentioned above that the practicability of measurement must be taken into account when planning a performance recording system, using the example of feed intake of a grazing animal. The taking of performance measurements is sometimes a part of normal husbandry, but in most commercial populations and many seedstock populations the extent of measurement is minimal. Any performance recording system needs to be integrated into the management of the population, and thus must fit in with other management operations. This can be done more easily in a seedstock population in the sense that genetic improvement in such a population can more readily lead to increased returns than in a commercial population where the sale of breeding animals is not a source of income.

In wool sheep, measurement of the quantity and quality of wool can be integrated into the shearing process if the fleece is normally handled for skirting by placing the fleece on a weighing table, and taking a sample for later determination of quality (e.g. yield, fineness) before it is packed with other fleeces in a bale. It will be necessary to introduce some changes into the shearing operation compared to one in which no measurement is done, where fleeces are subjectively classed, but the incorporation of the measurement process into the shearing shed procedure does not call for a major reorganisation. On the other hand, if a sheep breeder decides to breed for parasite resistance by using faecal egg count as a selection criterion, particularly if this is to be done using a challenge with a known dose of larvae, a whole new management procedure needs to be introduced. This is not necessarily an argument against such an operation, but it does illustrate the fact that some measurements can easily be added to existing management practices while others need substantial changes to husbandry if they are to be used. An important part of the design of a performance recording system is the establishment of a method of putting the system into operation, and this may need to be done in different ways in different populations if their management is sufficiently different. A system which is seen as disruptive by the manager of the population is not likely to be favourably regarded. Thus at an early stage it is important to find out what management procures are employed in order that an appropriate way of including measurements in the overall program can be devised.

2.3 Cost

Although there may be no clear distinction between practicability and cost, in the sense that at a sufficient expenditure virtually any procedure may be made practicable, there are nevertheless real differences. As an example, we may consider the case of wool measurement mentioned above. It may be quite practicable to institute a fleece measurement program, with samples of wool being kept for later laboratory measurement, but the cost of such measurements may be regarded as too great to be acceptable.

Where cost is an important consideration, as it very often is, it may be desirable to reduce expense by using a cheaper measurement procedure or by measuring only a proportion of the animals which might have been measured if costs were much smaller. The true costs of measurement and recording need to be recognised, since these costs may include the labour of gathering the animals together for measurement if the measurement cannot be done at a time when the animals would be normally collected together.

In general a cheap measurement is more attractive than an expensive one, not necessarily because the total expenditure can thus be reduced, but there is also the chance that the total expenditure may be the same, but several cheap measurements may be taken instead of a single expensive one.

The general principle which needs to be recognised is that a given total measurement budget can be spent in many different ways, and for any given budget, one should seek the most effective set of measurements which may be feasible for such a total cost. The contribution of the measurements to progress in the direction of the breeding goal is the criterion which should be used in the optimisation of the measurement procedure. Once the most efficient process has been found for a given budget, one may ask whether a larger or a smaller budget would be advantageous. But the optimum performance recording budget can be determined only when the budget is in fact spent in the optimal fashion. This involves the choice of which measurements are to be taken and on which animals these measurements are to be made.

3.0 Accuracy

It should be remembered when assessing a performance recording system that what we have are not actually performances, but records of measurements of performance. Thus there will be errors in our records, because of the precision of our measuring instruments, the accuracy of the procedure in which the instruments are employed, and the extent to which transcription and other errors arise in the recording process. A system should be designed with these potential sources of error in mind, but an obsession with unnecessary precision can be counter-productive. We thus need to consider the relative importance of such factors for the planning of a performance recording system.

3.1 Precision of instruments

Other things being equal, we will usually prefer a precise measuring instrument to an imprecise one, but other things are seldom, if ever, equal. Nobody, I believe, would want to weigh beef cattle with scales which recorded weight to the nearest gram, because such precision of measurement would be seen as unnecessary, and scales which would weigh to this precision would be much more expensive than scales weighing to (say) the nearest kilogram, and the weighing process for such precise scales would no doubt be too complex. It is easy to recognise extreme cases where precision of measurement may be much too great or much too small, but we should have a general approach which will allow a suitable precision to be chosen.

If the unit of measurement for a continuous variable is denoted as U, values of the variable are rounded up or down by an amount depending on how far they are from the nearest scale point. It has been known for a long time that the effect of this is to increase the variance of measurements by an amount $U^2/12$, known as Sheppard's correction. If the variance of the measured performance is σ^2 then a part of this variance is the rounding error. The rounding error variance as a fraction of the total is $U^2/12\sigma^2$, and a sensible choice of the unit of measurement can be made on this basis. For example, if the fraction of the variance due to rounding is regarded as acceptable if it is no greater than one percent, the implication is that $U^2 \leq 0.12\sigma^2$ or $U \leq 0.35\sigma$. Thus for a trait with a coefficient of variation of 10% the unit of measurement should be no greater than 3.5% of the mean. Or, if we consider the weighing of cattle whose weights have a standard deviation of 30 kg, an acceptable unit of measurement by this criterion would be 10 kg. Of course it is open to anyone to choose what level of rounding error variance is acceptable, but in my opinion it is hard to argue for greater precision than about one-third of a standard deviation, although more precision may be acceptable if it can be achieved without further cost.

Such a conclusion is sometimes resisted by practical breeders, on the grounds that it may lead to failure to recognise genuine differences. However, a proper consideration shows that the overall effect of such differences must be negligible, as removal of the rounding error would increase the heritability by at most one percent. An increase of this order can hardly be regarded as of major significance.

3.2 Precision of measurement methods

As a rule, the total variance of measurement errors will be appreciably greater than that due to rounding errors. Though it has been shown above that rounding errors are unlikely to be a serious problem, other types of measurement error are not so easily disposed of. For instance, in the weighing of animals it is possible that unless precautions are taken variations in factors such as gut fill will contribute substantial amounts of variation, much more than will arise from rounding. We must therefore consider the effect of measurement errors on response to selection.

This can be done by looking at the correlation between estimated and true breeding value. For individual single-trait selection this is the square root of the heritability. If the fraction of the phenotypic variance which is due to measurement error is denoted by m, then the ratio of selection accuracies with and without measurement errors is $\sqrt{(1-m)}$ so that the loss of response due to measurement errors is approximately 0.5 m. The exact percentage losses of response for different percentages of variance due to measurement errors are shown below.

	Percentages					
Measurement error	0.1	01	2	5	10	20
Loss of response	0.05	0.50	1.01	2.53	5.13	10.56

The situation is different if selection is to be on a progeny test, since in this case the measurement errors are averaged over the progeny group. The accuracy of a progeny test based on n progeny is $\sqrt{[n/(n + a)]}$ where $a=(4-h^2)/h^2$. On substituting the values of h^2 with and without measurement error we find that the ratio of accuracies is $\sqrt{[1-m/\{1+(n-1)h^2/4\}]}$. Thus the fraction of response lost due to measurement error is approximately $0.5m/\{1+(n-1)h^2/4\}$. As expected, this is less than for individual selection, and becomes less important as heritability and family size increase. If we consider an index combining individual performance with the average of n relatives we find that the loss due to measurement errors in the case when relatives are half sibs is intermediate between the losses with individual selection and with progeny testing. This is not surprising since the combined index is a weighted average of the selection criteria in the other two cases. These points are illustrated in the following table.

These cases involve selection for a single trait, but in practice selection is commonly based on several traits. The general case obviously has too many parameters for a useful summary, but to illustrate the nature of the effects of having to consider more than one trait we may treat the case of individual selection on an index of two traits each of equal economic importance, with equal heritabilities and equal fractions of measurement error variance. The analysis of this case is straightforward, and the ratio of accuracies with and without measurement errors turns out to be $\sqrt{[1-m/(1+r_P)]}$ where r_P is the phenotypic correlation between the traits. In this case the loss of response due to measurement error is approximately $0.5m/(1+r_P)$. If the traits are positively correlated the effect is less than for a single trait, while if they are negatively correlated the effect will be greater than for a single trait. In this balanced case the genetic correlation does not matter. Percentage loss of response due to measurement error for a range of values of heritability, family size, and fraction of variance due to measurement error. Progeny test values in normal and combined selection values in *italics*.

m	h^2	n				
		5	10	20	50	100
0.01	0.1	0.46 *0.48*	0.41 *0.45*	0.34 *0.40*	0.22 *0.30*	0.14 *0.23*
	0.25	0.40 *0.46*	0.32 *0.42*	0.23 *0.36*	0.12 *0.29*	0.07 *0.25*
	0.5	0.33 *0.45*	0.24 *0.42*	0.15 *0.38*	0.07 *0.35*	0.04 *0.34*
0.02	0.1	0.91 *0.96*	0.82 *0.90*	0.68 *0.80*	0.45 *0.60*	0.29 *0.46*
	0.25	0.80 *0.92*	0.64 *0.83*	0.46 *0.72*	0.25 *0.58*	0.14 *0.51*
	0.5	0.67 *0.91*	0.47 *0.84*	0.30 *0.77*	0.14 *0.71*	0.07 *0.68*
0.05	0.1	2.30 *2.42*	2.06 *2.26*	1.71 *2.00*	1.13 *1.52*	0.72 *1.16*
	0.25	2.02 *2.31*	1.61 *2.10*	1.15 *1.83*	0.62 *1.48*	0.35 *1.29*
	0.5	1.68 *2.28*	1.18 *2.12*	0.74 *1.96*	0.35 *1.81*	0.19 *1.74*
0.1	0.1	4.65 *4.89*	4.17 *4.59*	3.45 *4.06*	2.27 *3.09*	1.45 *2.37*
	0.25	4.08 *4.69*	3.25 *4.26*	2.31 *3.71*	1.24 *3.03*	0.70 *2.64*
	0.5	3.39 *4.64*	2.38 *4.32*	1.49 *4.01*	0.70 *3.71*	0.37 *3.59*
0.2	0.1	9.55 *10.06*	8.53 *9.42*	7.03 *8.33*	4.60 *6.37*	2.92 *4.93*
	0.25	8.35 *9.65*	6.62 *8.79*	4.68 *7.71*	2.49 *6.37*	1.40 *5.66*
	0.5	6.91 *9.60*	4.82 *8.99*	3.01 *8.42*	1.41 *7.90*	0.75 *7.68*

If we are concerned not with the choice of breeding animals within a single population but with the choice between two or more populations, the importance of measurement errors will be reduced because their effects will be averaged across the samples from the populations to be compared. In a sense this is rather like the case of progeny testing.

We see that measurement errors have a greater effect when selection is based on individual measurements than when selection is based on family information, and that when multitrait selection is practised the effects of measurement errors in the traits may be greater or smaller than for a single trait. On the assumption that errors of measurement may contribute appreciably greater variance than does rounding we must pay more attention to obtaining measurements in a way which will avoid unnecessary errors.

An important source of measurement error in many situations is the sampling of performance for measurement. Some examples of sampling would be:

- measurement of lactation milk yield of cows by testing daily milk yield on a number of test days;
- measurement of fibre diameter of the fleece on a wool sample taken from the fleece;
- measurement of egg weight in chickens by weighing eggs laid during a specified period;
- measurement of carcase fat content by measurement of the fat thickness at a specific body site.

In such cases it is perhaps more appropriate to take these as correlated characters rather than as inaccurate measurements of the trait of interest. From this viewpoint we are concerned with the heritability of the measured trait and its genetic and phenotypic correlations with the target trait. This is different from the pure measurement error case, where it is assumed that the genetic correlation between the measured trait and the target trait is unity, whereas it is sensible to assume an imperfect genetic correlation between total carcase fat and fat thickness at a given point. In fact this example is so clear that the fat thickness measurement would normally be regarded as a correlated trait rather than a measurement on a sample of the total phenotype. Such characters are perhaps best regarded as indicator traits, included in the performance recording program not for their own sake but to help estimation of breeding values through their correlations.

3.3 Precision of recording methods

As stated above, the data available for analysis and decision-making are records of measurements, and errors may be introduced in the recording process. Such errors are difficult to assess because they are often difficult to quantify. Recording errors may be of several kinds. For example, a record of 254 kg may be mistakenly written as 245 kg. Such transcription errors are not uncommon, and may be quite undetectable, as would probably be true in the example unless all weights were taken to the nearest 5 kg. On the other hand a similar error of transcription resulting in a record of 524 kg is almost certain to be detected as an error, and one may even guess that it should be 254 kg, but the record would usually be discarded.

In the same way it may be that a measurement is correctly recorded but is ascribed to the wrong animal, either because the animal identity is wrongly entered at the time of recording, or because the measurement was entered in the wrong place on a prepared data entry form. Experience suggests that such errors are less likely when prepared data entry forms are available, if only because there are then fewer entries to be made, so that having prepared data forms is to be recommended where it is feasible.

Technology is now available to enable automatic data capture at the time of measurement. If animals have electronic identification and appropriate sensors are used, the identity and the measurement can be entered on an electronic data base without the need for transcription by people involved in the measurement process. When suitable systems have been developed they not only reduce the frequency of recording errors because electronic devices are less prone to error than are humans, the automatic recording frees the attention of those involved in the measurement procedure from the needs of recording and is likely to lead to better concentration on other aspects of the process, thus leading to even better accuracy. The problem is that the technology is not yet developed for many measurement procedures and cost may be very high, as for instance in the measurement of individual food intake in pigs. Further development of automated measuring and recording devices could aid significantly in the improvement of performance recording.

When information is based on an individual animal's own performance alone it does not matter for selection whether its pedigree is known or not. But when information on relatives is used in making selection decisions it clearly does matter that the pedigree records should be correct. It is also necessary to know pedigrees if attempts to avoid close inbreeding are made. We know that pedigrees are often in error, and as a result records on animals are wrongly combined when information on relatives is used to estimate breeding values. Many methods of varying accuracy are available for determination of parentage, but the current range of DNA markers certainly provide the best method for identifying the pedigrees of animals in a group. Unfortunately the costs of this technology are as yet too high for its use except in special circumstances. While its cost will no doubt decrease, it seems unlikely to play a major part in animal breeding in the short to medium term.

The importance of pedigree errors can be illustrated by considering their impact in progeny testing of sires, assuming that a fraction f of progeny are falsely attributed to a sire and are randomly drawn from the progeny of other sires. The accuracy of the estimated breeding value of a sire under such conditions as a fraction of the accuracy when there are no pedigree errors can be shown to be

$$(1 - f) / \sqrt{[1 - f (2n - 1 - nf) / (n + a)]}$$

where n is the total number of progeny attributed to the sire and $a=(4-h^2)/h^2$. As the "family" size becomes large this approaches unity because the number of true progeny is very large. The following small table shows the percentage losses in accuracy for a few cases.

Percentage loss of response in progeny testing due to pedigree errors

Percentage errors in pedigrees	Heritability	Family size (including errors) 10	20	50	75	100
1	0.1	0.81	0.67	0.45	0.35	0.29
	0.25	0.62	0.45	0.24	0.17	0.14
	0.5	0.45	0.28	0.13	0.09	0.07
2	0.1	1.62	1.35	0.90	0.71	0.58
	0.25	1.25	0.90	0.49	0.35	0.28
	0.5	0.90	0.57	0.27	0.19	0.14
5	0.1	4.09	3.43	2.32	1.82	1.50
	0.25	3.19	2.31	1.26	0.92	0.72
	0.5	2.30	1.47	0.70	0.49	0.38
10	0.1	8.30	7.04	4.83	3.83	3.18
	0.25	6.57	4.83	2.69	1.96	1.55
	0.5	4.82	3.12	1.51	1.06	0.81
20	0.1	17.07	14.79	10.56	8.53	7.16
	0.25	13.93	10.56	6.12	4.53	3.60
	0.5	10.56	7.05	3.53	2.49	1.93

For small family sizes and low heritabilities the loss of response is almost equal to the rate of pedigree errors, but as family size and heritability increase the loss of response declines. It may be noted that erroneous pedigrees are worse than missing pedigrees because they contaminate the information on a sire whereas missing pedigrees simply reduce the amount of correct information. The greater the use made of pedigree information in a breeding program the greater will be the impact of missing and erroneous pedigrees.

3.4 Need for correction factors

Performances of animals are of value to the breeder as guides to their breeding values, non-genetic sources of variation essentially making recognition of genetic differences more difficult. Thus if some environmental factors which affect performance can be identified, making allowance for the influence of these factors will increase the accuracy with which breeding value can be estimated. For example, the weaning weight of a lamb will be influenced by its age at weaning, by whether it was born as a single, twin, or higher order multiple birth, whether it was reared as a single lamb, twin etc., by the age of its dam and so on. When information on these factors is available, records can be adjusted to a standard condition, for example, a single-born, single-reared lamb born to a mature ewe and weaned at 90 days of age. Provided that appropriate correction factors are applied the variation due to these influences can be removed from the phenotypic variance resulting in a higher heritability and therefore more accurate estimate of breeding value.

Before such corrections can be made the data on the factors must be available. Thus in the example the date of birth of the lamb must be recorded, as must its birth and rearing types, and the age of its dam must be known. If these pieces of information are not routinely recorded, the question arises as to the value of this information, which can be expressed as the reduction in variance brought about by the corrections. We can illustrate the nature of the considerations by taking the case of type of rearing and age at weaning in the above example.

Let us suppose that there are only two classes of animals reared, singles and twins. Let the fractions of singles and twins in the population be (1-t) and t respectively, and let the difference in weaning weight between the two groups be D. The variance due to type of rearing is $t(1-t)D^2$ and as a fraction of the total phenotypic variance it is $t(1-t)D^2/\sigma^2$. Its importance thus depends on two factors: the relative magnitude of the effect D/σ, and the incidence of twin-reared animals in the population. If they are rare, then t(1-t) will be small and even a moderately large value of D/σ will not cause a significant loss of accuracy if correction is not made. On the other hand, if the incidence is intermediate, of the order of 20% to 80%, then correction is likely to make an appreciable improvement in the accuracy of estimated breeding values. The incidence of the different groups is then crucial in assessing the need for corrections of effects of this kind. The percentage loss of response when a binomial factor is not corrected for is illustrated in the following table.

Percentage loss of response when a binomial factor with an incidence t or 1-t and an effect D/σ as a fraction of the total variance (including its contribution) is not corrected for in individual selection.

Factor effect	Incidence of the factor						
	0.01	0.05	0.01	0.02	0.03	0.04	0.05
0.01	0.00	0.02	0.04	0.08	0.11	0.12	0.13
0.02	0.02	0.10	0.18	0.32	0.42	0.48	0.50
0.05	0.12	0.60	1.13	2.02	2.66	3.05	3.18
0.75	0.28	1.34	2.56	4.61	6.09	6.99	7.30
1.00	0.50	2.40	4.61	8.35	11.12	12.82	13.40

If we consider the correction for age, we can assume that the correction is done by regression, so that if g represents the rate of gain per day at weaning, A represents age at weaning, and M the mean age at weaning, then the correction to weaning weight is g(M - A). Sometimes corrections are made on a proportional basis so that heavier lambs have larger adjustments than light lambs, but the differences due to such alternative correction methods are too small to be important here. The variance removed by such corrections is $g^2\ \sigma_A^{\ 2}$, where $\sigma_A^{\ 2}$ is the variance in the population of age at weaning. As a fraction of the phenotypic variance this is $g^2\sigma_A^{\ 2}/\sigma^2$. A very simple assumption would be that the growth was approximately linear over the pre-weaning period, in which case the mean weaning weight W would be approximately gM. Then we would have $g^2\sigma_A^{\ 2}\ /\sigma^2 = C_A^{\ 2}/C_W^{\ 2}$ where C stands for the coefficient of variation. Thus the crucial factor in deciding whether variation in age is important is the coefficient of variation of age as a fraction of the coefficient of variation of weaning weight.

In this example, it is clear that if dates of birth and therefore ages at weaning are not very different, there is little point in recording dates of birth and making corrections for weaning age. In the same way if there is a factor which has a fairly large effect on the trait in which we are interested but which is of very rare occurrence, there will be little value in trying to correct for it as so few animals will be affected. If corrections do not appreciably reduce the average squared error they will not make an important contribution to increasing genetic progress.

3.5 Group identification

One potential source of variation which should always be taken into account is the occurrence of what may be called management groups, that is, groups of animals which are run together, treated in the same way and generally differentiated from other such groups. Management groups may sometimes differ very distinctly in performance from one another, or in some cases may differ very little, but experience shows that even when on *a priori* grounds there is little expectation of large group effects they nevertheless can occur. The only safe way to deal with such group effects is to assume that they may be large and to allow for them. This means that a group identification system is required, and should be planned in the design of the performance recording system. In particular it needs to be made clear to those managing the animals that animals in different groups should be regarded as different and records be kept of group formation. This is so even when different management is applied only for a limited period, with the animals being later combined into a single group. If the importance of group identification is not stressed it is likely that in such cases the previous difference in treatment will not be remembered when performance is being measured and recorded. Failure to identify such groups properly has been a serious problem in many performance recording systems.

The number of ways in which animals may be grouped is very large. A few examples of effects which should be taken into account are:
1. animals born in different seasons;
2. animals born outside the herd;
3. animals cared for by different farm workers:
4. animals which have been given different veterinary treatments from others;
5. animals which have been given special feeding for any purpose, such as pregnant females;
6. animals which have been weighed in groups on different days;
7. animals which have been mated by artificial insemination versus those mated naturally.

All of these factors and many more can in some circumstances greatly affect performance, while in some cases the effects may be negligible. It is usually impossible to be sure that the effect would be negligible, and so the animals ought to be identified as forming different groups.

4.0 Choice of animals

When performance is being measured and recorded there is a wide range in the extent to which it may be done, from the extremes of being applied to all animals in a population to none (though this would be relevant only if the animals were being measured for some other trait). For an effective and cost efficient performance recording system it is necessary that the recorded animals be chosen from those available in such a way as to serve the purposes for which the data are collected without unnecessary trouble and expense. To satisfy such criteria we must consider the purpose of recording, the section of the population to be recorded, how many animals should be recorded, and the returns from recording in relation to their costs.

4.1 Characterisation of a population

On occasions performance records will be required in order to obtain an indication of the average productivity of a population, whether that population is a breed, a strain within a breed or a particular herd or flock within a strain. Such a characterisation may be desired because there are a number of such populations and we want to consider making choices among them, or because the population is being used in an improvement program and we want to monitor changes in traits which are not being measured as part of the selection criteria for the breeding program. If the intent is then to assess the average quality of the population it is clearly important that the animals measured should be representative of the population, and therefore they should be chosen by a random process for that purpose.

Let us first suppose that we are concerned to characterise the mean breeding value of a population for a specific trait. How shall we choose which animals to record? Usually a population will not be a homogeneous group but will be divided into subgroups more or less equally related among themselves. In the simplest case where we have no other pedigree information we may know the sire of every animal available for measurement, but know no more about relationships among sires, or who the dams are. In this case we know that if we choose to measure a total of T animals such that each of s sires has n progeny measured, and T = sn, then the sampling variance of the estimated mean is given by

$$\sigma_S^2/s+\sigma_W^2/T=(n\sigma_S^2+\sigma_W^2)/T$$

where σ_S^2 is the variance between sire breeding values and σ_W^2 is the variance between performance records of progeny of the same sire. Thus for a given value of T the sampling variance is smallest when n is smallest, that is, when all available sires are equally represented among the progeny. If it is assumed that the cost of measurement is not affected by the sire of an animal it follows that all sires should be represented when T>s, if necessary by only one offspring. In fact the optimum is to have T sires with one offspring each.

Similar principles apply when the population has a more complex structure, such as being divided into herds, with sires being nested within herds and having half sib progeny. If σ_H^2 is the between herd variance component then the sampling variance of the estimated mean is given by

$$(sn\sigma_H^2+n\sigma_S^2+\sigma_W^2)/T$$

where now T=hsn and h is the number of herds sampled. Again it is clear that as many herds as possible should be sampled and as many sires per herd as possible should be taken if the total cost is determined by the number of animals. In this second case it is more likely that there will be extra costs associated with measuring animals from different herds, and a proper solution would involve using the expression above to compute the accuracy attainable for different sampling plans with the same total cost.

The picture presented above will be oversimplified in practice. For various reasons it may not be possible to sample equally from all subgroups, but this is not of major importance, and the general principles are easy to apply. A more difficult problem if we wish to compare different genetic groups is likely to be that the genetic groups are not kept in the same environments. It was stressed above that management groups should always be taken into account, and if different populations are kept entirely separately it follows that a proper comparison between them is impossible. Only when there is some comparison among animals of different genetic groups in the same management group can a meaningful estimate of genetic difference be made. For this purpose it may be possible to use a control group of animals in several management groups to provide an indirect comparison of genetic groups which do not themselves share the same management group.

For a simple illustration, suppose we have two strains of a particular breed, and have t management groups of each strain, none of which include animals of the other strain, but each of which contains n progeny of each of s sires of the strain, all ts sires of each strain being unrelated. Each management group also contains a set of m progeny of a single sire of a different strain produced by mating the sire, probably by artificial insemination, to a random sample of females of the strain in the management group. The records of animals in all management groups are then linked by the occurrence of the common or link sire. We assume that any heterosis occurring is the same for progeny of the link sire with dams of both of the strains to be compared, and that interaction of genotype and environment can be ignored. If these assumptions fail, then the use of indirect comparisons is not possible using this procedure. The problem of heterosis could be overcome if animals of a third pure strain were used instead of progeny of a sire from such a strain mated to dams of the two strains to be compared, but the problem of genotype - environment interaction cannot be solved without direct comparison in the same management group.

It can be shown that for this experimental design the variance of the difference between the estimates of the two strain means is

$$2\sigma_S^2[mn+(sn+m)\alpha]/tsnm$$

where σ_S^2 is the component of variance between sires (assumed the same in all strains) and α is the ratio of within sire to between sire variance. As would be intuitively expected, the variance is reduced as t increases if the same structure is used for every management group. Similarly, the precision of the comparison increases as the number of sires tested in each management group increases. It is likely that the number of groups and the number of sires per group would be limited, so an important question about the design of such a comparison is the number of progeny of the link sire which will give the greatest precision. This is easily seen to occur when half the progeny in each management group are from the link sire. This design problem is related to that considered by Miraei

Ashtiani and James (1991) but differs in that they were concerned with the average accuracy of comparisons among individual sires, whereas here comparison is of two genetic group means.

In practice it would very seldom be possible to use a design such as that outlined here, but the optima found for this simple case should provide useful guidelines which can be aimed for in more complex situations.

4.2 Monitoring

If we are primarily concerned with monitoring, the situation is similar to that described above in the sense that we are concerned to characterise a population, with the difference that the interest is not in making a choice between populations but to assess the mean value of the population which is being improved. For example, we may have decided that it will be possible to improve the growth rate of a population without increasing its feed conversion ratio by use of an index which does not depend on the measurement of feed consumption. However, it will be desirable to check on the validity of our prediction by periodic measuring of feed consumption in the population. The question to be decided is the manner in which such measurements ought to be made.

The primary problem when difficult measurements are to be made is that allowance must be made for possible environmental changes with time. Some type of genetic control is therefore necessary. It will be very rarely that an unselected control population will be available, and so other methods, such as the use of frozen semen from males born a number of years ago to produce offspring for comparison with progeny of the current breeding population will be necessary. There are several variants of this system which have been discussed by Smith (1977). All require that advance planning be done, and that the appropriate expertise is available to apply them. A somewhat simpler method to apply is the comparison of progeny of sires of different ages using field records (Smith, 1962). This approach depends on the existence of a sufficiently long record file, but otherwise is not very demanding. On the other hand, the accuracy is not very high, and its use for estimation of genetic change has limited value when the trait investigated is of major importance, but for a trait which is being monitored to check for gross changes it may be of real value. Of course, if a fully pedigreed population is involved and the data are available, it would be sensible to use a suitable BLUP analysis rather than the type of analysis considered by Smith before BLUP was a realistic option, but the precision depends on the data structure rather than the method of analysis, which can extract no more information than is in the data, though it may not extract all information which is present. Perhaps the use of a Bayesian analysis could be taken as not consistent with this statement, since Bayesian analysis depends on the introduction of prior information, but while this does add information it does not add information to the data itself. In this sense it is analogous to the assumption of a normal distribution for the data in conventional statistical analyses, which does allow extraction of more information from data than if we can assume only (say) that the data are symmetrically distributed, but not in a known form.

4.3 Candidates for selection

When performance recording is intended solely for the purpose of making genetic improvement, as distinct from being used as a general management tool, it follows that there is no reason to record performance on an animal unless it is a candidate for selection. Of course if one wishes to measure genetic progress or conduct a research program the situation is different, but from the point of view of making genetic progress, a performance record is of value only if it contributes to decisions as to which animals will be selected or what matings will be made. A measurement on an animal which will not be considered as a possible parent will make no difference to breeding program decisions and is therefore unnecessary. Thus animals which are culled as being unacceptable for some reason need not have performance records made. Similarly, an animal which has already been chosen as a breeding animal need have no further measurements made, since these will not affect whether it will be selected or not.

The principle enunciated above is oversimplified for application in modern breeding programs, especially those in which information on relatives is an important contributor to selection decisions. For example, if lambs which are extremely small at weaning are culled without being weighed then a progeny test of sires for yearling weight based on the weights of surviving lambs will be biased in favour of the sires whose lambs were culled, providing that the culling was dependent at least in part on genetic factors, and not solely on large environmental effects. A similar consideration will apply in other cases such as animal model BLUP evaluation where biased samples of relatives would be involved. With animal model BLUP the absence of information does not lead to bias provided that the information on which selection decisions is made is included in the analysis. Nevertheless, if the suggestion above that no further measurements be made on animals which have already been selected is accepted, then information on the traits which were not measured for that animal is not available for the assessment of its relatives. Thus when information from relatives is used in making selection decisions it is much more difficult to justify the failure to record performance on any animals, since all animals have some relatives, and therefore their performance could be relevant to the genetic improvement being made.

However, when selection is being made on individual performance, it is true that performance records are only of value when made on candidates for selection. Thus it is often possible to reduce costs through use of independent culling levels, when decisions are made progressively, and animals culled at any stage of the selection process need not be measured for further traits. This has long been recognised as an advantage of

independent culling level selection over index selection (e.g. Turner and Young, 1969) especially as in some cases the genetic improvement achievable through index selection may not be very much greater than that obtainable by shrewd use of independent culling. In principle this concept can be extended, so that at any stage of selection animals can be divided into three classes:
1. those which will definitely be culled;
2. those which will definitely be used for breeding;
3. those whose fate is still undecided.

Clearly animals in groups 1 and 2 need no further measurements, and performance recording can be concentrated on those animals for which a decision has yet to be reached. This approach has been investigated by Wade (1989) who found that there was in fact usually little to be gained by this division into three classes over what could be achieved by conventional independent culling. In effect the approach can be seen as a combination of independent culling and selection of extremes (Abplanalp, 1972). A similar problem was dealt with by James (1979) in considering optimum progeny group size for selecting among sires when prior information was available. He showed that depending on the relative importance of existing and future information, it might be best to obtain more progeny from sires whose current estimates of breeding value were intermediate and fewer progeny of sires with either high or low current estimated breeding values. The justification for this was similar to that in the case dealt with by Wade, namely that if a sire had a low EBV, or a high EBV, the probability that further information would greatly alter its chance of selection was low, and so it was not worthwhile to expend effort on improving the accuracy of its EBV, the effort being better spent on resolving differences among those sires with EBVs which were closer to the truncation point.

These are examples of the general principle that for genetic progress attention should be concentrated on making better selection decisions, and that information which does not contribute to that purpose is less valuable than possible alternative data which does.

4.4 Number of candidates to measure

When a given number of breeding animals is required to be chosen it is clear that the more candidates that are evaluated, the greater will be the selection differential achieved, though the increase in selection differential will follow a diminishing returns curve. For example the small table below shows how the selection differential changes as the ratio of number tested to number required increases.

Ratio	2	4	8	16	32
Selection Differential	0.7979	1.2711	1.6469	1.9678	2.2523

Clearly, as the amount of measurement doubles, the selection differential increases at a slower rate, and doubling the number measured leads to progressively smaller increments in the selection differential. It is then obvious that at some point the cost of measuring more animals will not be repaid by a corresponding increase in the value of genetic improvement made. Of course in practice there will usually be a limit on the number of animals available for measurement, and it may be that the point at which further measurement becomes unprofitable is at a greater number of animals than there are present, so that all available animals should be measured. It is particularly when measurements are very expensive that a restriction on measurement is likely to be desirable, for the obvious reason that it is then more difficult to recoup the expenditure in greater genetic gain.

When not all candidates are measured, there is an important point to be taken into account. It is always better to select an unmeasured animal than a measured animal which is below the average, because the EBV for an animal which is unmeasured is zero, as we have no information on it, whereas an animal whose performance is below average has a negative EBV (Smith, 1959). This means that unmeasured animals may still be candidates for selection, depending on the number of breeding animals needed and the number of animals measured. We need to distinguish between the concepts of candidates for selection and animals which are performance recorded.

4.5 Allocation between sexes

As the sexes are usually selected with different intensities and often play different roles in the production process the measurements made on males and females will commonly be different.

Even if the same traits are measured in both sexes it is possible that the heritabilities of the traits will differ between males and females, or that the genetic correlation between performances of males and females is less than unity. These factors are likely to mean that a different amount of testing in males and females is optimal. In principle we may look at the problem as follows. If H represents the breeding objective or overall genetic merit, the rate of genetic gain can be written as

$$R_H=\sigma_H[i_M r_{HI\,(M)} + i_F r_{HI\,(F)}]/[L_M+L_F]$$

where i is the standardised selection differential, r_{HI} is the correlation between breeding objective and selection criterion, and L is the generation length, with the subscript denoting the appropriate sex. We can approach the question of optimum use of performance testing by assuming that there is a total budget which is to be allocated. This budget can be spent to different extents on males and females and in each sex the allocation can be spread over different traits. This chosen allocation will result in a particular accuracy of selection for each sex, depending on the traits recorded, a particular selection differential which depends on the number of animals of that sex tested, and a particular generation length depending on the time scale over which recording is conducted. Upon inserting these values in the equation for genetic gain we find the response to be expected for that strategy. Other strategies can then be investigated and the one which gives the best response can be identified. In any particular case some sort of trial and error process is probably necessary, but some general ideas can be obtained by making some assumptions about the way in which the accuracy of estimation of breeding value depends on the amount of money spent. This has been done by Jackson *et al.,* (1986) and Wade and James (1996) with particular emphasis on the division of the total testing budget between the sexes.

4.6 Avoidance of recording

Even in a very simple situation, selection on performance records may be complicated. As an example consider selection on fleece weight in a sheep flock. Sheep must be shorn, the fleeces must be weighed, the weights must be recorded and then the best animals identified by comparison of the records. Then the selected animals must be separated from those to be culled. This process requires at least a temporary form of identification to be attached to every animal so that it can be associated with the performance record and the appropriate animal then chosen on the basis of the records. It also means that the animals must all be handled at least twice, once when the shearing is being done, and once when the sheep selected for breeding are being separated from those culled. In some circumstances this extra work will be unwelcome and may act as a disincentive to use performance measurements. It would be simpler if one could set a standard before the shearing began, and as each sheep's fleece weight was measured it could be compared with the standard and a decision could be made at once. This would eliminate the need for individual identification and for a second handling, though it would probably slow down the shearing and weighing somewhat. However, there would be a substantial saving. The difficulty would be in setting the standard, since the mean and standard deviation of fleece weight are not known in advance, because of large environmental differences between years. If the standard is set in advance it may be far too high or far too low. If the standard is set too high, then too few animals will be kept, and since the number required for breeding will be fixed, it will be necessary to make up the numbers from those culled, but this must of necessity be done at random, since there is no recorded information on which to base the choice. If the standard is set too low then too many animals will be kept, and their mean will be lower than if the correct number had been kept. Some can be discarded in order to reduce the number to that required, but again this must be done at random. The result in either case is that the mean of those kept for breeding will be lower than it would have been had the exactly correct standard been set.

Of course, the exactly correct standard can be set only after all the animals have been measured, but Tallis (1961) has shown that a culling standard can be set by sampling a small number of the animals and using the measurements to estimate the truncation point. He has also considered an alternative strategy of forming three groups, one of which consists of animals to be culled, one of animals to be kept, and a third intermediate group of animals to be kept in reserve as spares in case the group of animals to be kept turns out to be too small. Tallis gives an example where 60% of the animals measured are to be retained for breeding. If a sample of 75 animals is taken, the fleece weight of the 38th is used to set the standard for animals retained, all those with fleece weights between those of the 38^{th} and 52^{nd} are put in reserve, then the efficiency of the procedure is 97%. In doing these calculations he assumed that the sheep in the sample were tagged for later selection to avoid loss of efficiency. While the technique developed by Tallis may have limited application, it is well worth consideration when a minimal cost procedure is required. There are tables provided in Tallis (1961) so that calculations need not be made by the practitioner.

5.0 System design

So far we have considered a number of factors which are of importance in the development of a performance recording system. This background now enables us to look at the overall design of such a system. The design of a system should begin with the objective, since the system is intended to serve the purpose of the genetic improvement program. If the goal of the program is not clearly defined then a logical design of the measurement and recording system is not possible because there is no rational basis on which different designs can be compared.

In the case of a single breeding program such as might be controlled by a large breeding company the objective might be defined in simple economic terms as the maximisation of company profit over a certain time period, perhaps reduced to net present value. However, in other cases the goal will be to provide a service to many breeders whose objectives will not be identical, as is the case for many government-supported schemes, which aim to provide performance records for the use of many independent breeders, whose goals may differ appreciably. In such a case the provision of a service may be determined by the demand expressed by the breeders, perhaps expressed as a willingness to pay for the service. When there is a demand for performance records to the extent that their costs are willingly paid by their users, a government or commercial service can easily justify the provision of the information. Nevertheless, it will often be the case that in planning a service it will not be clear beyond doubt what will or will not be paid for ungrudgingly, and in the design stages any service provider will want to have some confidence that the system will have relevance to users' needs, and one important way of assessing this is to try to relate the information provided to the goal of a breeding program. Therefore, it will often be advisable to try to define breeding goals as the basis for design of a recording system.

5.1 Consideration of breeding goal

There have been several general discussions of defining breeding goals in recent years, and some of these have been mentioned earlier. This is not the place for a detailed discussion of how this should be done. There is evidence that the definition of the overall breeding value can be in error to some degree without greatly reducing the rate of genetic progress, although the errors may result in the redistribution of change across different characters (e.g. Smith 1983). The major problem is to ensure that all economically important characters are taken into account when the objective is defined, and are given the correct signs. It seems that a factor of two in the relative weights attached to different traits can be accommodated without serious loss of response in most situations. This is comforting when one is planning a performance recording system since it is likely that errors will be made, and also because in cases where the system has many users these users will wish to use different economic weights. The general procedure is first to consider a production system, and then to identify the inputs to the system and the outputs, where inputs include capital items and outputs include quality of product. It is important that all inputs and outputs should be identified, including those which are not formally traded. The unpaid work done by family members should be appropriately valued and included as an input, and products consumed by the farmer and family should also be valued and included as outputs. In some systems these components may be major parts of the input-output system and their omission could seriously distort the analysis.

The prices for inputs and for outputs must then be estimated, and these prices should logically be those which are expected to apply when the improved animals are incurring the costs or providing the returns. Unless there is good reason to expect the relative prices to change markedly in the future it is usually adequate to take an average of recent prices for this purpose. It is sometimes thought desirable to define a “biological” goal such as lean tissue feed conversion rate in meat animals, but there can seldom if ever be a real justification for this approach. To take lean tissue feed conversion rate as an example, it is assumed costs other than feed can be ignored, and that outputs other than lean tissue have no value, whereas they may have either positive or negative value. And certainly there will be other costs such as those for health care which will be relevant. It may be that variation in such other components is considered negligible in relation to variation in the chosen goal, but this assumption is not likely to be checked if the “biological” goal is preferred as a matter of principle. Whenever there are two or more inputs and two or more outputs (including quality) these must be reduced to a common unit of measure before they can be combined into an overall figure, and the simplest way to do this is in terms of money.

5.2 Alternative selection criteria

In the context of performance recording systems the point of having a breeding goal is to enable the comparison to be made of different combinations of selection criteria, while in the context of planning a breeding program the comparison of alternative selection criteria is done to enable the greatest progress to be made towards the goal. When a performance recording system is to serve a number of different breeding programs, those criteria which may be of value in one are not necessarily of value in another, and some compromises may need to be made.

As a first step the traits to be considered for recording should usually include all of the economically important traits, even if these may include characters which are regarded as too difficult for routine measurement, such as feed intake of grazing animals. If some important traits are excluded *a priori* there will never be a consideration of what their possible contribution to progress could be, and thus no chance to assess whether some effort to include such performance among selection criteria ought to be made. Naturally, in such a case it is probable that feed intake will quickly be eliminated from the list of criteria, but if it is thought about initially it is at least possible to assess what loss is incurred by not measuring it, and to investigate the extent to which other characters can be used to provide some of the information lost by ignoring it.

As a general rule, when considering criteria for selection, we should begin by being willing to evaluate any trait for which an argument can be advanced to support its use as an aid to selection. Type or conformation traits may be in this category, if they can be shown to lead to better estimation of overall breeding value, even if they are of no intrinsic value (though in some cases they may have value because of subjective preferences). However, while we should start by being willing to investigate the potential of any trait, we should also be willing to discard any trait which has been demonstrated to make a negligible contribution to the accuracy of genetic evaluation.

5.3 Prediction of change

As was pointed out previously, the rate of genetic improvement is proportional to the accuracy of estimation of breeding value, measured as the correlation between the true and estimated breeding values. Thus in order to predict response it is necessary to be able to calculate this correlation. Given that a breeding goal has been defined, the correlation can be calculated based on the parameters of the traits in the objective and the traits used as criteria for estimation of breeding value. The variance of overall merit can be computed as a'Ga where a is the vector of economic weights and G is the matrix of genetic variances and covariances among the traits in the objective. The variance of a genetic evaluation is b'Pb where b is the vector of coefficients for traits used to estimate breeding value and P is the matrix of (phenotypic) variances and covariances of criteria, which may include records on relatives, in which case some of the phenotypic covariances may be fractions of genetic covariances. The covariance of true and estimated breeding values is a'Qb where Q is the matrix of (genetic) covariances between the traits in the objective and the evaluation criteria. Then the correlation is

$$a'Qb/\surd[(a'Ga)(b'Pb)]$$

Now since the vector b is the solution of

$$P\,b = Qa$$

we can replace b in the expression for the correlation and obtain

$$a'QP^{-1}\,Qa \;/\; \surd[(a'Ga)(a'Q'P^{-1}\,Qa)]$$

That is, in order to calculate the correlation we must know a, P, Q and G. Note that this is more information than is actually needed to predict breeding values, since G is not needed for this. Only genetic covariances between objective traits and evaluation criteria are necessary to compute EBVs, genetic variances and covariances of objective traits being needed only for the variance of overall merit. Since this is a constant and unaffected by the criteria used, we can ignore it. This is easily seen if we look at the genetic superiority of selected individuals for overall merit H based on selection on an index I where the genetic superiority is $ir_{IH}\,\sigma_H$ with i as the standardised selection differential so that in the above notation it becomes

$$i\surd(a'QP^{-1}Qa)=i_{\sigma I}$$

Thus to evaluate the relative merits of different sets of criteria it is not necessary that G be known though the actual values of r_{IH} cannot be calculated without this knowledge. So the minimum necessary knowledge is a, Q and P.

It may be objected that in some cases this data may not be available, and that therefore the suggestion that decisions require the data cannot be correct. This is not so. Decisions can be made without all these data, but they cannot be based on a rational comparison of the outcomes of using different sets of criteria, since it is then impossible to predict the outcomes. If the outcomes are unknown, they cannot be compared. If the data are not known, then some guesses must be made as to their values before the various sets of criteria can be evaluated. Such an exercise may be particularly useful in showing the importance of gathering parameter estimates for objective traits or evaluation criteria. This would be done by assuming what appear to be reasonable values for unknown parameters, perhaps taking upper and lower limits, and seeing what the contributions of the criteria are over the range of assumed values. If a criterion appears likely to be of little value regardless of the true parameter values, it can be dismissed and no further attention need be paid. However, if the criterion appears to be possibly useful for an apparently reasonable set of parameters, then there may well be good reason to recommend a program of research to obtain the necessary estimates.

Of course, in practice the parameters are never known, but more or less accurate estimates may be available. If the parameter estimates are somewhat imprecise it will be wise to consider a range of possible values in making assessments. It should also be remembered that errors in parameter estimates can lead to inconsistencies, and the possibility of inconsistency ought to be checked. Another point which should always be considered is that if a number of criteria are considered, the probability of obtaining an inconsistent set of estimated parameters increases as the number rises, and so does the chance of finding an apparently useful criterion when it is in fact not helpful.

The result of these calculations will be a set of predicted relative rates of response to selection based on a range of sets of criteria. These predicted responses are then used to determine the contributions which different criteria can make to genetic improvement.

5.4 Program costs

If all information were to be made freely available, then clearly the criteria which gave maximum response would be chosen for use. When information is already collected for other purposes its cost will be zero for use in breeding programs, and so the cost can be ignored in costing. Other data may be collected for the purpose of the breeding program but be used as aids in other management problems. In such cases the cost of the data collection and recording can be discounted for the value it contributes to other management before being added as a cost of breeding. The main point is that the marginal cost should be debited to the breeding program.

In an earlier section the costing of performance recording was discussed in a general way. Here we do not need to consider the details of costs of particular schemes, but to concentrate on the manner in which an approach to the cost of the system should be made. There will usually be a basic system of a fairly simple nature which can be used as a starting point. For example, in wool sheep it is possible by inspection to gain a rough idea of the amount and fineness of wool in the fleece. The accuracy of such subjective assessment depends on how good a judge is used, which is always hard to know, but studies have been made which show that some judges are fairly good, and an average value of accuracy can be established. In such a baseline the costs would be restricted to the mustering of the sheep, payment of the judge and any assistants required in the judging process. Decisions can be made as animals are inspected, and further mustering is not needed, so the overall costs can be low, especially if the judge is the breeder and the judging costs are simply part of the whole operation. A system like this is in fact widely used in practice, and can make useful genetic progress, though at a slower rate than achievable through objective measurement. When a breeder is introducing objective measurement therefore, the cost of measurements should be assessed against the cost of the alternative subjective assessment method. If it is decided to add the measurements to the existing program then the full costs of performance recording would be added to the breeder's costs. However, for a proper evaluation of the objective measurements they should be also treated as replacing the subjective judging process, thus resulting in the saving of any costs associated with it. One may wish to consider three cases: the traditional system, replacement by objective measurement, and combination of traditional and objective assessments. Strictly, this is the correct thing to do, as all possibilities should be taken into account. But for reasons not connected with such rational analysis there may be a necessity to include some practices in a breeding program if it is to have credibility in the marketplace. At the stage of introduction of new methods it may be necessary to treat them as additions to existing practices rather than as replacements for them, although replacement may be the best long-term option.

Essentially, what is required is an analysis of costs within the framework of the farming operation, with all changes which will be introduced by performance recording having their costs (or savings) carefully accounted for. This will be very difficult to do with great precision, but should be done as well as possible. It would be a serious mistake to set up a performance recording system based on an analysis of costs which was badly wrong and find that the system was unused because the costs were much greater than had been thought. One aspect which can easily be overlooked is the cost of providing advice to users who are unfamiliar with the practice of performance recording. In many countries there has been a tradition of government support for agricultural advisers, but this support is being reduced, and if the costs of such support are omitted because they are considered to be zero in a marginal sense (because the advisers are paid whether or not they give advice on the recording scheme) this may have an important influence on the total costing of the scheme. This is only one example of the way in which subsidies can affect breeding programs.

Many performance recording systems have been set up and operated quite successfully without preliminary costing having been established for a range of options. This has been possible because not all options have been considered, and because it has been clear that a system will be useful. The approach discussed here has been based on trying to find the best system, whereas it will often be fairly easy to find a system which is better than the current one, even though it may not be the best possible. Nevertheless, it will always be the case that we are comparing several contemplated systems, not all possible ones, and choosing among those under consideration. Perhaps the choice will be obvious without analysis in some situations, but even in these a demonstration of the superiority of the preferred option has much to recommend it.

5.5 Evaluation of benefits

It is generally much easier to evaluate the costs of a breeding program than the returns, despite some of the difficulties mentioned in the last section. This is because the costs are for things done by the breeder and can therefore be accounted for in a comparatively straightforward manner. Returns are dependent on many factors, some of which are very difficult to predict, and some of which are outside the control of the breeder, such as changes in consumer demand for products. It is difficult enough to predict accurately what genetic changes will take place following introduction of a specific selection program, given uncertainties in parameter estimates and problems of predicting response in the long term. Even if this can be done satisfactorily, it is hard to decide how much benefit will accrue to the breeder. It is commonly accepted that the major beneficiary of genetic improvement is the public, since if better and/or cheaper products are available competition will prevent the breeder from keeping the profits from this improvement, and eventually any excess profit level will return to normal. And yet experience seems to show that in at least some cases breeders do retain benefits from genetic progress for long periods. The enormous genetic improvement in the poultry meat industry over the past half century has led to a great expansion in the consumption of chicken meat, and this has benefited poultry breeders in an expanded market. And within the industry those firms with successful programs have expanded and many have disappeared, whether from weakness in genetics or business sense.

The results of competition are so difficult to predict because they depend not only what the breeder does but what others do, both in the same industry and in other industries. In that sense the value of genetic progress to a breeder may simply be the maintenance of his present competitive position. In view of these uncertainties we must regard all calculations of returns with a degree of scepticism. Yet if we are to make rational decisions we must make such calculations. A rather clear account of how this can be done has been given by Amer and Fox (1992). A detailed example using a different procedure can be seen in Ponzoni (1986). Whatever way of calculating returns is chosen, there will be a value of the returns, and this can then have the costs of achieving these returns subtracted to give the economic benefit of the program.

Choices can then be made among programs based on their relative economic benefits. A performance recording system can conceivably serve several different breeding programs, so the choice of such a system may depend on the range of breeding programs put in operation by users of the system.

6.0 Choice of potential systems

The principle has been enunciated here that the selection of a recording system ought to be rationally based, and that the decision should rest on a cost-benefit analysis of the problem. Some uncertainty is unavoidable in such situations, and it may seem that in the light of these the methodical approach outlined can hardly be justified. It must be recognised, however, that the establishment of performance recording will have value only if it is put to proper use after it has been introduced, and this will normally involve its use for several years before its operation can be reviewed. There will thus be substantial costs incurred when a system is set up, and only if there is evidence that these costs can be recouped can an argument be advanced in favour of the initiation of the system.

This should not be interpreted to mean that every such scheme will need an independent complete analysis. There may be prior experience in a similar situation which can be taken as support for introduction of a similar scheme, perhaps with modifications to adapt it to the particular circumstances. Provided that the existing scheme is known to be worthwhile, it may be rather easy to justify starting a similar scheme, without going through all of the steps mentioned. The result may then be a good scheme, perhaps not the best, but one which will clearly improve on the current situation.

However, if a scheme is being considered it will always be advisable that the questions raised in the previous discussion be brought out into the open and considered. Even if it is then decided to adopt a “ready to wear” system the possible weaknesses of such a system will have been brought to our attention, and the way will have been cleared for the introduction of modifications at a later stage. There will also have been calculations made which will be helpful in demonstrating the value of the scheme to users and backers. The comparatively small amount of effort (in relation to the work of setting up a system) will be amply repaid.

7.0 Implementation strategies

A performance recording system can be organised on many levels:
1. it may be run by a government agency;
2. it may be run by an industry body (e.g. breed association);
3. it may be privately run (e.g. breeding company, individual breeder).

There may or not be an option to choose among these options in any particular case. Often the possibility of establishing a scheme is seen by a group at one of these levels, and the organisation of the scheme will be left to be carried out at that level if it is done at all. However, at any time there may be the chance to make such a choice or to make a change in organisation of an operational scheme. It is therefore important to consider the properties of all such types of system.

7.1 Government schemes

Many performance recording systems have been run by government agencies (including universities and other research groups as well as government agriculture departments in this class) because employees of these agencies have seen the need for such a scheme and have had the necessary expertise to conduct an analysis of the possibilities and devise methods of running performance recording. Schemes of this kind have generally been motivated by a desire to increase the value of animal production for the public benefit, whether the public has been seen primarily as the general consumer or the animal production section of the economy.

Such a scheme will usually have good technical quality, and will address what are seen by the agency as the important issues for improvement. The direct costs of such a system to the breeder may well be reduced because much of the input in operation of the scheme is paid from general funds. There will often be indirect subsidy also from research programs carried out to estimate parameters or design better selection programs which are not funded by the industry. Since the agency will have no direct stake in the results of the program the system will have a built-in lack of perceived bias.

Despite the high technical quality of such schemes they often have drawbacks. In the first place they are not seen as being “owned” by their users but as being imposed on them. Secondly they may turn out to be rather inflexible, since once a scheme is in place it may be bureaucratically difficult to alter it, though this difficulty may be faced in other situations. A third problem which has been noticeable in recent times is the financial problem raised by governments which are cutting spending. A scheme run by a government agency or a university which has even temporary money troubles may be in danger of closing down.

7.2 Industry schemes

Schemes run on a breed or an industry basis share many of the properties of a government scheme and may indeed be closely associated with a government agency, in the sense that perhaps the industry funds a great deal of the program, but the system is managed by government employees who perhaps use the data collected as research material. However, it is also possible that the industry retains complete control of the management of the scheme, employs the experts who manage the system and perhaps may fund research in outside bodies, or more rarely conduct it in-house. If the industry scheme is large enough, it will be possible to employ highly skilled staff and the scheme can be designed to meet the needs or desires of the industry. In this case there is unlikely to be great concern about the “ownership” of the scheme, and breeders are likely to have direct input to the decisions regarding the structure of the scheme, and this ought to make it easier to iron out problems which are discovered over time. On the other hand, when consensus must be reached and there are very different opinions held by breeders, the reaching of consensus may become virtually impossible and breeders may feel that they have been locked in to a scheme with which they are dissatisfied. When a scheme is run by a breed association it may not be trusted by others since it may be seen as a part of the promotion program of the association. But this need not prevent it serving its members well, if there is no perception that it is designed to serve the interests of some breeders more than others.

An industry controlled system is not likely to be suddenly discontinued because of decisions made for reasons unconnected with the worth of the system and therefore may be more secure than a government agency system. Provided it has a large enough base of users it can support a group of professional officers to run the scheme and contract out research to improve it. This is then a particularly valuable option when individual breeders cannot design and implement a scheme without support.

Another virtue of an industry or government scheme is that data collected from different breeders' populations can be combined and there may be then the possibility of across flock or herd genetic comparisons.

7.3 Individual breeders

For a large breeding company the establishment of a performance recording scheme for its own use will be straightforward and essential. The technical staff will have the necessary expertise to develop an appropriate breeding program and the measurement procedures on which it is based. For an individual breeder the situation is likely to be more difficult unless the measurements are few and simple. Even the basic statistical methods employed may be unfamiliar, and some assistance with technical problems is likely to be required. Often such assistance can be provided by a government extension service or by an agricultural management adviser. This will be especially the case when the breeder wishes to use a system which resembles those used by other breeders, because there is likely to be an "off the shelf" solution known to the adviser. In the past it has generally been possible, at least in many countries, for a breeder to acquire such assistance free or for nominal cost, and indeed the cost of learning to set up a simple system should not be high.

8.0 Data processing and analysis

The amount of data collected and the complexity of the analyses to which it is subjected can vary over a very wide range, from essentially no processing or analysis to the establishment of a national database and the analysis of the data with extremely complex statistical models. Beyond specifying that the scale of data processing should be appropriate to the application it is not possible to make general statements. Nevertheless there are some points which can usefully be discussed.

8.1 Simple analyses

At the simplest level where selection decisions are made immediately after performance has been measured and there is no further use for the data no permanent storage of records may be needed, as in the example of the technique proposed by Tallis (1961). This is an extreme case and nearly all applications will call for some data storage and some form of adjustment of raw data. This can be as simple as writing data in special books and then using a small calculator to make adjustments for effects such as age of dam or age at weaning. In these cases it will usually be best to have a set of standard corrections to apply, rather than estimating them from the data, although the standard values may be only roughly appropriate in a particular herd or flock. As emphasised previously, if there are different management groups there is no alternative to estimating their effects from the data, but this may mean no more than summing values and dividing by the number of animals to obtain the mean which can then be subtracted from each individual record. While these are simple operations they do introduce many opportunities for errors to be introduced, and if data processing is to have this form there is a strong reason to make only those calculations which are absolutely necessary.

With the increase of availability of computing power at low prices, there is now much greater likelihood that a simple analysis will be carried out by computer. For simple problems this can usually be done using a spreadsheet or a database program supplied with the basic operating software of the computer. Even a very simple spreadsheet program, some of which are freely available, can easily be used to make standard corrections, calculate means and deviations from means without requiring much expertise in computing. Such spreadsheet programs also include sorting facilities and it is then possible to sort the animal records in the order desired to make the job of locating the best animals simpler. At a slightly more complex level, it is possible to estimate regression corrections with a spreadsheet as well as use the simpler types of correction mentioned above. The advantage of a spreadsheet or a database program over a dedicated performance recording program written in (say) FORTRAN or C^{++} is that when a computer is in use on a farm it will generally be used for management with spreadsheets and/or databases so that the user will be familiar with these programs and will feel at home using them for other applications. Even users with no special computing skills often learn to develop such applications relatively easily. Should the development of a performance recording spreadsheet application be beyond the capability of the end user there are many people competent to set up a spreadsheet when given the specifications. Modification of a spreadsheet application should also be simple if changes are later introduced. Similar remarks apply to database programs but spreadsheets seem to be more commonly in use.

For the reasons given above it seems sensible to consider first when a simple performance recording system is being established whether a spreadsheet can be set up to handle the calculations. If not, then a special program will need to be developed. The actual calculations will form probably the easiest part of the program to construct, with most of the effort being devoted to ensuring that data input is simple for the user, that checks for obvious errors are included, and that the output is easily interpreted. An advantage of such a system is that it can be precisely tailored to the application and thus be more efficient in terms of time and space usage than a general spreadsheet, and can have its interface constructed to simplify interaction between user and computer. However, writing such a program calls for a much more highly skilled programmer, and will be correspondingly much more expensive to produce. The production of a custom-built performance recording program rather than use of a spreadsheet is then justifiable only when it will be widely used. It would certainly not be likely to be customised for each user, though it may be written in such a way that a number of options are available.

One advantage of a pre-compiled program is that unlike a spreadsheet it cannot be altered by the user and thus cannot have new bugs (those not inadvertently put there by the programmer) introduced by the user, and thus should be more stable and provide for easier troubleshooting when this becomes necessary.

8.2 Complex analyses

When complex analyses are to be done as part of the performance recording system, there seems no alternative to the use of specially written dedicated computer programs. Such programs may be highly specific, resident on a mainframe computer, and run centrally by a group who also monitor the data input and maintain the database on which the program relies for its operation. This is the approach taken by many national dairy cattle breeding programs throughout the world. Because the data which is needed for genetic evaluation is spread over many herds and the selection decisions (choice of proven sires) is not made by the people who actually record the data which is used to make the decisions, a central facility is needed to collect and combine the data, which is voluminous and therefore has stringent storage requirements. In addition the processing of such data is computationally demanding. Despite the amazing increase in computing power in recent years it is still not feasible to provide the full amount of information which is often desired, such as multitrait BLUP evaluations with their accuracies.

An alternative approach is the use of a fairly general program such as PEST (Groeneveld, Kovac and Wang 1990) which incorporates the capacity to carry out very complex analyses, but is flexible in the sense that it is not dedicated to a particular problem. For smaller scale systems use of such a program is to be preferred to development *de novo* unless there are good reasons for a new development (problems not covered by the available packages, wish to produce and market a new program with new features,...) because a program which has already been widely used will have a number of bugs already located and fixed, and there will also be a pool of expertise available through existing users of the program if difficulties arise. The writing, documentation and maintenance of such a computer program is a major effort and such effort may be much better invested in other ways of improving the breeding program.

Though large scale systems have important advantages they also have some significant weaknesses. In particular, quality control of data is much harder to guarantee when the data is collected by many different people under very different conditions. Experience shows that such matters as definition of management groups can be seriously mishandled, that measurement processes can be misunderstood and escape detection more easily that when a scheme is controlled by one unit. In large schemes too the opportunity may arise for some members of the system to exploit others by falsification of data, and although such fraud will probably be discovered in the medium term it can do harm in the short term. Incorporation of automatic data snooping routines in the processing program can help to locate suspect items, but positive identification of fraud is very difficult. Innocent errors may be just as serious as fraud and may be even harder to discover because no pattern is discernible.

9.0 Models

It is becoming increasingly common for the estimation of breeding values to be based on animal model BLUP, using multitrait models where feasible and single trait models otherwise. These methods are known to give the most accurate estimates of breeding values when the data are analysed using models appropriate for the data. Selection based on such EBVs may not give the greatest response in the long term and it is not at present generally agreed how the breeder should cope with the conflict between genetic progress in the short and long terms. It has been suggested that the estimation of breeding values should be biased in order to get a trade-off between short and long term gains, but others feel that deliberate mis-estimation of breeding value can hardly be the best way to proceed. In principle the balance between short and long term response can be reached by discounting future gain to present value, and in a simple case this has been used to find an optimum selection intensity (James, 1972). One difficulty with using biased estimation of breeding value is that in general the production of breeding value estimates and the making of selection decisions are separate activities unless the recording scheme is run by a single breeder or company. For example, in a national dairy cattle breeding program selection decisions are made independently by many different people, and national evaluations are also used in other countries, so that deliberate introduction of bias may have many undesirable consequences. Of course, if the bias is known then it can be allowed for.

More likely is the unintentional introduction of bias through the use of a model which is wrong in one or more of its assumptions or parameter values. Thus if a trait is affected by maternal effects but these are not included in the model used for estimation there will be biases in the estimated breeding values for direct genetic effects. Nevertheless it will usually be desirable to keep a model relatively simple, even at the risk of introduction of some bias. If the effects omitted from the model do not have large effects the estimates of these effects may have standard errors of comparable magnitude to the effects and the random errors introduced by the erroneous adjustments may cancel out the increase in accuracy obtained by removal of the bias. For example, the effect of age at weaning on weaning weight often varies between management groups, and so it would seem sensible to estimate the correction separately for each group. However, if the groups are small, and especially in groups with small ranges in age, the regression estimates will have substantial standard errors. Large deviations from the average regression may then be mainly caused by sampling error. The larger the apparent discrepancy from the average regression, the less attention should be paid to it when the discrepancies are due to sampling. But these are precisely the cases in which the effect of estimating the regression will appear to make the biggest improvement. This is analogous to the situation in fitting a linear model when the null hypothesis is true. Making adjustment for any estimated effect will then introduce only random error. But the corrections which appear to be most significant and to make the biggest improvement in accuracy are those which introduce the most error. It is more complicated when some of the effects do have an effect and some do not, but there are difficulties in using too complex a model.

Animal model BLUP is known to perform well when all pedigrees are known and trace back to the base population, when all data used to make selection decisions are available and used in the analysis, when the correct model is fitted to the data and when all parameters are known without error. These conditions will never apply exactly in practice, but this is not an argument against the use of such analyses, rather it is an argument for not placing blind trust in the results of the analyses.

10.0 Conclusion

In this document I have tried to outline the main factors to be taken into account in the design of a performance recording system, with particular emphasis on the statistical and quantitative genetic implications of the data collection and data analysis. In the design of any particular system there will be many highly specific matters to be taken into account, from the nature of individual identification methods to the detailed model of analysis of the data. In fact much of the hard work of planning a scheme is associated with these “nuts and bolts” questions, and with the difficult social interactions often necessary to arrange acceptance by breeders and producers of a proposed system. These hard details should not, however, be allowed to obscure the need to consider the general questions which have been considered in this document. If these questions are not considered it is possible that all the hard work done to organise the system and its acceptance will result in a flawed program which could have delivered much greater rewards for all of that work.

11.0 Acknowledgements

Some of the work on this document was done while on leave from the University of New South Wales to which I am grateful for the grant of leave. Prof.W.G.Hill kindly provided facilities at ICAPB for which I thank him.

A few specific computer programs have been mentioned in this document. I believe these to be excellent programs, but do not imply that other programs not mentioned are not also excellent.

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Guidelines for Development of Performance Recording in Low-to-Medium Input Production Systems - A Perspective

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Two thirds of the world livestock population are in developing countries where the great bulk of animal products is from low-to-medium input production systems. Such systems range from animal based pastoral systems to mixed farming and landless systems. Animals or systems recording is a prerequisite for any serious effort to develop animal production at the farm or the industry level. However, such a recording is not common in developing countries and where this has been attempted, frequently high-input system technology has been inappropriately employed. In the desire to achieve food security in many of these areas, development of a range of adapted animal genetic resources will be essential. This will commonly involve the use of appropriate recording and breeding strategies for these medium input systems.

Developing an animal recording system in general and in low-to-medium input animal production systems in particular is a challenging task for it has to take into consideration a wide range of basic factors like what records to take to achieve what objective, the socio-economic situation, the structure of the livestock industry etc. FAO is attempting helping all concerned to develop sustainable recording systems in a range of production environments. FAO plan is to establish Guidelines for the development of performance recording in medium input production environments. In relation to the FAO Global Strategy for the Management of Farm Animal Genetic Resources, These Guidelines represent one segment of the Primary Guidelines for country use for each livestock species. The document: Primary Guidelines Document for development of National Farm Animal Genetic Resources Management Plans can be viewed on the Domestic Animal Diversity Information System (DAD-IS):
(URL http://www.fao.org/dad-is/).

Another segment of this activity will concern breeding strategies per se and will utilise aspects of this performance recording activity.

In taking this comprehensive approach it is accepted that all breed development must be based on one or more visually observed and/or measured traits of interest; and that the logistics of doing this and the technologies applied can be complex over time and are often poorly considered and maintained. There is now a great deal of experience in the development of performance recording systems for high-input production environments and that is why the main emphasis in the development of these guidelines should be low to medium input systems, perhaps emphasising the medium in the first instance. Further, it is recognised that until now the development of performance recording systems has been somewhat of an art, at which technicians are often poorly equipped. It is also accepted that irrespective of the situation (developed or developing country, high or low input, etc.), for performance recording systems to produce (maximum) useful information in making the desired management and breeding decisions, at minimum cost of time and money, and for these systems to have continuity, good principles of experimental design and proper use of relevant technology, must be integrated with livestock system structural, input and output variables, and with the capabilities and social aspects of the human resource. This is often taken for granted but it serves to highlight the issues and level of complexity which need to be considered in arriving at useful guidelines.

The approach to reach the goals of this activity was : i. The documentation of a range of case of studies of actually functioning recording systems in a range of production environments (emphasising low-to-medium). These case studies are published among country presentation in these Proceedings (Part II); ii. Preparation of four seminal by world authorities on the subject to delineate the topic and develop a knowledge-base of principles. These seminal papers are presented in this Part; and iii. Collaborate with international (International Committee for Animal Recording, ICAR) and national (Indian National Dairy Development Board ,NDDB) to organise a meeting with participation from mainly developing countries to discuss country and general presentations and the seminal papers to arrive at useful conclusions/recommendations..

FAO had also a consultant to participate in the Workshop and prepare the Guidelines on Animal Recording.

Part V
Annexes

Annex 1: Procedures for Reaching Recommendations

The format for the Workshop was such that there were sessions for presentations and country reports and others to discuss special substantive issues related to animal recording in medium input production systems in all ruminants and for all products. In the latter, specific agreed upon questions were addressed in three fixed subgroups over three consecutive rounds in two days. Conclusions arrived at in each round were discussed in plenaries where they were discussed and finalised. These conclusions served as a basis for reaching the nine main Recommendations addressed to ICAR, FAO and national official bodies reported on following pages of these Proceedings. Questions addressed by each round and conclusions reached regarding them are shown below.

1. Round I

1.1 Questions

1. How to form the recording system on goals that provide the maximum management benefits, both short and long term to farmers?
2. Should service provision be integrated across recording, breeding, veterinary service and extension service?

1.2 Summary of discussion

1. An animal recording system should be for:
    - Monitoring of performance
    - Genetic improvement of animals
    - Understanding constraints
    - Providing decision support
    - Making culling decisions
2. A recording system must provide direct benefit to farmers.
3. A recording system should increase the value of recorded animals.
4. It is necessary to define needs of farmers, planners and policy makers in designing an animal recording programme.
5. A recording system should be simple in operation.
6. A recording system must define the traits that are to be considered for improvement.
7. It is desirable to integrate extension, breeding, feeding and animal health care into a single recording system.
8. It would be better if a single organisation provides all recording, extension, breeding, feeding and animal health care services.
9. The recording system should identify the animal characteristics that are important to the farmer as the productivity of their animals increases. These traits should then be added to the recording system.

2. Round II

2.1 Questions

1. How to overcome the difficulties of establishing and sustaining a recording scheme (Dairy, beef, sheep, goats)?
2. How to identify animals in recording schemes and how to do performance evaluations in small herds?

2.2 Summary of discussion

Overcoming the difficulties of establishing:

1. Obtaining support of the farmers through meetings and possible incentives.
2. Initiating a small pilot project.
3. Effective use of extension services.
4. Minimising initial direct costs to the farmer.
5. Identification of local institution to co-ordinate a programme is necessary for its success.
6. Networks of other local recording schemes may evolve later.
7. Obtaining adequate funds from the government or external sources is necessary to initiate the recording system and possibly to provide a part of the costs of operation for an agreed period. Subsequently, the running costs could be paid proportionately by the beneficiaries which could probably include the farmer.

2.3 Overcoming the difficulties of sustaining

Ensure long term funding by:

1. Obtaining firm financial commitment from all beneficiaries.
2. Farmers' organisations should be responsible for obtaining payment by participating farmers.

2.4 Identification of animals

A number of acceptable methods of animal identification were mentioned including:

- ear tags
- ear notching
- neck chains
- hot branding
- cold branding

It was agreed that each animal's number must be unique within the recorded population. However, it was agreed that in very small herds where the individuals have names, the animals may not be marked with their identification numbers, but their recording will include both names and their unique number.

3. Round III

3.1 Questions

1. What proportion of costs should be paid by the government and by the farmers at the start and subsequently?
2. How to encourage farmers' participation in recording schemes by providing information? What information should be provided to the small farmers?

3.2 Summary of discussion

The government and/or external sources should pay a very high proportion of the costs of establishing the infrastructure of the scheme and of its initiation.

The use of extension personnel in recording is often desirable and may be cost effective, but the percentage of their time allotted to this purpose must be the subject of a long term agreement.

Beneficiaries of recording programmes may include: farmers; planners and policy makers; livestock product industries, and consumables. The cost of recording schemes should be born proportionately by the beneficiaries once the scheme is established.

Those who contribute data to a recording scheme should receive information for decision making and planning from the scheme in a timely manner and in a form that is useful to the recipient.

Assistance in the interpretation will probably be an essential part of the duties of recorders and extension workers who should receive training for this duty.

The analysed and interpreted results provided to the farmer must permit and assist in improving productivity by appropriate changes in management recommended by the action lists and analysed results.

Providing farmers with comparative information on performance of their animals relative to others in the area may be a powerful tool to motivate farmers to adopt changes in management practises recommended by analysed and interpreted feedback from the recording scheme.

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Animal recording in medium input-animal production systems, is a challenging task as it has to take into consideration a wide range of basic factors, such as what records to use to achieve what objectives, the socio-economic context, the structure of the livestock sector etc. The International Committee for Animal Recording's (ICAR) main concern, is the progressing of animal recording world-wide on solid scientific and technical basis and in collaboration with other interested organisations. Since 1994, ICAR has established a Development Fund Task Force to lend support to sustainable recording systems in developing countries. The Food and Agriculture Organisation of the United Nations (FAO) sustains this initiative within its mandate of assisting countries in developing and better managing their genetic resources; this requires appropriate recording systems in a range of production environments.

ICAR and FAO, along with India's National Dairy Development Board (NDDB), collaborated to organise this Workshop held at Anand, India. The Workshop, attended by experts from 25 countries and organisations, was an appropriate and timely platform for discussing issues related to animal recording with special reference to medium-input production systems.

These Proceedings include national experiences in the form of country reports, seminal papers dealing with basic aspects of recording and recommendations addressed to different international and national bodies.

The proceedings of the workshop will be a most useful document for policy makers and people engaged in the implementation of animal recording programmes in developing countries.