Buffalo breeding programmes in India

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Introduction

The major objective of this paper is to describe the genetic improvement programmes implemented by the National Dairy Development Board (NDDB) in buffaloes in six districts in Gujarat and outline the experiences gained in designing, running and sustaining breeding programmes that are relevant to developing breeding strategies in low to medium input production environments in developing countries.

The NDDB has initiated a comprehensive programme of milk recording and genetic improvement of animals referred to as 'Dairy Herd Improvement Programme Actions (DIPA)' in a few selected districts where the infrastructure of artificial insemination has been well established. The first DIPA programme was started in 1987 by the Mehsana District Cooperative Milk Producers' Union in the Mehsana district for selective breeding of Mehsana buffaloes. Later, in 1989 the Kheda District Cooperative Milk Producers' Union initiated a DIPA programme in the Kheda district for up-grading of local non-descript buffaloes with Murrah bulls. In 1992 another four cooperative unions namely the Sabarkantha District Cooperative Milk Producers' Union, Baroda District Cooperative Union, Panchmahals District Cooperative Unions and Surat Cooperative Milk Producers' Union in collaboration with the Sabarmati Ashram Gaushala (SAG) initiated a similar programme for up-grading the local non-descript buffaloes with Murrah buffalo bulls in their districts. These district milk cooperative institutions are farmer-owned organizations collecting, processing and marketing milk of their member producers. In 1998-99 these six cooperative unions together collected and processed on average 3.2 million litres of milk a day. These organizations also provided technical input services to their member producers, like artificial insemination, cattle feed, fodder seed and veterinary health care. DIPA programmes are integrated with the other services provided by the unions for enhancing milk production. Before details of the DIPA programmes are provided, it may be worthwhile to know about the buffalo populations that are intended to develop in these six districts.

Target population

All six districts have proportionately more buffaloes than cows (see Table 1). About two thirds of the total breedable animals are buffaloes. Buffalo milk production constitutes about 70 percent of the total milk produced in these districts.

In Gujarat, buffaloes are primarily kept for milk production, but they also provide meat. They are not used for draught power. They provide manure which forms an important source of organic matter to the soil increasing productivity of soil in a sustainable way. Dung is used as fuel for cooking and it constitutes the major fuel supply for many farmers in rural areas. Dung is also used for production of biogas which provides an alternative to fuel wood in rural areas. Buffaloes are considered to be more efficient converters of poor quality roughage than cattle.

Table 1. Number of buffaloes, milk production, AI coverage and DCSs under DIPA in six districts.

Particulars	Mehsana	Kheda	Sabar	Baroda	Panch	Surat
No. of villages	1 093	970	1 395	1 651	1 908	1 185
No. of households in '000	550	643	325	567	463	629
Breedable Females in '000:						
Buffaloes	362	413	261	20 2	231	140
Cows	113	102	112	111	177	98
Predominant Buffalo Breed	Mehsana	ND	ND	ND	ND	ND
Other		Surati	Mehsana			Surati
Milk prod.in '000 tons / year						
Buffalo	437	374	213	157	141	115
Cow	125	137	81	65	61	56
Total DCSs	984	985	1 556	884	1 107	917
DCSs under AI	435	863	313	420	550	448
DCSs under DIPA	33	50	30	35	30	40
% recorded buffalo population	4	6	3	2.5	2	3

DCS: Dairy Cooperative Society; ND: Non-descript buffaloes

More than 70 percent of households have animals. Farmers have one to five animals. Very few farmers will have more than five animals. Farmers in villages live near to each other in conglomeration, and hence, they learn from each other and often follow common management practices. Buffaloes are largely maintained on crop residues and agricultural by-products and supplemented with green fodder and concentrate. They are mainly looked after by women. The production systems followed could be categorised as low-to-medium input systems.

Breeds involved

The Mehsana district has predominantly Mehsana buffaloes, while the other five districts have non-descript buffaloes or non-descript buffaloes crossed with either the Murrah, Mehsana or Surati. A brief description of these breeds is given below.

Mehsana

The Mehsana breed arose from crosses between Surti and Murrah breeds. The home tract of this breed is the Mehsana district in Gujarat and they can also be found in the adjacent districts of Sabarkantha and Banaskantha. Mehsana buffaloes are also found in the Ahmedabad and Gandhinagar districts and in Bombay. These buffaloes are black in colour with white markings on the face or a white switch are not preferred. These are considered disqualification for the breed. Their horns are short and initially they assume a sickle shape similar to the Surati breed, but later turn upwards and form a curve similar to the Murrah buffaloes. Compared with the Murrah, the Mehsana has a longer body. Mehsana buffaloes have a reputation of being persistent milkers and regular calvers. Lactation yields of Mehsana buffaloes vary from 1 500–2 000 litres. Elite Mehsana buffaloes produce more than 3 000 litres in one lactation.

Murrah

The Murrah is the most popular breed in India. These buffaloes originate from the Rohtak, Hissar and Jind districts of Haryana and the Napha and Patiala districts of Punjab State in North India. The buffaloes have spread to many parts of the country for commercial production. Murrah bulls are extensively used for up-grading local non-descript buffaloes and have been used in many countries including Brazil, Bulgaria, China, Egypt, Italy, Malaysia, The Philippines and Thailand, etc. The average lactation yields of Murrah buffaloes in institutional herds have been reported to be between 1 500 and 2 000 litres. Some elite buffaloes in their native tract produce more than 3 000 litres.

Non-descript buffaloes in these districts are mostly crosses of the Mehsana, Murrah and Surati breeds. They produce between 1 000 to 1 500 litres in one lactation.

DIPA Programme

Need for initiation of DIPA programme

As seen in table 1, the cooperative unions have established village level dairy cooperative societies in more than 90 percent of the villages in their respective districts, except the Baroda and Panchmahals district cooperative unions which have covered about 60 percent and 70 percent of villages, respectively. These cooperatives unions collect more than 90 percent of the milk available for sale by farmers from the villages where village dairy cooperative societies have been established. These districts already have very large buffalo and cow populations. As each district in Gujarat has a dairy cooperative union, it is common understanding among unions that every dairy union will only collect milk from its own district. It was therefore imperative to each of these cooperative unions that unless they

plan to increase the productivity of buffaloes and cows in their district, they would not be able to expand their business. The DIPA programme in fact was initiated by these unions primarily to increase the productivity of cows and buffaloes in their district.

Breeding goals

Indian consumers prefer milk with high fat percentage. A number of milk products are made from milk. Milk and milk products are an essential part of the diet across regions, age and income groups and in rural and urban areas. A variety of sweets (with very high fat percentage) made from milk, are considered valued products and are widely consumed. The village level dairy cooperative societies pay the producers on the basis of volume or weight and fat content. These trends are likely to be continued and it is expected that milk with a high fat percentage will continue to be preferred by the Indian consumers for many years to come. High volume and high fat percent or high kilo fat production are therefore considered as the key goals for improving productivity of buffaloes.

Breeding plan design

The core breeding strategy adopted for the genetic improvement of buffaloes in all six districts is progeny testing of buffalo bulls involving farmers in selected villages. In the Mehsana districts, a straight-breeding strategy has been adopted to improve the Mehsana buffaloes of the district. In the Kheda district, a strategy of cross-breeding of local non-descript buffaloes with the Murrah breed has been implemented. Here the plan is to use Murrah bulls obtained from the Murrah breeding tract in Punjab and Haryana for two generations and then follow the strategy of straight-breeding in the resulting up-graded buffalo population as in the case of the Mehsana district. A similar breeding strategy has been planned in the third programme jointly implemented by the Sabarkantha, Baroda, Panchmahala and Surat milk unions and the SAG.

The core design adopted in all three programmes is depicted in figure 1. A set of ten to twenty bulls are tested every year. About 30-50 villages, each village having 200-300 breedable buffaloes, are selected for the programme in each district. This means, about 6 000 to 10 000 breedable buffaloes in each district or two to six percent of the total breedable buffaloes are selected for the programme. This population is referred to as the recorded population of the DIPA programme. At present, 40 percent of villages overall in the six districts have facilities for artificial insemination. This means about 0.65 million buffaloes constitute the target population which is intended to be improved through the DIPA programmes. The cooperative unions have planned to increase their AI service to about 70 percent of villages in the next five years. The base population therefore will increase to some one million buffaloes in another five years.

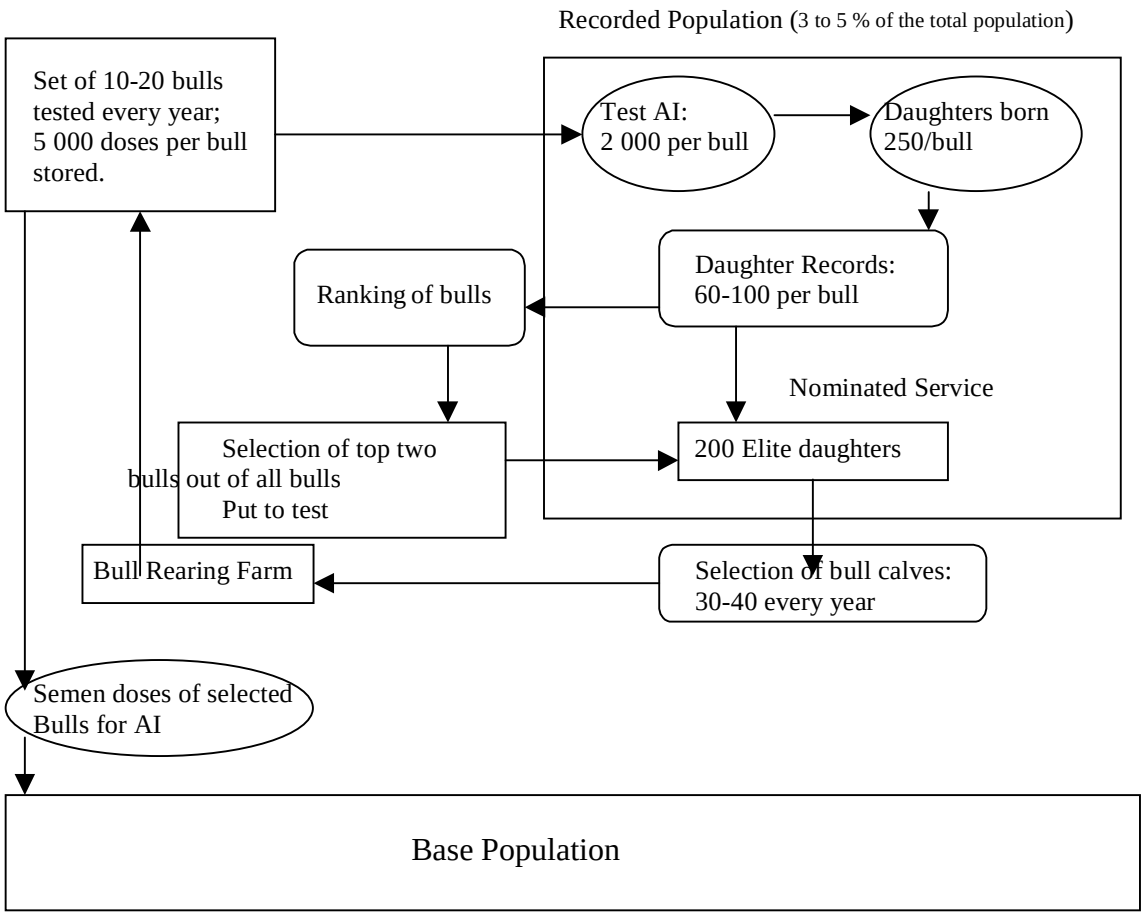

Figure 1. Breeding Plan of DIPA Programme.

Some 2 000 semen doses per bull are distributed in DIPA villages in a way that the number of daughters born to all bulls tested in each village across all DIPA villages would more or less be equal. To achieve this, a bull wise semen distribution schedule is prepared. Semen doses of all bulls tested are distributed each month. Each DIPA village gets semen doses from only one bull. Semen doses of different bulls are used in each DIPA village every month and it is ensured that within a year, the maximum of bulls tested are used in each DIPA village and across all DIPA villages. This ensures production of daughters of bulls tested in most villages and in all months. Apart from test doses, a minimum of 5 000 doses per bull are stored till progeny test results of bulls tested are available. The stored doses of some top bulls are later used for a nominated service to produce the next generation of bulls.

When any village is selected for a DIPA programme, all breedable buffaloes of that village are eartagged with a plastic eartag having an eight-digit number. All eartags are supplied by the NDDB to ensure that no number

is repeated. The last digit of an eight-digit number written on the eartag is a check digit derived from the other seven digits. While registering buffaloes under the programme, information on breed type, number of lactation completed, in milk or dry and age or date of birth is collected. When a registered buffalo is brought for insemination at the village society for insemination, it is inseminated with a semen dose from the semen doses of a particular bull supplied to that society for that month. If any buffalo has not been eartagged, it is eartagged at the society. At the time of insemination, information on date of insemination, number of service bull, batch number of semen dose and inseminator code is recorded. Pregnancy diagnosis is carried out once a month in every society by persons employed by the dairy cooperative union. At the time of pregnancy diagnosis, the code number of the person who carried out the pregnancy diagnosis and date and result of pregnancy diagnosis are recorded. When registered, buffalo calves, date of calving, sex of calf and any genetic defect observed are recorded. Every female calf born is eartagged.

Every female calf born under the programme is followed during growth. As an incentive to farmers participating in the programme, all farmers having a female calf born under the programme are given five bags of cattle feed (350 kgs feed) over a period of one and a half years. Cattle feed to farmer is supplied in five to ten instalments. At the time of supplying the next instalment of cattle feed, the weight of the calf is estimated by measuring length and heart girth by the visiting supervisor who decides, based on weight gain, whether the next instalment of cattle feed is to be supplied to the participating farmer. Apart from providing an incentive to farmers, the practice of feeding an equal amount of cattle feed to all calves born has reduced to some extent, management differences followed by different farmers and helped in identifying true genetic differences.

When daughters are in heat they are inseminated and three to four months later they are pregnancy-diagnosed and when they calve, their calving details are recorded. Each daughter born under the programme is milk-recorded once a month, morning and evening, by the village level inseminator who is paid for every milk recording. Milk recording is done by a measuring jar. At the time of milk recording a sample is taken in a sample bottle for fat testing. Fat testing is done in the village at the society building. Every village dairy cooperative society uses fat testing equipment for testing fat content in milk supplied by farmers in order to decide the price per litre to be paid to farmers. Milk payment to individual farmers is made on the basis of volume or weight and fat test. Monthly milk recordings of each daughter are continued until it completes its lactation.

All events of the programme starting from registration of dams, their insemination, pregnancy diagnosis and calving, birth details of female calf, body weights of calf, insemination, pregnancy diagnosis, calving and monthly recording of milk and fat test for whole lactation of daughters born, are all recorded through the Management Information System

(MIS-DIPA) developed for the programme. Data collected on a monthly basis in different formats are processed at the Union's headquarter and many reports are produced to evaluate the performance of buffaloes, villages, bulls, inseminators, supervisors, etc. Since farmers have just one or two animals, information like animals to breed, animals to examine for pregnancy diagnosis, animals to calve, animals to dry off, animals crossed more than three inseminations per conception, etc., generated through the MIS-DIPA is not of great relevance to an individual farmer. They in any case have all the information and any such output does not provide any additional information. However, when output is produced for all farmers within a village comparing performance of each individual farmer with all other farmers, the comparative performance report becomes very informative and provides very valuable information to each individual farmer to evaluate his own performance and adopt improved practices followed by better performing farmers. An action list for a village taking into consideration all animals of the village, is also produced. For a village, village comparative performance reports become very valuable. Poor performing villages can find out why the performance of their village is poor in relation to others and can jointly decide together what they need to do to improve overall performance of their village. All such outputs are produced in the local language and are displayed in the dairy cooperative society so that all farmers can see their performance in relation to others when they come to deliver their milk to the society. Reports are also produced for supervisors and inseminators which help in evaluating their performance.

Bull performance reports are produced for evaluating the performance of all bulls tested with respect to conception, milk production and fat percentage of their daughters. Bulls are ranked on the basis of breeding values estimated using sire model employing the best linear unbiased prediction method (BLUP). Right now breeding values are estimated using the following model:

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

Where:

Y= an observational vector consisting of 305 days standard first lactation milk yield of daughters,
a= effect of age at first calving assumed to be a continuous variable,
b= a vector of village-year-season effect,
c= a vector of random sire effects,
W, X, Z= are known matrices, and
e= a vector of random residual effect.

Traits included in the breeding goals and method used for dissemination of improved genetics

Under the DIPA programme, at present, information on conception, age at first calving, standard lactation yield and fat percentage have been collected for bulls on the basis of their daughters' performance in the field. As mentioned earlier, breeding values of bulls for milk yield are estimated using sire model employing BLUP. As more records will be available and genetic parameters will be estimated more accurately, a multi-traits animal model would be employed to estimate breeding values of both males and females together.

As shown in figure 1, the genetic progress in the target population has been planned to be achieved through selection of sires to breed sires, selection of dams to breed sire and selection of sires to breed replacement stock. Higher genetic gain on the sire to sire path has been sought to be achieved through increasing selection intensity of sires to produce sires by putting more and more bulls under test programme, increasing accuracy of selection of sires by producing as many daughters as possible per bull and in as many villages as possible by systematic semen distribution schedule and reducing the generation interval extent possible by putting sires to test as early as possible. On the dam to sire path, the higher genetic progress is planned to be achieved through increasing selection intensity of dams to produce the next generation of sires by increasing as many buffaloes as possible under recording and through increasing accuracy of selection of dams by having at least two lactation records. Once bulls are obtained through nominated mating using the top ranked progeny tested bulls and elite recorded bull mothers, some selected bulls after they complete their test mating are used for artificial insemination in the base population, buffaloes of villages having artificial insemination facilities which are not part of the recorded population. Thus, a gradual genetic progress occurs not only in the recorded population, but also in the base population.

Results achieved so far

The DIPA programme in Mehsana was started in 1987. So far seven batches in all 95 bulls have completed their test mating. The semen doses of the eighth batch are being distributed. The overall simple average standard 305 days first lactation yield of daughters born under the programme was 1 946 litres based on 2 846 observations. The progeny test results of the first four batches or 60 bulls based on more than 30 records per bull are now available. All new batches of bulls that are tested are now obtained from the field using top bulls and the top elite recorded daughters in the field. The DIPA programme in Kheda was started in 1989. So far 57 bulls have completed their test mating and another 16 bulls are being tested. The average simple standard 305 days first lactation yield of recorded daughters was 1 481 litres based on 1 106 observations. The progeny test results of the first two batches or 29 bulls are available. At present, bulls are obtained from the Murrah breeding tract based on recorded dam yield.

Still one more batch of Murrah bulls is planned to be used. There after bulls will be obtained from the Kheda district using top bulls and elite recorded daughters in the field. The joint milk unions and SAG DIPA programme was initiated in October 1992. So far 50 bulls have completed their test mating and another ten bulls are being tested. The daughters of the first two batches are recorded. In another six months time, progeny test results of the first batch will be available based on more than 30 records per bull. The average lactation yield of daughters which have completed their lactation was 1 738 litres based on 77 observations.

Table 2. Status of DIPA programmes.

Set No	No. of Bulls	AI / Bull	Daughters Born / bull	Daughter complete Lact / bull	Avg. 305d 1st lac. Yld
1. DIPA by Mehsana Union, since 1987					
1	13	1 714	195	52	1 960
2	20	1 392	135	34	1 910
3	12	2 716	262	58	1 924
4	15	1 493	162	21	2 013
5	12	1 831	163	33	1 962
6	12	1 031	86	5	2 005
7	11	1 604	88		
8	12	1 768			
2. DIPA by Kheda Union, since 1989					
1	13	5 032	345	42	1 478
2	16	4 844	337	35	1 484
3	17	5 011	363		
4	11	11 069			
5	16	5 878			
3. DIPA by Sabar, Baroda, Panchmahals and Surat Unions and SAG; since 1992					
1	10	1 914	254	7.7	1 738
2	10	2 017	237		
3	10	2 074	240		
4	10	2 262	244		
5	10	2 463	214		
6	10	2 240			

Farmers and Government involvement

The DIPA programmes have been implemented by the respective farmer owned dairy cooperative unions under the technical guidance of NDDB. There is no involvement of the State or the Central Government in the programme. Each DIPA programme was initiated with the financial support of NDDB. NDDB met all the cost of implementation of the programme for the first five years. After five years of implementation of the programme, a separate corpus fund for each of the three DIPA programmes was created with the contribution from respective unions and the NDDB. Each programme at present meets its costs from the interest earned from the long-term investment of the corpus fund and does not depend on any external agency for funding. If the cost of implementation of the programme in any particular year is more than the interest earning, the additional cost is met by the respective dairy cooperative union. Farmers do not pay for recording. The fact that the Mehsana Union has been running the DIPA programme now for almost 12 years, the Kheda Union for ten years and the other four unions for six years, it indicates that the programme has been well accepted by the farmers and will be continued by farmers themselves for many years to come. No legislation has been formed so far for implementation of the programme. From the experiences gained, however, NDDB has been planning to evolve standards for recording of all DIPA activities and a mechanism to ensure that all participating agencies adhere to the standard set.

Technical support

A Management Committee with a representative from each union and the NDDB oversees the implementation of the programme and provide necessary technical guidance. This Committee meets every three months and reviews progress made and takes decisions on implementation aspects of the programme. It approves budgets and reviews expenditures. A separate investment committee with a representative from the union and NDDB decides on the investment of the corpus fund. Apart from this, NDDB provides all help in running and modifying the software used for data processing and generating required information. NDDB also helps in analysing the data and estimating breeding values. NDDB organizes regular training programmes for inseminators, supervisors and officers involved in implementation of the programme for updating their skills and knowledge.

Activities and design peculiarities that enabled the DIPA programme to succeed

The key design peculiarities and activities that have enabled the DIPA programme to succeed are briefly described below.

Implementation of all activities by a single organization

The DIPA programme in each district is implemented by the respective district cooperative milk producers union. It is integrated with other activities implemented by the union. Each participating union is a large dairy cooperative organization that collects milk from village cooperative societies, processes collected milk into milk and milk products and pays village societies for their milk. It organizes farmers at the village level to form independent village dairy cooperative societies managed by farmer representatives. All such village level cooperative societies in a district federate into a district cooperative union. A board of directors mainly elected by the chairman of village cooperative societies, manages the district cooperative union. At the village level, the village cooperative society collects milk twice daily from milk producers and pays on the basis of weight or volume and fat test. The milk collected by the village level societies is bulked in cans that are collected by the union twice daily at a pre-specified time. The milk collected by the union is processed into milk and milk products. Processed milk is sold by the union, while the products are sold by the Milk Marketing Federation. All milk unions in Gujarat are federated to the Gujarat Milk Marketing Federation. The union also provides all inputs like cattle feed, fodder seed, veterinary health care service and artificial insemination services to farmers.

All DIPA activities beginning with the registration of farmers and their animals, insemination (AI) and pregnancy diagnosis of animals (PD), recording of AI, PD and calving, monthly recording of milk yields and testing of fat content, supervision of recording, measuring weights of calf and distribution of cattle feed, collection and processing of data, providing feed back to farmers and societies, estimation of breeding values and selection of bulls and bull mothers for production of the next generation of animals, and dissemination of superior genetic material to the large population of the district through the creation of the AI network within the district, are carried out by the same organization. More coordination is ensured when all activities are carried out by a single organization than when they are implemented by many organizations.

Participation of farmers in the programme

Although, the participating farmers did not initially understand what benefits the recording system would bring to them, they carried out whatever was asked of them by union officials as they trusted the Union and their village cooperative society. However, the following four activities implemented under the DIPA programme further boosted their interest and increased their faith in the programme.

- *Incentive to farmers in the form of cattle feed for female calves born*: for every female calf born under the programme, five bags of cattle feed (about 350 kgs feed) were given to farmers to feed the calf over a period of 18-24 months. This initially provided sufficient motivation to farmers to participate in recording activities. However, it helped the programme in many ways. The early feeding of concentrate to buffalo calves ensured good growth. Many buffalo female calves grew well, they matured

early, came in heat early, conceived early, calved early and gave much more milk. Many buffalo heifers calved in less than 30 months. This also increased the market value of their animals considerably. Thus, supplying cattle feed to farmers provided the first major impetus to the programme and many farmers came forward to participate in the programme. It also to some extent reduced the differences in management of calves and greatly helped in resolving the problem of treating a village as a herd in a smallholder situation;

- *Providing village level performance reports*: comparing their performance with other farmers in the village was additional valuable information to participating farmers. Such information greatly helped them to improve their existing feeding and management practices;
- *Organization of calf rallies*: every year at least one calf rally is organized in each DIPA village wherein participating farmers bring the calves born under the programme and compare their calves with others. Farmers from neighbouring villages also participate in such rallies. Talking to visiting farmers the participating farmers realise that the value of their animals has considerably increased. This provides further incentives to participate in the programme;
- *Farmers' DIPA Programme Monitoring Committee*: in some districts a Farmers' DIPA Programme Monitoring Committee has been formed with a few selected chairmen of the DIPA village dairy cooperative societies. The Committee meets every three months in different villages and explains to farmers the importance of the programme. They also take responsibility to ensure that cattle feed supplied to farmers is fed to female calves born under the programme and not to others. They also take responsibility to supervise milk recording and improve quality of data collection, and also provide feed back to officers implementing the programme.

Financial independence

Each DIPA programme has created a corpus fund with a contribution from the union and the NDDB. At present the programme meets its expenditure from the interest earned from the long-term investment of the corpus fund and does not depend on any external agency for funding.

Development of local software for monitoring of the programme and decentralizing data processing

The NDDB developed its own software for processing data and generating information for all participants of the programme. Since software was locally developed, all changes required in the software could be made locally and the system became increasingly more relevant for the users. All data processing activities were totally decentralized from the beginning which helped in the rapid processing of data and provision of information to farmers and others without delay.

Back-up support by the NDDB

A national organization like the NDDB provides all technical and policy support to DIPA programmes. The NDDB also provided initial financial support and created a corpus fund for each programme. The NDDB

organizes review meetings for evaluating the performance of each programme and stimulating enthusiasm among the implementing officers of the unions. It also organizes regular training programmes for inseminators, recorders, supervisors, data processing personnel and project managers to update their skills and knowledge. The NDDB gathers the data together and provides valuable feedback to all participating agencies. It centrally estimates and circulates breeding values to all concerned. This kind of support from a central organization helps in maintaining and sustaining the programme for a long time.

Changes envisaged in the operation of the programme

In the next five years all six districts will have a similar base population. It is envisaged that after five years, all three programmes will be jointly operated and each bull tested will be evaluated with more daughter records spread over many villages across many districts. In this way both the intensity and the accuracy of selection of bulls could be raised. Over a period of time more villages will be added in the programme and more buffaloes will be recorded. This will also help in increasing intensity of selection of bull mothers for producing sires. At that stage the breeding value estimation will be carried out centrally by the NDDB and will publish a common sire directory.

Many village societies are now computerising their operations at village level. It is envisaged that very soon it will be possible to process the data collected under the DIPA programme directly in the village and the information required by farmers for management of their animals will be generated in the village itself without delays. Participating farmers would be able to update their files in the society and obtain the necessary outputs in their own local language.

The data generated under the programme will later be used not only for management decision of participating farmers and genetic improvement of local buffalo populations, but also for planning of breed improvement efforts in other parts of the country. Superior bulls produced under this programme will be used in breed development in other parts of the country. Some elite recorded buffaloes of these programmes were recently exported to Thailand. In the future, semen doses of progeny tested buffalo bulls and bulls and buffaloes born using progeny tested semen will be exported to many other countries.

It is a little early to estimate the genetic gains in the target population due to the programme, but in the next four to five years, it will be possible to make precise estimates of genetic change and the benefits the participating farmers gained from the programme. It would also be possible to carry out a cost-benefit analysis of the programme and record the benefits such programmes bring to the participating farmers in particular and to the dairy cooperative unions and the nation in general.