List of key outcomes/ideas from workshop sessions.

Participants were broken into four workshops of approximately 20 people per workshop. Each group were given two questions; one specific question for that group and one general question, to be answered by all groups. Each workshop included two moderators, to act as facilitators and to take notes. The following is a summary of the key outcomes/ideas gathered from each of the groups.

Group 1. Facilitators; Roel Veerkamp & Brian Wickham.
Key questions; (i) What needs to happen to deliver genomic evaluations at the local (or national) level, and (ii) How can ICAR/Interbeef respond to the challenge of genomics.

(i) What needs to happen to deliver genomic evaluations at the local (or national) level?

1. Central coordination at local level – get funding – makes it happen at local level.
2. Training and validation population – genotypes of well-known animals /phenotype – now and in future – sufficiently large numbers with phenotypes – related to breeding population – related to breeding decisions.
3. Resources – money - willingness of farmers to pay and share data.
4. EU Zootech legislation – impact on data collection – how Herd Books can operate within and across countries – risk of fragmentation. Risk of competition impacting on sharing.
5. Willingness and understanding of breeders to say "yes" to genomic evaluations.
6. Sharing of funding, data and DNA at local level – especially for new data.
7. Limitation of small local population even across Nordic countries, also Czech Republic.
8. Mechanism for data sharing that all are comfortable with.
9. Risk loss of focus on the animal – must always understand relationship between genotype and environment – are they comparable across countries.
10. Service to farmers – get them involved and how they can use genomics.
11. Extend range of phenotypes that are important – especially hard to measure ones – eg. Disease resistance, female fertility.
12. Lack of evidence that breeding will give rise to more profit for decision maker (breeder).
13. Confidence in technology, confidence industry especially in beef – beef is seen as least profitable in Ireland – how can this be changed?
14. Lack of international co-operation in pseudo-political context – share data – share genotypes.

(ii). How can ICAR/Interbeef respond to the challenge of genomics?

1. Facilitate technical co-operation.
2. Extend range of traits to the new and hard ones – provide guidelines for recording.
3. Sharing of genotypes and phenotypes.
4. Changing the mindset – find technical solutions to political problems.
5. Similar role to Interbull for Dairy.
6. Start exchange of genotypes amongst big guys (France, Ireland, UK) – will help smaller countries.
7. Provide leadership.
8. Not sure how Interbeef and ICAR interact.
9. Sharing is caring – if want to go fast then exchange knowledge and lessons, methods and tools – do not make same mistakes – give clear guidelines on what works well.

10. Big players and small players – need to be convinced that sharing will help them (big and small).
11. These sorts of meetings are great at facilitating knowledge sharing.
12. Intergenomics model.
13. Lessons that can be taken from other countries.
14. Service to compare local evaluations.
15. Try to share for some traits to start – not weaning weight – this is easy for big country – start with feed intake where even big country needs collaboration – create large enough reference populations.
16. Code of practice on how to behave toward each other – how to share – show leadership on coming up with models – write the book on collaboration.
17. Early delivery of conventional breeding values – spread awareness by demonstrating capability and benefits of collaboration. Then move to genomic evaluations collaboration. Industry has been waiting for a while.
18. Collaboration of small breeds across countries – Aubrac, Hereford – France, USA. Do not build competition between breeds.
19. Act in lobbying role – fund to support R&D at EU level – competitive but conditional on collaboration.
20. Provide education of regulatory bodies on how industry can best be organized.
21. Learn lessons from Interbull – set standards for genomic evaluation of beef cattle – book to be written. Get quick wins to establish sharing principles. Eg feed intake.

Group 2. Facilitators; Francis Kearney & Dorian Garrick.
Key questions; (i) What are the "pros" and "cons" of international collaboration, and (ii) How can ICAR/Interbeef respond to the challenge of genomics.

(i). What are the "pros" and "cons" of international collaboration in the area of genomics?

Pro's.
1. Increase size of reference population, especially for smaller breeds.
2. Genomic predictions will be better.
3. Building critical mass around; (i) personnel, (ii) software and (iii) reduced cost of genotyping.
4. More attractive to funding bodies.
5. Validation of methods & results.
6. Sharing of rare phenotypes.
7. Spirit of common good.
8. Help with new technologies such as sequence & computing.

Cons.
1. Benefits smaller populations more.
2. Requires correct leadership qualities.
3. May be slower to implement.
4. Some data is more useful than other.
5. Politics at local level.
6. Communication becomes even more critical.
7. Cost of administration and travel.
8. Stifle local recognition.

(ii). How can ICAR/Interbeef respond to the challenge of genomics?

1. ICAR should provide accreditation for genomic evaluations/predictions which give more meaning to results in comparison to predictions published by private companies.
2. Independent facilitator to capture the pros of collaboration.
3. Repository of genotypes and phenotypes.
4. Full range of services that are dependent on customer's requirement (may differ from provision of data to full genomic evaluation services).
5. Broader than Interbull to pool data and resources to provide the definitive methodology around 1-step and sequence information or newest developments.
6. Interbeef could become a "Cloud" based service.
7. Correct business model needed

Group 3. Facilitators; Ross Evans & Esa Mantysarri.
Key questions; (i) What are the steps to make it happen, both organisational and technical and (ii) How can ICAR/Interbeef respond to the challenge of genomics.

i. Organisational and Technical steps needed to make International Collaboration happen

The following four steps are the recommendations of group 3 and outline various levels of potential across country cooperation to deliver genomics to beef programs worldwide. Countries/organisations should have the flexibility to participate at different levels of the 4 recommendations below depending on the breed population size, ability to collaborate, or current needs from international sharing.

1. Interbeef could facilitate a listing of all genotyped animals (not actual genotypes) in addition to extra information such as chip size and contact details for the countries/organisations wishing to share genotypes. This would allow countries to engage with each other on a 1:1 basis to share genotypes if they so wished.
2. Interbeef could hold a repository of genotypes. An example of this is the current common database for Brown Swiss animals. Flexibility on the options around sharing would allow different arrangements between different countries/organisations. Some countries /organisations may wish to share all genotypes with all other organisations. Others may wish to only do this with selected organisations/countries. This common database could also facilitate the exchange of pedigree data along with the genotype i.e. help to fill in the gaps in the database of the importing country.
3. Interbeef could provide an Imputation service.This would be where countries are participating at the level of step 2 above. Costs could be tailored based on the level of imputation requested. Checks such as parentage validation and sex validation could be part of this service with a reporting mechanism built in to provide feedback to the country/organisation.
4. Interbeef could provide a service where they produce International breeding values and genomic breeding values where participating countries are submitting pedigree, phenotypic and genotype information. A related example of this collaboration arrangement on the dairy side is the Intergenomic evaluation for the Brown Swiss breed. Interbeef could also produce supplementary information such as DYDs, recommendations for each of the collaboration partners on reference bulls to be used in each country and provide assistance with validation steps.

(ii). How can ICAR/Interbeef respond to the challenge of genomics?

As per above.

Group 4. Facilitators; Donagh Berry & Theo Meuwissen.
Key questions; (i) What are the consequences of implementing/not implementing genomics on future beef breeding program structures, and (ii) How can ICAR/Interbeef respond to the challenge of genomics.

i. What are the consequences of implementing/not implementing genomics in future beef breeding program structure?

1. Confusion in industry about genomic proofs led by commercialisation.
2. Increased use of young bulls to reduce generation interval and increase genetic gain.
3. Low reliability of GS bulls might be a risk but can use bull teams.
4. Fear that increased genetic gain in terminal trait may result in unfavourable trends in lower reliable (functional) traits.
5. Fear of commercial companies running their own genomic evaluations and genotypes (and thus selection decisions) not entering the national genetic evaluations.
6. Future role of herdbooks. Splitting of herdbooks by strains.
7. Genomic evaluations for new traits.
8. Loss of minority breeds.
9. Maybe increased use of AI.
10. Increased globalisation in the trade of semen.
11. Competition by natural bulls to AI.
12. If no genomics then 50% slower genetic gain.
13. Poor genetic gain in low heritability traits.
14. No more genotyping laboratories.
15. Lack of competitive advantage if one population decide not to implement genomic selection and other populations do.

(ii). How can ICAR/Interbeef respond to the challenge of genomics?

1. Repository of biological samples.
2. DNA of different genotypes of important SNPs (e.g., CVM)
3. Repository of SNP patents.
4. Housing SNP primers for those who want to make their custom SNP chips.
5. Technical group of how to store and use sequence data.
6. Forum to answer technical queries.
7. Bulk purchasing of SNP chips to reduce costs.
8. Validation tests for genomic predictions like currently for INTERBULL.
9. International database for genotypes.
10. International genomic evaluations.
11. List of genotyped animals.
12. Cryopreservation.
13. Accreditation of companies who develop genomic proofs.
14. Lobby EU on rules of use of bulls (e.g., low reliability).
15. Recommendation of base SNP panels that should exist on all panels for cross compatibility.
16. Guidelines on genomic evaluations and SNP QC.

17. Phenotype standardisation.
18. Validation of putative causal mutations.