Recent trends in the global organization of animal breeding

Chanda Nimbkar¹
Johan van Arendonk²

¹Nimbkar Agricultural Research Institute
Phaltan, Maharashtra, India

²Animal Breeding and Genomics Centre,
Wageningen University, The Netherlands
Outline of presentation

• Consumption and production trends of major livestock products
• Basics of animal breeding programmes
• Species-wise organization of breeding
• Impact of genomic selection and other technological developments
• Breeding programmes in low input systems
• Conclusions
Consumption and production trends of major livestock products

• Per capita consumption of eggs, meat and milk
  – increased significantly in developing countries (except sub-Saharan Africa) from 1980 onwards

• Production also increased greatly in developing countries and more modestly in developed countries
  – Eggs 150%, milk 44%, meat >100%
  – Most increase in meat production from monogastrics

• Largest increases in per head productivity in broiler, eggs, pork and milk production

• Organization of breeding had a significant influence

• Genetic progress central to success of livestock sector
Animal Breeding

• “Optimal exploitation of the biological variation of species, under given constraints of reproductive capacity, using appropriate breeding value estimation tools.” (Ollivier, 2000)

• Aim: To use between and within breed genetic diversity.

• Dynamic search for improvement

• Application of reproductive techniques
Cervical Artificial Insemination of does and ewes
Breeding schemes

Generation of improvement

Nucleus

- Multipliers

Dissemination to producers
Breeding

• Highly specialised activity
• Involves considerable investment in facilities and human resources
• To generate competitive rates of genetic progress over a long time
• While preserving genetic variation
• And maximizing biosecurity
Genetic progress

Accuracy

\[ \Delta G = \frac{\text{Intensity of selection}}{\text{Genetic variance}} \]

Generation interval

Parameters to evaluate scheme:

\[ \Delta G = \text{rate of genetic change} \]

\[ \Delta F = \text{rate of inbreeding} \]
Determinants of genetic progress 1

- Accuracy depends on quality and quantity of performance records
- Animals with highest predicted genetic merit selected as parents
- Dairy cattle: breeding schemes use records from on-farm milk recording schemes (production, fertility, conformation)
Determinants of genetic progress 2

• Selection intensity: proportion of animals needed as parents for next generation
• Determines rate of genetic improvement
• Selection of bulls contributes 70% to total genetic change in dairy and beef cattle
• Nucleus animals form less than 1% of the entire population
Value added by livestock genetic improvement in Europe

- Annual value of livestock production in Europe €123 billion (conservative estimate)
- Annual genetic gain at producer level: 1.5% (€1.8 billion)
- Annual R & D cost: €150 million
- Benefit cost ratio: 10

Flint and Wooilliams (2008)
Species wise organization of breeding - Poultry

- **Primary breeders**
- **Multipliers**
- **Egg producer / Broiler grower**
- **Grandparents / Parents**
- **Final product Pullets / broilers**
Species-wise organization of breeding - Poultry

- Large breeding corporations
  - 4 companies broilers, 2 layers, 3 turkeys
- Companies manage population size and scale of recording with their own resources
- 2/3rds broiler and half of world egg production industrialized
- Indian example: adapted strains developed
Organization of breeding - Pigs

- Pyramid structure and less concentration than poultry
- Large corporations with world wide distribution networks
- Sows and boars of specialized lines – crossbred pigs produced for slaughter
- Breeding associations
Organization of breeding: Dairy cattle

- More complex and open organizational structure
- Improvement based on progeny testing: Candidate bulls judged by performance of a large number of daughters on private farms
- Pedigree information – breed societies Milk production records – farmers, milk recording organizations
- International genetic evaluation of bulls: Interbull
- Mergers and expansion: Genus and ABS Genetics
Dairy cattle breeding

- Exports of North American Holstein genetics increased from 1970s into 1990s.
- Closely related bulls and increasing average inbreeding level
- Selection emphasis moving away from production traits and towards functional traits (started in Scandinavian countries)
- Fertility – major issue
Murrah buffalo breeding herd – NDRI, Karnal, India
Sheep and goats

- Few large breeding corporations
- Fine wool sheep studs in Australia, NZ
- Stratified sheep industry U.K.
- Most dairy goats in developing countries but breeding programmes not well developed
- Success rate of some breeding programmes with native breeds is encouraging (Kosgey et al., 2006)
Barberi goat breeding programme – CIRG, India
Impact of genomic selection

- Simultaneous selection for many markers covering the genome densely so that all functional genes are associated with at least some markers
- Genome-wide selection will use dense SNP maps emerging from genome sequencing projects
- Cost of dense genotyping decreasing
- Robust analysis of vast array of genotypes on each animal along side recorded phenotypic data on performance
Benefits of genomic selection

• Increased accuracy
• Ability to overcome age and sex limitations
• Allows estimation of relationships where pedigrees are not recorded
• Direct link between genetic evaluation and the genome
• Better opportunity to select for traits with unfavourable genetic correlation
Genomic selection in developing countries?

• Extensive validation of association between genotypes and phenotypes needed

• ‘You can’t manage what you do not measure’: GS cannot be used if accurate performance records not available

• Only genotyping without phenotyping and efficient data analysis will be wasteful expenditure.
Breeding programmes in low input systems

• Smallholders generally do not get benefit of organized genetic improvement for their native breeds

• Within-breed improvement programmes can contribute to improved livelihoods if compatible with production system and needs of smallholders.

• Necessary to involve producer at every stage in planning and operation of breeding programmes
Available options?

- Governments largely unaware of the benefits of breeding programmes and apathetic about establishing them
- Lack of appropriate and adequate institutional structures for community breeding programmes
- Awareness created by Interlaken about conservation of indigenous breeds needs to be taken a step further to encompass the necessity of genetic improvement.
Examples:
community breeding programmes
Conclusions

• Significant progress made in livestock breeding in developed countries
• Increasing concentration of breeding in a few multi-national corporations
• Effective genetic improvement programmes generally absent in developing countries
Conclusions

• Developing country policy makers need to be convinced of the potential of effective breeding programmes to alleviate poverty
• Increased awareness about conservation needs to be extended to genetic improvement
• Greater international collaboration and exchange of knowledge needed.
Thank you