Recent trends in the global organization of animal breeding

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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
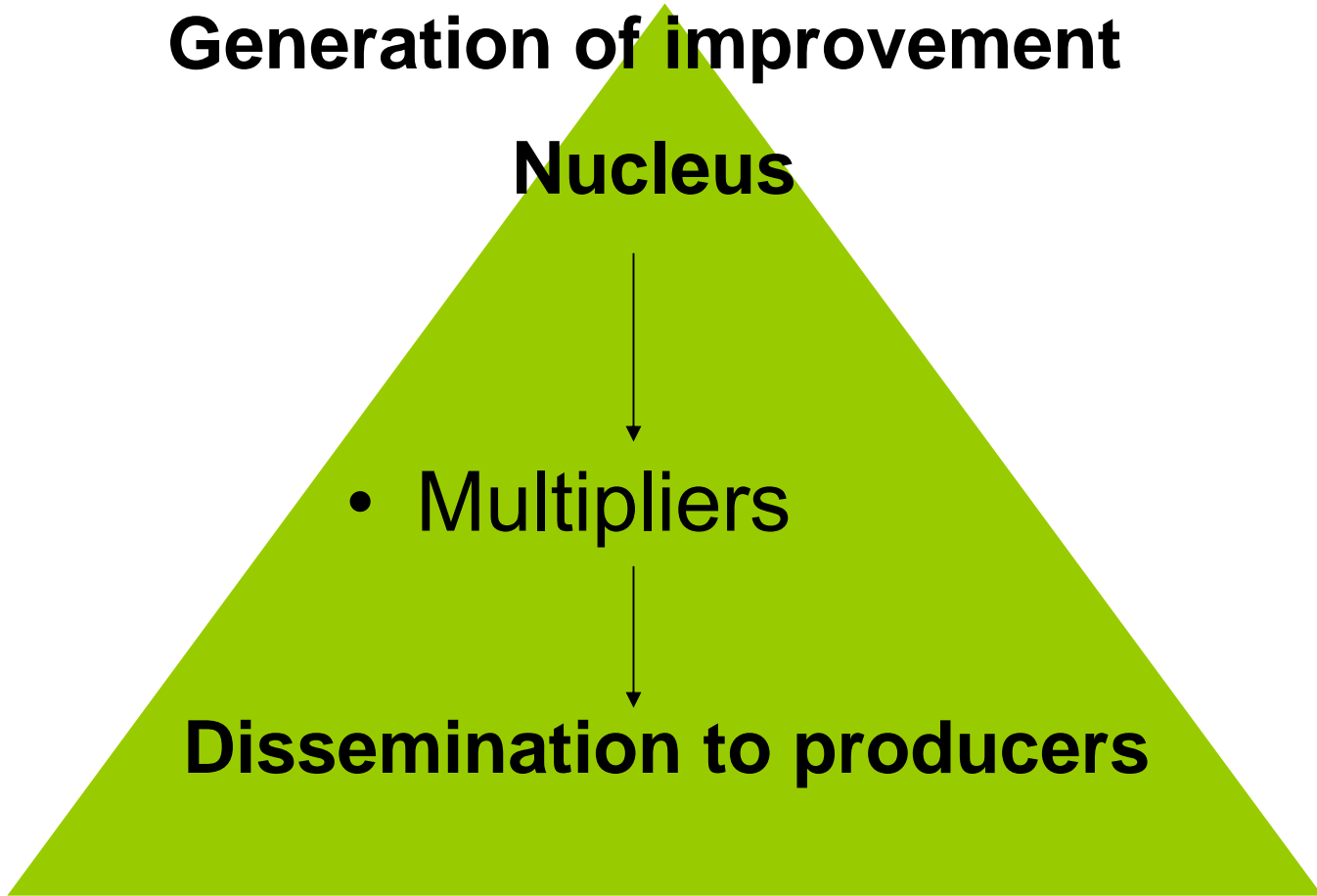
Breeding schemes

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

$$\Delta G = \frac{\text{Accuracy} \quad \text{Intensity of selection} \quad \text{Genetic variance}}{\text{Generation interval}}$$

Parameters to evaluate scheme:
ΔG = rate of genetic change
ΔF = 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)
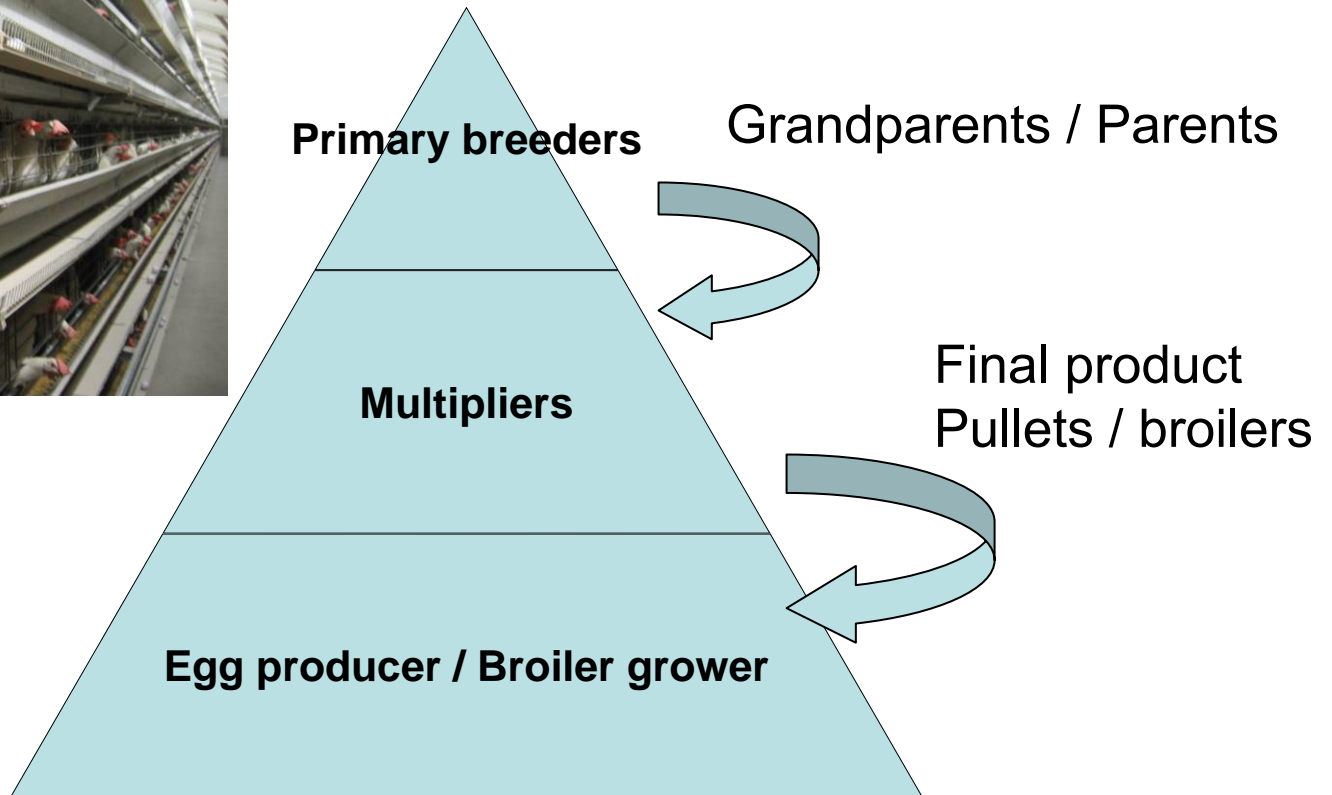
Determinants of genetic progress 2

- 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 Woolliams (2008)

Species wise organization of breeding - Poultry

Primary breeders

Grandparents / Parents

Multipliers

Final product
Pullets / broilers

Egg producer / Broiler grower

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