Genetic Improvement of Dairy Animals in Asia – Working Group on Dairy Genetics

Dairy Asia: Towards Sustainability
Contents

• Brief presentation on the working paper:
  ➢ Preparation of working paper - “Genetic Improvement of Dairy Animals in Asia - Strategies for Developing Effective and Sustained Breeding Programmes” (April-June, 2016)
  ➢ A meeting of a group of dairy geneticists on 8-9 November 2016 – dairy geneticists from Bhutan, China, India, The Philippines, Thailand, Vietnam participated

• Presentation on function, structure, planned activities of the working group
A brief presentation on Working Paper on Dairy Genetics
General Background

• Two-thirds of world’s 800 million undernourished are in Asia-Pacific region.

• A 20% increase in productivity would provide a glass of milk a day for every child in region

• Demand for milk in Asia by 2021: 320 MMT; desirable to meet demand producing milk within region

• 80% of milk is produced in small holdings

• Genetic improvement is identified as key factor to increase productivity – genetic change is relatively SLOW – but it is permanent and additive

• PROBLEMS of Climate Change – direct and indirect effects.

10 March 2017
• Cattle population in Asia: 492 million – 35% of global

• Growing at 0.68% per year - average global 0.46%

Source: FAOSTAT
Buffalo Population in Asia

- Buffalo population in Asia: 187.6 million – 97.1% of global

- Growing at 1.13% per year
In-milk animals, productivity and production

- Asian countries together have 106 million milking cows – 39% of the global milking cows.
- Average productivity of cows: 1676 kgs against global average 2347 kgs.
- Total Asian milking buffaloes: 59.27 million – 97% of global milking buffaloes
- Average productivity of buffaloes: 1674.
- Cow milk production: 178 MMT, 28% of the world, growing @ 4.3% against global average 1.6 %
- Buffalo milk production: 99.22 MMT, 97% of global production, growing @ 3.86%

Source: FAOSTAT
Rich biodiversity in Asia

Cattle Breeds in South Asia

Gir

Sahiwal

Rathi

Cholistani

Red Sindhi

Kankrej

Tharparkar

HF Crossbred

Jersey crossbred
Cattle breeds in China

Chinese Holstein

Chinese Simmental

Xinjiang Brown

Sanhe

Caoyuan Red

Shuxuan
Breeds in South East Asia

Thai Holstein

Vietnam Yellow Cow

Red Sindhi crossbred

Bali cattle

Madura cattle

Sahiwal crossbred
Dairy Production Systems in Asia

Mixed Farming
- Irrigated
  - Highland tropics/temperate
  - Humid and sub-humid tropics
  - Arid and semi-arid tropics
- Rain-fed
  - Highland tropics/temperate
  - Humid and sub-humid tropics
  - Arid and semi-arid tropics
- Large herds
- Smallholders
- Rain-fed
  - Highland tropics/temperate
  - Humid and sub-humid tropics
  - Arid and semi-arid tropics
- Grassland
  - Irrigated
    - Humid and sub-humid tropics
    - Arid and semi-arid tropics
  - Rain-fed
    - Highland tropics/temperate
    - Humid and sub-humid tropics
    - Arid and semi-arid tropics
  - Large herds
  - Smallholders
  - Highland tropics/temperate
  - Humid and sub-humid tropics
  - Arid and semi-arid tropics
- Landless
  - Irrigated
    - Humid and sub-humid tropics
    - Arid and semi-arid tropics
  - Rain-fed
    - Highland tropics/temperate
    - Humid and sub-humid tropics
    - Arid and semi-arid tropics
  - Large Herds
  - Smallholders
  - Highland tropics
  - Humid and sub-humid tropics
  - Arid and semi-arid

As described by Sere and Steinfeld, (FAO, 1996)
Smallholder Arid Production system
Mixed Farming Semi-arid Production System

Small Herds

Large Herds
Landless Large herds Production Systems in Peri-urban Areas
Smallholder Landless System
Survey Results
Population growth trends in cattle and buffaloes

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<th>Trend</th>
<th>China</th>
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<td>Brown, Sanhe</td>
<td>Holstein, Simmental, Jersey</td>
<td>Chinese Holstein, Chinese Simmental</td>
<td>Swamp - Binglangjiang</td>
<td>Murrah, Nili Ravi</td>
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<td>Bali, Sumba Ongole, Madura, Pesisir, Aceh, Sumbawa, Jabres, Donggala, Pasundan, Kuantan, PO Kebumen</td>
<td>Holstein, Limousin, Simmental</td>
<td>Simmental CB, Limousin CB, Brahman, HF CB</td>
<td>Swamp buffalo breeds - Simuel, Pampanga n, Sumbawa, Moa, Toraya, Kalimantan Timur, Kalimantan Selatan</td>
<td>Murrah, Nili Ravi</td>
<td>Swamp and Riverine CB</td>
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<td>Nublang, Yangkum, Doebam, Doethra, Jaba</td>
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<td>Jersey CB, Brown Swiss CB, HF CB</td>
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<td>Sahiwal, Gir, Red Sindhi, Rathi, Kankrej, Hariana, Tharparkar, Ongole, KrishnaValley, Deoni</td>
<td>Holstein, Jersey</td>
<td>Holstein CB, Jersey CB, Brown Swiss CB</td>
<td>Riverine buffalo breeds - Murrah, Mehsana, Jaffarabadi, Banni, Surti, Pandharpu ri, Nili Ravi, Toda, Bhadawari</td>
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Dairy Asia

Breeds of Cattle and Buffaloes
### Semen Production

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<thead>
<tr>
<th>Institution</th>
<th>China</th>
<th>Indonesia</th>
<th>Thailand</th>
<th>Afghanistan</th>
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<th>India</th>
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<tbody>
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<tr>
<td>Government</td>
<td>2</td>
<td>18</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>37</td>
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<tr>
<td>Cooperative</td>
<td>1</td>
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<td>8</td>
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<tr>
<td>National Private</td>
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<td>2</td>
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<tr>
<td>International Pvt.</td>
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<td>Others</td>
<td>44</td>
<td>5</td>
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<td><strong>Total</strong></td>
<td>46</td>
<td>18</td>
<td>14</td>
<td>1</td>
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<td>51</td>
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<td><strong>Doses produced:</strong></td>
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<tr>
<td>Government</td>
<td>1,500,000</td>
<td>7,800,000</td>
<td>988,691</td>
<td>100,000</td>
<td>10,189</td>
<td>48,262,830</td>
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<tr>
<td>Cooperative</td>
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<td>15,165,950</td>
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<td>NGO/Trust</td>
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<td>30,709,500</td>
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<td>National Private</td>
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<td>2,979,140</td>
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<td>Others</td>
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<td><strong>Total</strong></td>
<td>24,500,000</td>
<td>7,800,000</td>
<td>988,691</td>
<td>100,000</td>
<td>10,189</td>
<td>97,117,420</td>
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</table>

- Semen Stations are mainly government owned/operated except for China
- In India cooperatives and non-government organisations play an equal role in semen production
- 75 percent of semen doses produced is of cattle breeds and 25 percent of buffalo breeds.
- India is the largest semen producing country in the world.
AI Delivery

<table>
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<tr>
<th>Particulars</th>
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<th>Indonesia</th>
<th>Thailand</th>
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<tbody>
<tr>
<td>No. of AI Centres</td>
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<td>2215</td>
<td>746</td>
<td>518</td>
<td>144</td>
<td>103,580</td>
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<tr>
<td>No. of AI</td>
<td>5,800,000</td>
<td>1,600,000</td>
<td>263,000</td>
<td>NA</td>
<td>8,247</td>
<td>65,320,000</td>
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<tr>
<td>% of animals Inseminated</td>
<td>95%</td>
<td>60%</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>27%</td>
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</table>

- About 60 percent of AI centres in these six countries are in government sector, 16% in cooperative sector, 8% in NGO sector and 16% in private sector.

- The number of breedable animals inseminated is 95%, 60% and 27% in China, Indonesia and India respectively.
Genetic Evaluation – Progeny Testing

• China implementing since 1983 in Chinese Holstein
• India in HF, HF crossbred, Jersey Crossbred, Murrah buffalo and Mehsana buffalo; Mehsana since 1977, HF CB and Murrah since 1992 and rest since 2010.
• Thailand in HF since 1990
• Funding support is primarily from government
Data collection and dissemination of information

- All countries are using centralised systems for genetic improvement programmes.
- All have decentralised systems for AI, except in India and Bhutan where some centralisation has been attempted.
- Semen production systems are generally de-centralised except in Bhutan where they have a centralised system and in Afghanistan where they have a manual system.
- In Thailand and India some attempts have been made to aggregate semen production data centrally.
Training and Research

- Training facilities for AI and semen production and processing “good” in all countries except in Afghanistan.
- Training facilities both for genetic improvement and information systems are rated “good” in Thailand and India, “medium” in China, Indonesia and Bhutan, and none in Afghanistan.
- Research facilities are rated as low to medium except in India and Thailand.

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Identified Constraints

- Limited Performance recording system
- Limited AI coverage
- Limited genetic evaluation programmes
- Continuity of funding support
- Inadequate competency in carrying out the Genetic improvement programmes
Priority areas

- Assessment of current breeding programmes
- Expanding and Continuing progeny testing programmes
- Developing genetic improvement programmes for local breeds of cattle and buffaloes
- Establishment of institutions for proper recording and evaluation systems
- Capacity development for systemic monitoring and implementation of genetic improvement programs
- Introducing genomic selection procedures under existing genetic improvement programmes
- Software for collection and dissemination of information
- Setting up genotyping and bio-informatics facilities
- Establishing a few nucleus herds with ET and IVF facilities for indigenous breeds
Breeding Strategies
Breeding Strategies

• **Dairy farmers want:**
  – Animals that can be fed and managed for economically optimal production in their existing agro-climatic conditions.
  – To raise gradually genetic potential of their animals and thereby productivity of animals and their income.

• **Planning efforts need to decide on:**
  – What kind of animals suit best in a given area, and
  – How a steady genetic progress could be achieved in the targeted population.
Building infrastructure for genetic improvement

1. Defining a breeding goal
2. Developing an appropriate breeding structure for finding the best animals
3. Dissemination of superior genotype
4. Building information network
5. Putting in place systems of quality control.
Building Infrastructure – Setting Breeding Goal

• Defining breeding goals involves identifying traits that farmers would like to improve and assigning a goal value to each identified trait.
• Need to know future environment and market requirements.
• Genetic improvement programme could be initiated with most important breeding goal and later with more information, the goals could be further refined.
Building Infrastructure - Breed improvement options

• If there is good AI coverage in target population, Progeny Testing is best option for genetic improvement in any population

• If AI coverage is limited in target population, any of alternate Nucleus Breeding Systems could be considered.

• Genomics
Progeny testing scheme – Young Sire Model

Base Population

Bull sire

Bull dam

year n

X

young male calf

year n+2

Progeny test

20-40 bulls/year

10-20 bulls/year

Year n+7

Selection EBV

Genetic evaluation

year n+6

daughters with 1 lactation

(20-40 bulls/year
Small number of stored semen doses)

Year n+2.5

daughters born

2-5 bulls/year

3/10/2017

NDDB
Two-tier breeding system – *Nucleus Herd and village herds*

- Females selected on their own performance & pedigree
- Males on their pedigree
- AI in nucleus herd
- Bulls produce in Nucleus herd(s) used in target population for natural service or AI
- 20% of females are replaced every year

Three-tier Breeding Structure – *Nucleus herd, multiplier villages and target villages*

- If number of males produced in nucleus herd(s) is not enough, one more layer is added.
- Bulls produced from nucleus herd(s) used in multiplier herds (20-25 villages) to produce the required number of bulls for natural service in the target population.

Two-tier breeding structure – *Multiplier villages and target population*

- When farmers have better animals than nucleus; Multiplier herds used as nucleus
- AI is practiced in multiplier herds
- Bulls produced in multiplier herds used for AI or Natural service in target population
- All 9 indigenous breed development programmes implemented by NDDB in NDP follow this design
Genomics – very relevant for many Asian countries

**Base Population**

**Bull sire**

**Breed**

**X**

**Bull dam**

**Progeny test**

**year n+2**

**20-40 bulls/year**

**Year n+6**

**daughters**

**with 1 lactation**

**Year n+7**

**Selection EBV**

**Genetic evaluation**

(20-40 bulls/year
Small number of stored semen doses)

**Year n+2.5**

**10-20 Young bulls selected for AI based on Genomic Breeding values**

**year n**

**young male calf**

**2-5 bulls/year**

**20-40 bulls/year**

**10-20 bulls/year**

**daughters born**

**2-5 bulls/year**
Dissemination of genetics

Small number of large capacity stations preferred
Certification and independent monitoring is essential

AI technicians training
LN and semen deliver system
SOP for AI

NS unavoidable in some areas, but high risk in spreading diseases
Important to evaluate cost effectiveness of NS against AI
Information Network

• Putting in place an information system essential for any genetic improvement programme

• Building information system comprises two set of activities:
  – Designing and developing an application
  – Building an infrastructure for data capture, processing, storage, and generation and dissemination of information.
Putting in place systems of quality control

• Need to establish an Independent Authority for registration, evaluation and certification of:
  – bulls,
  – semen stations,
  – AI service providers, and
  – AI training institutions
Conservation and development of local breeds

- There are many local breeds of cattle and buffaloes in Asia
- Number of some of these breeds declining – as economic returns declining in absence of programmes to improve their productivity
- Systematic genetic improvement programmes need to be established for some of these important breeds.
Crossbreeding

- F₁ crossbreds produce two to three times more milk compared to local cows, provided they are fed optimally and protected and managed well.

- F₂ and subsequent generations generally do not produce more milk than F₁ generation, unless animals of F₂ and subsequent generations are provided optimal environmental conditions, fed to their requirement and protected well against diseases.

- A strategy of maintaining exotic inheritance around 50% in the crossbreds and breeding them with selected *inter se mated* crossbred bulls obtained from progeny testing programmes may be the most ideal strategy for genetic improvement of crossbreds in average conditions prevalent in many Asian countries.

- Farmers with better resources may be advised to keep crossbreds with up to 75% exotic inheritance, but further grading up of crossbred beyond 75% exotic inheritance generally may not be advisable in most of the Asian countries.

- *Inter-se mating* of crossbreds at any level will lose heterosis – reduce Reproductive rate, etc.
Research and Development

• Proper designing of breeding programmes:
  – KNOW 4 pieces of information: Sel. Int.; Accuracy of EBV; Genetic Variation; Gen.Int.
  – 4 pathways: S→S; D→S; S→D; D→D.

• Developing information systems
• Breeding value estimation under smallholder production systems
• Introduction of Whole Genome Selection procedures - Genomic Selection can increase rate of change but accurate phenotypic info is ESSENTIAL
• Bioinformatics is required
• ET/IVF can assist if accuracy of EBV is good
Potential areas for International Cooperation

- Share and update information on dairying in the region
- Developing standard operating procedures: ICAR guidelines could be useful
- Capacity Building: Training programmes; Seminars/Conferences with proceedings to all
- Study tours – report to all.
- Exchange of genetic material – within; outside.
- Collaborate having a dairy consortium research for genetic improvement
- Facilitate making experts available.
- Joint Ventures
- Advisory Groups
Role of DAIRY ASIA?

- Umbrella as the RFP for NFPs
- Information Centre – ensure sharing
- Forum – comments, discussions
- Assistance for project proposals/outside funds
- International Link on all dairy matters
- Assist with administration for regional workshops/training courses.
- NOT A FUNDING AGENCY but needs funds to operate effectively
- ONLY USEFUL IF MEMBERS PARTICIPATE FULLY
Working Group on Dairy Genetics
Structure of Working Group

Membership:

• Each National Focal Point has been invited to nominate one member (13); more people will be invited to join for specific task forces.

• National Genetics Working groups could be formed; the model has been introduced in Thailand. The Chair of National Working Group can then represent the Dairy Asia Working Group.

• Membership is for 3 years, but can be extended by another term (i.e., maximum 6 years).

• Members are expected to commit 2 days per month to the work of the group and chairman 4 days per month.
Structure of Working Group

Governance:
Working Group will have Chairman, Co-chairman and Secretary

Communication:
• Through all electronic means
• Once per year face-to-face meeting
• Chairman will communicate with secretariat, steering committee partners

Resources:
• Time commitment by members
• Explore and utilize synergies between planned activities of the group and present work conducted by members
• Dairy Asia does not commit any money to the working group but the secretariat would support the group in reaching out to investment partners to finance specific products or services of the group.
Structure of Working Group

Support of secretariat

• Help finding resources
• Connect between working group and all other groups
• Support communication within the group - disseminating agendas and approved minutes, organizing electronic and face-to-face meetings.
Activities envisaged for the Working Group

- Developing a database on genetic resources, production systems, breeding infrastructure
- Characterization of the indigenous genetic resource in each country:
  - Description of physical and production characteristics, natural environment, management practices
  - Genetic characterization
    - Identifying markers for extreme conditions
    - Elucidating genetic architecture
- Sharing each other’s practices/experiences
- Developing standard operating procedures:
  - Setting breeding goals
  - Implementing Progeny Testing Programmes, nucleus schemes and genomics
  - Semen production and processing
  - AI delivery
  - Information Systems
  - Quality control
- Evaluation of countries’ breeding programmes, semen stations, AI delivering and AI training centres
- Analysing cost effectiveness of various genetic improvement programmes
- Sharing experience of developing software
- Facilitating trainings/ study tours/ workshops/ seminars
- Facilitating exchange of genetic material
- Developing a database on local experts
Developing a database on genetic resources, production systems, and infrastructure

Propose to carry out a survey on genetic resources, production systems and breeding infrastructure through a structured questionnaire:

Objectives of survey:
1. Document promising local dairy breeds of cattle and buffalo in Asian countries.
2. Document native tract and production systems followed, environment (temperature and precipitations), and extreme events occurring in the respective native tract.
3. Assess expected impacts of climate change in near, medium and long terms in native tracts of identified breeds.
4. Document the existing infrastructure for performance recording, semen production, artificial insemination, natural service, information systems, quality control, training and research in Asian countries.
5. Assess the size and quality of genetic improvement programmes (in particular progeny testing) being implemented in Asian countries with a view to improving their effectiveness.
6. Assess needs of capacity building and research capabilities.
7. Identify constraints faced, prioritise interventions, identify policy interventions and regulatory mechanisms to be set up.

A questionnaire has been prepared and finalised and is ready to be sent to representatives of National Focal Points for filling the questionnaire.

Based on the response received a report will be prepared and activities that can be implemented through Dairy Asia Platform will be identified.
Other activities planned

- Prepare SOP for genetic improvement programmes
- Working Group Meeting in Sept-Oct, 2017
- Invite ICAR representative in Working Group Meeting
Thank You