Nutritional Strategies for Efficient Milk Production and Reproduction

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Major issues faced by the dairy farmers
- Low productivity against genetic potential
- Slow growth rate of calves and higher AFC
- Poor quality cattle feed
- Lack of mineral mixture
- Poor fertility of animals
- Imbalanced rations: higher production cost & less income
- Round the year supply of green fodder
- Poor management of crop residues

Environmental impact

Animal Nutrition Programmes

Objective
“Productivity Enhancement of Dairy Animals through the Introduction of Innovative Farmer Friendly Technologies”

NDBB’s technologies mainly deals with:
- Increasing dairy animals’ productivity
- Improving milk quality
- Optimizing cost of feeding
- Increasing availability of green fodder seeds
- Efficient utilisation of available feed resources and crop residues
- Reducing environmental impact of dairying

Technical Support to Cooperatives and Federations
- Setting up cattle feed, mineral mixture, bypass protein, bypass fat and TMR plants
- Production of various types of feeds / TMR
- Ensuring quality of feed through ‘Quality Mark’
- Capacity building through training

Strategic Feed Supplements
- Area Specific Mineral Mixture
- Mastitis supplement
- Bull supplement
- Fertility supplement
- Heat stress supplement
- Supplement for improving Fat & SNF

Major Activities

Programmes
- Calf Rearing
- Ration Balancing

Environmental Impact Assessment
- Methane emission
- Carbon footprint
- Water footprint

Fodder Development & Crop Residue Management
- Propagation of high yielding fodder varieties
- Modern fodder farming techniques
- Enrichment & densification of crop residues
Technical Advisory to Cattle Feed Plants

- Set up 70 cattle feed plants (CFP) under dairy cooperatives (300-1000 t/d), producing about 3.60 million tonne cattle feed per year.
- Providing advisory services to cattle feed plants (http://cfp.nddb.coop)
- Organizing training programmes for various CFP related activities.

CFP, Amul (capacity: 1000 t/d)

Development of Processes and Plants for production of Feeds and Feed Supplements

- Developed process for production of Bypass Protein and set up 20 plants (50 t/d).
- Standardized production process and plant for Bypass Fat supplement (6 t/d).
- Based on mineral mapping, NDDB has developed Area Specific Mineral Mixtures (ASMM) and set up 37 plants (12 t/d).
- Cold process for production of Urea Molasses Mineral Blocks (UMMB) has been developed and set up 20 plants (3 t/d).
- Established 2 plants for Straw Densification and Enrichment (50 t/d).

Quality Mark – To ensure quality of feed

- Developed 'Quality Mark' for different variants of CF & MM.
- Total 12 CFPs have signed MoU for implementing QM.
- Assist in promoting cattle feed through promotion of media.

Need for Quality Mark
- In 2013 'Feed Regulation Act' excluded from Sec 3 of EC Act 1955.
- Lack of regulatory mechanism for monitoring quality of CF and MM.

Lack of variants:
- 13% BIS Type-I
- 68% BIS Type-II
- 19% Bypass protein

'Quality Mark' launched on 8th Sep. 2018
**Major Activities**

- Technical Support to Cooperatives and Federations
  - Setting-up cattle feed, mineral mixture, bypass protein, bypass fat and TMR plants
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  - Capacity building through training

- Strategic Feed Supplements
  - Area Specific Mineral Mixture
  - Fodder supplement
  - Bull supplement
  - Heat stress supplement
  - Propagation for high yielding fodder varieties
  - Modern fodder farming techniques
  - Methane emission
  - Enrichment & densification of crop residues

- Programmes
  - Car Rearing
  - Ratn Balancing

- Fodder Development & Crop Residue Management
  - Provision of cattle feed, minerals, vitamins, and bolus

- Environmental Impact Assessment
  - Methane emission
  - Carbon footprint
  - Water footprint

**Technical Support to Cooperatives and Federations**

- Setting-up cattle feed, mineral mixture, bypass protein, bypass fat and TMR plants
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**Fodder Development & Crop Residue Management**

- Provision of cattle feed, minerals, vitamins, and bolus

**Environmental Impact Assessment**

- Methane emission
- Carbon footprint
- Water footprint

**Fat and SNF supplement**

- Milk fat and SNF – important constituents that determine the milk price.
- Nutrient deficiency – often results in lower milk fat and SNF, rejection of milk at DCS.
- Supplement for early lactating animals.

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Milk yield (kg/d)</td>
<td>10.11</td>
<td>8.86</td>
<td>10.17</td>
<td>8.94</td>
<td>12.37</td>
<td>10.40</td>
</tr>
<tr>
<td>Milk fat (%)</td>
<td>4.26</td>
<td>4.65</td>
<td>4.90</td>
<td>4.34</td>
<td>4.76</td>
<td>4.56</td>
</tr>
<tr>
<td>SNF (%)</td>
<td>3.67</td>
<td>3.97</td>
<td>3.94</td>
<td>3.82</td>
<td>3.97</td>
<td>3.77</td>
</tr>
<tr>
<td>Return over feed cost (Bull animal)</td>
<td>139</td>
<td>157</td>
<td>148</td>
<td>162</td>
<td>204</td>
<td>229</td>
</tr>
<tr>
<td>Extra net income (Bull animal)</td>
<td>18</td>
<td>14</td>
<td>25</td>
<td></td>
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</tr>
</tbody>
</table>

**Mastitis supplement**

- Sub-clinical mastitis (SCM) 30-40 times more prevalent that clinical mastitis.
- Minerals (Zn, Cu, Cr, I) and vitamins (A, E) essential for immunity & preventing SCM.
- Supplement (-30 to calving).
- Tested in more than 300 animals at various locations, having history of SCM.

- Incidence of SCM in Control (30%) vs. Treatment (21%).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ctrl.</th>
<th>Treat.</th>
</tr>
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<tbody>
<tr>
<td>Initial milk yield (kg/d)</td>
<td>10.12</td>
<td>10.11</td>
</tr>
<tr>
<td>Milk fat (%)</td>
<td>5.00</td>
<td>5.00</td>
</tr>
<tr>
<td>SNF (%)</td>
<td>3.75</td>
<td>3.75</td>
</tr>
<tr>
<td>Return over feed cost (Bull animal)</td>
<td>201</td>
<td>229</td>
</tr>
<tr>
<td>Extra net income (Bull animal)</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

**Heat stress supplement**

- THI > 72 units results in reduced feed intake (5-20%), drop in milk yield (10-30%), panting and increased body temperature. Affects fertility (ovarian function, GF, GL, CR & prolong NEB).
- Estimated economic loss > Rs 5000.

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**Area specific mineral mixture**

- Mineral mapping by NDDB and ICAR Micro-Nutrients Network Programme.
- Total 20 ASMM formulations have been developed for various agro-climatic zones to address deficiencies which have direct impact on production and reproduction.

**GarbhaMin**

- Coated vitamins and chelated minerals based bolus.
- Effective in reproductive disorders like anoestrous, repeat breeding, delayed ovulation etc.

**Bull supplement**

- Coated vitamins, chelated minerals and amino acids based pelleted supplement.
- About 400 extra semen doses per bull per month (+400).
- Improved sperm plasma membrane integrity and per cent intact acrosome.

**Fertility supplement**

- Chelated minerals, vitamins and omega fatty acids based supplement (under testing).
- A pilot study revealed confirmed pregnancy in 70% of the tested animals (n=168) in Odisha and Gujarat.
Major Activities

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- Fertility supplement
- Heat stress supplement
- Supplement for improving Fat & SNF

Programmes
- Calf Rearing
- Ration Balancing
- Calves
- Minerals Mixture
- Excess in both CP and TDN
- Deficit in both Ca and P
- Excess in Ca and Deficit in TDN
- Deficit in CP and excess in TDN
- Deficit in Ca and excess in TDN

Fodder Development & Crop Residue Management
- Propagation of high yielding fodder varieties
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Calf Rearing Programme (CRP)
- 6 milk unions in 3 states
- 5692 pregnant animals in 199 villages
- 2001 female calves under growth monitoring

Effect of feeding calf starter/growth meal on growth and puberty

Control
- Age: 6 months
- BW: 91 kg
- Wt. gain: 325 g/d

Treatment
- Age: 6 months
- BW: 123 kg
- Wt. gain: 498 g/d

Control
- 1st heat: 25 months
- BW: 236 kg

Treatment
- 1st heat: 17 months
- BW: 250 kg

Present status of feeding in-milk animals in various states
(n=23,68,728)

CP and TDN
- Excess in both CP and TDN
- Deficit in both CP and TDN
- Excess in CP and Deficit in TDN
- Deficit in CP and excess in TDN
- Deficit in Ca and excess in P
- Excess in Ca and Deficit in P
- Deficit in both Ca and P
- Excess in both Ca and P

Ca and P
- Excess in both CP and TDN
- Deficit in both CP and TDN
- Excess in CP and Deficit in TDN
- Deficit in CP and excess in TDN
- Deficit in Ca and excess in P
- Excess in Ca and Deficit in P
- Deficit in both Ca and P
- Excess in both Ca and P
Ration Balancing Programme (RBP)

- Educate milk producers on ration balancing (RB) and nutrients required by milch animals by providing doorstep advisory services through LRPs.
- Judicious use of feed resources
- Optimum nutrient supply
- Feed data library
- Nutrient masters
- Information Network for Animal Productivity and Health
- Registration (unique ear tag)
- Nutrient req. (milk yield, fat)
- Nutrient supply (current feeding)
- Nutrient status (+/-)
- Least cost balanced ration

Impact of Ration Balancing Programme

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Before RBP</th>
<th>After RBP</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk yield (kg/animal/d)</td>
<td>7.12</td>
<td>7.39</td>
<td>+0.27</td>
</tr>
<tr>
<td>Milk fat (%)</td>
<td>4.7</td>
<td>6.8</td>
<td>+0.10</td>
</tr>
<tr>
<td>Cost of feeding (Rs./animal-d)</td>
<td>135.25</td>
<td>118.69</td>
<td>-16.76</td>
</tr>
<tr>
<td>Cost of production (Rs./kg milk)</td>
<td>19.45</td>
<td>17.59</td>
<td>-2.86</td>
</tr>
<tr>
<td>Net income (Rs./animal d)</td>
<td>+26.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of AI per conception</td>
<td></td>
<td></td>
<td>+0.45</td>
</tr>
</tbody>
</table>

Technical Support to Cooperatives and Federations

- Setting up cattle feed, mineral mixture, bypass protein, bypass fat and TMR plants
- Production of various types of feeds: TMR
- Ensuring quality of feed through 'Quality Mark'
- Capacity building through training

Strategic Feed Supplements

- Area Specific Mineral Mixture
- Mastitis supplement
- Heat stress supplement
- Supplement for improving Fat & SNF

Programmes

- Calf Rearing
- Ration Balancing

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- Modern fodder farming techniques

Environmental Impact Assessment

- Methane emission
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Enteric Methane Emission

- Methane emission – energy loss (1 L CH4 = 39.5 KJ)
- Represents 4-12% of gross energy intake

Feeding balanced rations reduced CH4 emission (g/kg milk) by 17%.
Carbon Footprint of milk

FAO (2013)

North America

Oceania

Latin America

Europe

Russian Federation

Near East & North Africa

Sub-Saharan Africa

East & Southeast Asia

South Asia

Global average

5.5

3.2

1.8

1.8

5.1

4.4

1.6

3.9

1.3

3.2

Relationship between GHG emissions & milk output

Gerber et al. (2011)

India

Output per cow, kg FPCM per year

kg CO2-eq. per kg FPCM

Water Footprint (WF) of milk

Agriculture sector:
- 90% of freshwater withdrawal (MWR, 2017)
- 70% crops, 30% livestock

Consumptive water use for dairy:
- 98% feeding, 2% (drinking, servicing)
- 65% Irrigation, 35% rain water

RBP resulted in 14% reduction in WF_milk

Water Footprint (lt/kg milk)

Cow 1071

Buffalo 1416

Source: Garg et al. (2018)

Scope to reduce CF of milk
- Farm management:
  - Feeding balanced rations reduced carbon footprint by 30% (Garg et al., 2016).
  - Improving herd efficiency
  - Manure management
  - Biogas, solar energy
- Crop production (crop varieties, fertilizers, FYM)
- Feed manufacturing (efficiency of CFPs, solar)
- Post-farm gate (refrigerants, effluents, solar, packaging, waste recycling)

North-West region
- 40% of national milk
- High to extremely high water stress

Cow 1071

Buffalo 1416

n = 1,97,244; p < 0.01; bRB: Before RB; aRB: After RB
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Strategic Feed Supplements

- Area Specific Mineral Mixture
- Maltitius supplement
- Bull supplement
- Fertility supplement
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Programmes

- Cash Reaping
- Ratio Balancing

Fodder Development & Crop Residue Management

- Propagation of high yielding fodder varieties
- Modern fodder farming techniques
- Enrichment & densification of crop residues

Environmental Impact Assessment

- Methane emission
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- Water footprint

Fodder Development and Crop Residue Management

(under National Dairy Plan-I)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Sub-activity</th>
<th>Unit</th>
<th>Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fodder development</td>
<td>Fodder seed processing plants</td>
<td>Nos.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Fodder seed production support</td>
<td>MT (Rs.2750)</td>
<td>40215</td>
</tr>
<tr>
<td></td>
<td>Sludge demonstration (57081 farmers in 2573 villages)</td>
<td>Nos. (Rs.0.25 lakh)</td>
<td>1966</td>
</tr>
<tr>
<td></td>
<td>Re-vegetation of common grazing lands</td>
<td>Hectare (Rs. 0.5 lakh)</td>
<td>144</td>
</tr>
<tr>
<td>Crop Residue Management</td>
<td>Mixers - without pick up devices</td>
<td>Nos. (Rs.0.5 lakh)</td>
<td>432</td>
</tr>
<tr>
<td></td>
<td>Mixers - with auto pick up devices</td>
<td>Nos. (Rs.7.5 lakh)</td>
<td>181</td>
</tr>
<tr>
<td></td>
<td>Straw enrichment and densification plants</td>
<td>Nos. (Rs. 500 lakh)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Biomass bunkers/ stores</td>
<td>Nos. (Rs.10 lakh)</td>
<td>110</td>
</tr>
</tbody>
</table>

Ensuring round the year fodder availability through ‘DCS based low-cost commercial scale silage making model’

<table>
<thead>
<tr>
<th>Capital &amp; Operational (1st year)</th>
<th>Rs. lakh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime mower, disc mower &amp; trolley</td>
<td>12.5</td>
</tr>
<tr>
<td>Chopper &amp; trolley</td>
<td>1.5</td>
</tr>
<tr>
<td>Silage packing &amp; pressing machine</td>
<td>1.75</td>
</tr>
<tr>
<td>Vacuum pump &amp; weighing scale</td>
<td>0.35</td>
</tr>
<tr>
<td>Total capital expenditure</td>
<td>16.8</td>
</tr>
<tr>
<td>Fodder and others</td>
<td>2.5</td>
</tr>
<tr>
<td>Grass fodder</td>
<td>0.75</td>
</tr>
<tr>
<td>Silage bag</td>
<td>1.0</td>
</tr>
<tr>
<td>Total cost of silage making</td>
<td>5.9</td>
</tr>
<tr>
<td>Net income</td>
<td>14.3</td>
</tr>
</tbody>
</table>

Crop residue generation: 502 MT/yr

Crop residue burned: 84-140 MT/year

Reasons:
- Less time window (Paddy-Wheat)
- Labour shortage
- High cost of removal
- Mechnaized harvesting
- Lack of mechanism for straw management

Surplus crop residues

Punjab
Haryana
Uttar Pradesh
West Bengal

Nutrient loss: (kg/MT straw)
- N: 5.5
- P: 2.3
- K: 25
- B: 1.2
- Organic Carbon

Loss of soil fertility:
- Loss of soil microbes
- Lower N and C in root zone

Emissions: (kg/MT straw)
- CO2: 1460
- NOx: 3.5
- SO2: 0.2
- CH4 and N2O

Surplus crop residues

Punjab
Haryana
Uttar Pradesh
West Bengal


Straw Densification & Enrichment - TMR Plant

Advantages:
- Provide uniform and nutritionally complete feed, less variation in milk fat and SNF.
- Discourage selective feeding by animals, reduce wastage of feed.
- Help to maintain optimum rumen pH, fewer digestive upsets.
- Effective way of feeding balanced rations in different stages of lactation.
- Promising technology to abridge the gap of perennial shortage of fodder.

Balanced Total Mixed Rations for improving profitability of dairy farming

<table>
<thead>
<tr>
<th></th>
<th>Early lactation (51 to 90 d)</th>
<th>Mid lactation (91 to 180 d)</th>
<th>Late lactation (181 to 305 d)</th>
<th>Per lactation (value in Rs.)</th>
<th>Traditional feeding</th>
<th>TMR feeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentrate: Roughage</td>
<td>40.55</td>
<td>40.62</td>
<td>30.72</td>
<td>Feeding cost</td>
<td>53,100</td>
<td>54,300</td>
</tr>
<tr>
<td>TMR pellets (DM kg/d)</td>
<td>14</td>
<td>13</td>
<td>12</td>
<td>Income from milk*</td>
<td>70,000</td>
<td>80,500</td>
</tr>
<tr>
<td>Green fodder (DM kg/d)</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>Net Income</td>
<td>16,900</td>
<td>28,200</td>
</tr>
<tr>
<td>TMR: Grains (%)</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>Change in net income (Rs 30/kg)</td>
<td>8000</td>
<td></td>
</tr>
<tr>
<td>TMR: Straw (%)</td>
<td>35</td>
<td>45</td>
<td>50</td>
<td>Lactation yield</td>
<td>+12% (300 kg)</td>
<td></td>
</tr>
</tbody>
</table>

* Milk price @ Rs. 30/kg

Take Home Message

- Ration balancing - should be considered as an immediate and most practical strategy for improving profitability of farmers and productivity of dairy animals in an environmentally sustainable manner.
- Strategic feed supplements - can help to address reproductive disorders, improve quality of milk and thereby income of smallholder farmers in India.
- Scientific fodder production, conservation of green fodder and crop residue densification/ TMR are the promising technologies to abridge the gap between demand and availability of fodder in the country.
Priority areas:
- Improving digestibility of crop residues/biomass management to reduce cost of milk production.
- TMR for various categories of animals.
- Feeds for improving fertility of animals.
- Nutritional approach for reducing metabolic disorders.

Additional areas:
- Outcome of nutrient-gene interaction studies for the benefit of farmers.
- Integration of feed technology.
- Use of Information Technology tools for precision animal nutrition.