Academic Institutions and Industry Interactions: Sharing Experience by NDDB

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
- Lower milk fat and SNF content
- 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"

NDDB'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

Major Activities

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

Programmes

- Calf Rearing
- Ration Balancing

Environmental Impact Assessment

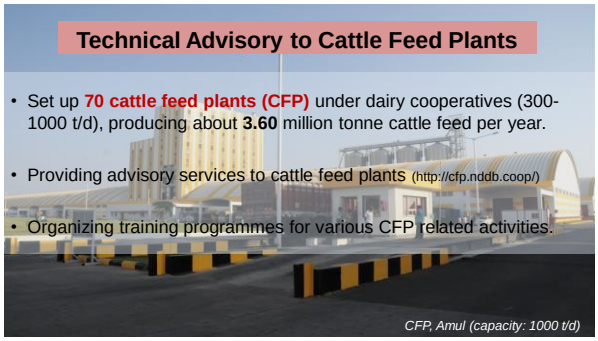
- Methane emission
- Carbon footprint
- Water footprint

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).


Bypass protein plant


Mineral mixture plant

'Quality Mark' – To ensure quality of feed

❑ **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**
- 18% Bypass protein

- ✓ 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.

'Quality Mark' launched on 8th Sep. 2018


Calf Starter

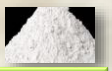

Calf Growth Meal


Feed for Lactating Animals


Pregnancy Feed


Buffalo Feed


Bypass Protein Feed


Mineral Mixture

Feeds/ supplement covered under Quality Mark

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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.

Bull supplement

- Coated vitamins, chelated minerals and amino acids based pelleted supplement.
- About 400 extra semen doses per bull per month (*n*=100).
- Improved sperm plasma membrane integrity and per cent intact acrosome.

GarbhaMin

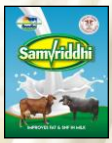
- Coated vitamins and chelated minerals based bolus.
- Effective in reproductive disorders like anoestrous, repeat breeding, delayed ovulation etc.

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.

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.



Parameter	Gir cows		Crossbred cows		Buffaloes	
	Ctrl.	Treat.	Ctrl.	Treat.	Ctrl.	Treat.
Milk yield (kg/d)	10.11	10.89	13.10	13.67	8.81	9.40
Milk fat (%)	4.26	4.65	3.88	4.24	7.09	7.37
SNF (%)	8.61	8.79	8.54	8.69	9.07	9.23
Return over feed cost (Rs/d/ animal)	139	157	148	162	204	229
Extra net income (Rs/d/ animal)		18		14		25

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 **(80%)** *vs.* Treatment **(21%)**.

(Bhanderi and Garg, 2012; Bhanderi *et al*., 2015)

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, CL, CR & prolong NEB).
- Estimated economic loss > Rs 5000.

Parameter	Crossbred cows	
	Ctrl.	Treat.
Initial milk yield (kg/d)	19.10	19.00
Milk yield_90 d (kg/d)	16.58[a]	18.33[b]
Milk fat (%)	3.70[a]	3.96[b]
SNF (%)	8.54[a]	8.63[b]
Return over feed cost (Rs/d/ animal)	201[a]	221[b]
Extra net income (Rs/d/ animal)		20

(*P*<0.05)

Urea Molasses Mineral Block (UMMB)

- Crop residues based rations deficient in Nitrogen, energy and minerals.
- UMMB stimulates rumen fermentation and microbial N synthesis, leading to improvement in milk yield.
- Developed process and plant for production of UMMB by modified cold process.

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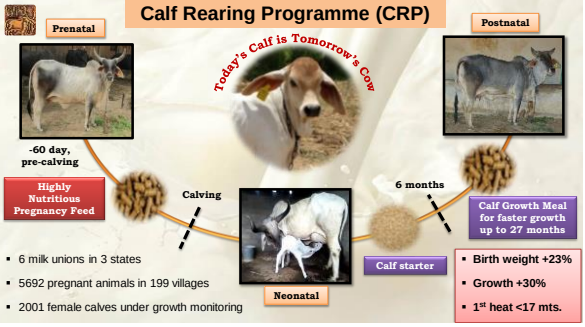
Calf Rearing Programme (CRP)



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

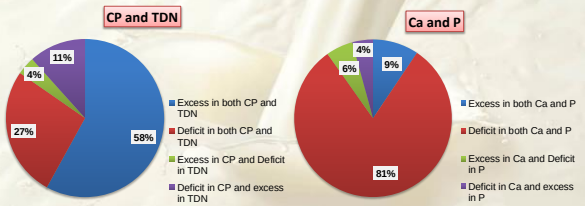
1st heat: 25 months
BW: 236 kg

Treatment

1st heat: 17 months
BW: 250 kg

Present status of feeding in-milk animals in various states

(*n*=23,68,728)



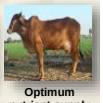
Ration Balancing Programme (RBP)

- Educate milk producers on ration balancing (RB) and nutrients required by milch animals by providing doorstep advisory services through LRPs.


Feed data library


Nutrient masters


Judicious use of feed resources


Optimum nutrient supply

- Registration (unique ear tag)
- Nutrient req. (milk yield, fat)
- Nutrient supply (current feeding)
- Nutrient status (+/-)
- Least cost balanced ration

Information Network for Animal Productivity and Health

States	18
Milk unions, PCs	115
Animals	28,05,038
Farmers	21,15,679
Villages	33,099
LRPs deployed	30,820

Impact of Ration Balancing Programme

Parameter	Before RBP	After RBP	Change
Milk yield (kg/ animal/ d)	7.12	7.39	+0.27
Milk fat (%)	4.7	4.8	+0.10
Cost of feeding (Rs./ animal/ d)	135.25	118.49	-16.76
Cost of production (Rs./ kg milk)	19.45	17.09	-2.36
Net income (Rs./ animal/ d)			**+26.10**
Net income (Rs./animal/ lactation)			**+7748**
FUE (kg milk/ kg DMI)	0.55	0.72	+0.17
BUN (mg/dl)	18.90	15.77	-3.13
Serum IgG (mg/ml)	13.10	22.32	+9.22
Lactation length (d)	275	298	+0.23
Number of AI per conception	1.92	1.47	-0.45

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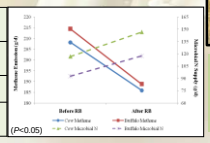
Enteric Methane Emission

- Methane emission – energy loss (1 L CH_4 = 39.5 KJ)
- Represents 4-12% of gross energy intake.

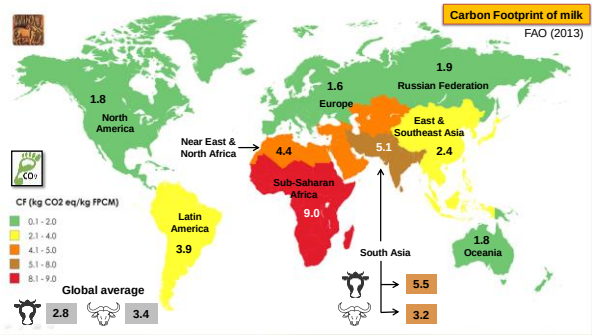
Losses
- **Animals** – Wastage of feed energy
- **Farmers** – Energy loss for milk production
- **Environment** – CH_4 – a potent GHG (**34** GWP)

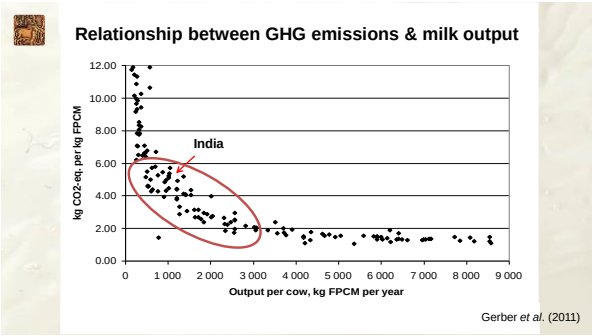
(*n*= 252)	Before RB	After RB	Change
Milk yield (kg/d)	9.3[a]	9.7[b]	**+5.2%**
CH_4 (g/d)	215.5[a]	189.4[b]	**-12.1%**
CH_4 (g/kg MY)	25.4[a]	21.0[b]	**-17.3%**

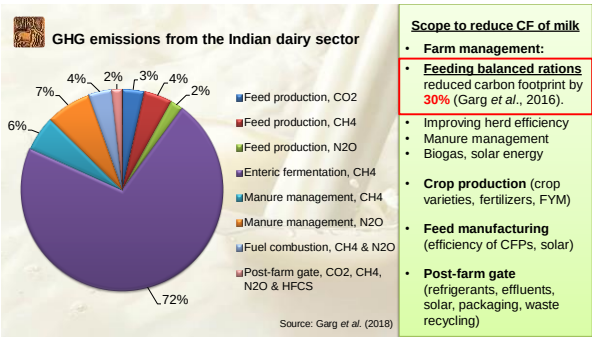

(*P*<0.05)

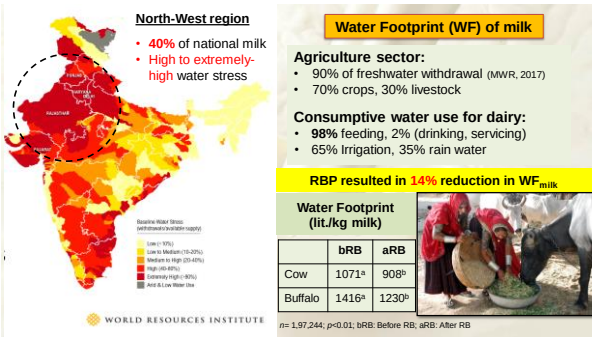
Methane measurement by SF_6 Tracer Technique

Feeding balanced rations reduced CH_4 emission (g/kg milk) by **17%**.


Carbon Footprint of milk
FAO (2013)
1.8
North America
1.6
Europe
1.9
Russian Federation
Near East & North Africa
4.4
East & Southeast Asia
5.1
2.4
Sub-Saharan Africa
9.0
Latin America
3.9
South Asia
1.8
Oceania
CF (kg CO2 eq/kg FPCM)
0.1 - 2.0
2.1 - 4.0
4.1 - 5.0
5.1 - 8.0
8.1 - 9.0
Global average
2.8
3.4
5.5
3.2


Relationship between GHG emissions & milk output
kg CO2-eq. per kg FPCM
12.00
10.00
8.00
6.00
4.00
2.00
0.00
India
0
1 000
2 000
3 000
4 000
5 000
6 000
7 000
8 000
9 000
Output per cow, kg FPCM per year
Gerber et al. (2011)


GHG emissions from the Indian dairy sector
7%
4%
2%
3%
4%
2%
6%
72%
Feed production, CO2
Feed production, CH4
Feed production, N2O
Enteric fermentation, CH4
Manure management, CH4
Manure management, N2O
Fuel combustion, CH4 & N2O
Post-farm gate, CO2, CH4, N2O & HFCS
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
WORLD RESOURCES INSTITUTE
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 WFmilk
Water Footprint (lit./kg milk)
bRB
aRB
Cow
1071a
908b
Buffalo
1416a
1230b
n= 1,97,244; p<0.01; bRB: Before RB; aRB: After RB

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Fodder Development and Crop Residue Management

(under National Dairy Plan-I)

Activity	Sub-activity	Unit	Achievement
Fodder development	Fodder seed processing plants	Nos. (Rs.100 lakh)	5
	Fodder seed production support	MT (Rs.2750)	40215
	Silage demonstration (57081 farmers in 2573 villages)	Nos. (Rs.0.25 lakh)	1966
	Re-vegetation of common grazing lands	Hectare (Rs. 0.5 lakh)	144
Crop Residue Management	Mowers - without pick up devices	Nos.(Rs.0.5 lakh)	432
	Mowers - with auto pick up devices	Nos.(Rs.7.5 lakh)	181
	Straw enrichment and densification plants	Nos. (Rs. 500 lakh)	2
	Biomass bunkers/ stores	Nos. (Rs.10 lakh)	110

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


Mechanised harvesting


Wilting


Chopping & loading


Mechanised filling & compaction


Silage in HDPE bags

Capital & Operational (1st year)	Rs. lakh
Prime mover, disc mower & trolley	12.5
Chopper & loader	1.5
Silage packing & pressing machine	1.75
Vacuum pump & weighing scale	0.25
Total capital expenditure	**16.0**
Capital + operational expenditure	**20.0**

Fodder and others	Rs/ kg
Green fodder	2.5
Operational & labour	1.5
Silage bag	1.0
Cost of silage making	**5.0**
Sale price of silage	**6.0**

15 tonne maize fodder/ acre (3x/ year)

1440 t silage/ year (30 t/ week)	Rate (Rs/ t)	Cost (Rs lakh)
Income from sale	0.06	86.4
Production cost	0.05	72.0
Net income		**14.4**

- Silage for 260 animals/ year (15 kg/d)
- Fodder – buy back guarantee
- Supply to landless & marginal farmers
- Employment generation for 4-5 persons

Reasons:

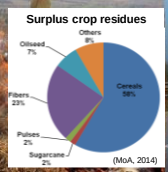
- Less time window (Paddy-Wheat)
- Labour shortage
- High cost of removal
- Mechanised harvesting
- Lack of mechanism for straw management

Crop residue generation: **502 MT/ year**
Crop residue burned: **84-140 MT/ year**

- Punjab
- Haryana
- Uttar Pradesh
- West Bengal

- Paddy
- Wheat
- Sugarcane

Surplus crop residues



(MoA, 2014)

Nutrient loss: (kg/ MT straw)

- N : 5.5
- P : 2.3
- K : 25
- S : 1.2
- Organic Carbon

Loss of soil fertility:

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

Emissions: (kg/ MT straw)

- CO_2 : 1460
- CO : 60
- NOx : 3.5
- SO_2 : 0.2
- CH_4 and N_2O

Combine Prevention Mowers

Brush Cutter | Walk Behind Reaper Liner | Reaper Binder | Front Mounted Reaper Liner

Pick-up Devices

Straw Reaper | Flail mower | Raker | Baler

Straw Densification & Enrichment - TMR Plant

Straw conditioner | Concentrate mixer | TMR mixer | TMR Pellets

❑ **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

	Early lactation (31 to 90 d)	Mid lactation (91 to 180 d)	Late lactation (181 to 305 d)
Concentrate: Roughage	45:55	40:60	30:70
TMR pellets (DM kg/d)	10	9	8
Green fodder (DM kg/d)	4	4	4
Total DM (kg/d)	14	13	12
TMR: Grains (%)	25	20	15
TMR: Oilseed meals (%)	25	20	15
TMR: Straw (%)	**35**	**45**	**55**
TMR: Bypass fat (g/d)	100	-	-
TMR: Minerals and Vitamins	ASMM, Vit.	ASMM, Vit.	ASMM, Vit.

Per lactation basis, values in Rs.	Traditional feeding	TMR feeding
Feeding cost	53,100	54,300
Income from milk*	70,000	80,500
Net income	16,900	26,200
Change in net income (Rs 30/d)		**9300**
Lactation yield		**+15% (300 kg)**

* 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.

Possible Areas for Future Research

Research orientation: Field survey → Institute level trials → Field trials → Tie-up with industry → Strong extension

Priority areas:

- Improving digestibility of crop residues/ biomass management/ 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.