Workshop on Water use assessment of livestock production systems and supply chains
(Potsdam, Germany; 14-16 Dec. 2022)

Ration Optimization to reduce Water Footprint & Methane Emission Intensity of Milk

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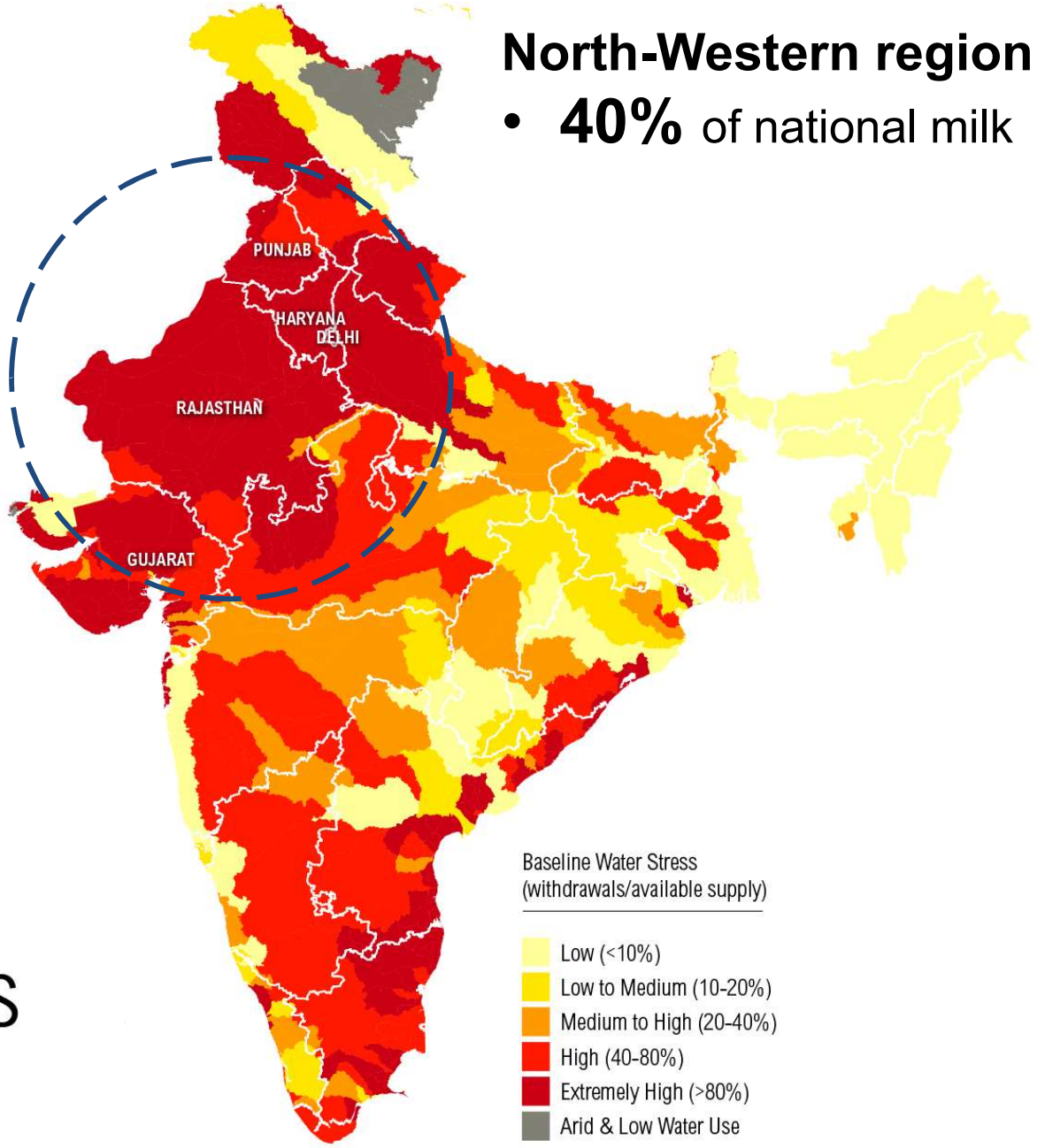
Overview

- Current scenario/ challenges
- Development & implementation of strategy
- Impact assessment (water footprint & methane)
- Way forward

Current Scenario/ Challenges

54%

of India Faces **High** to **Extremely High** Water Stress



North-Western region:

- **40%** of national milk

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WORLD RESOURCES INSTITUTE

❑ Feeding pattern

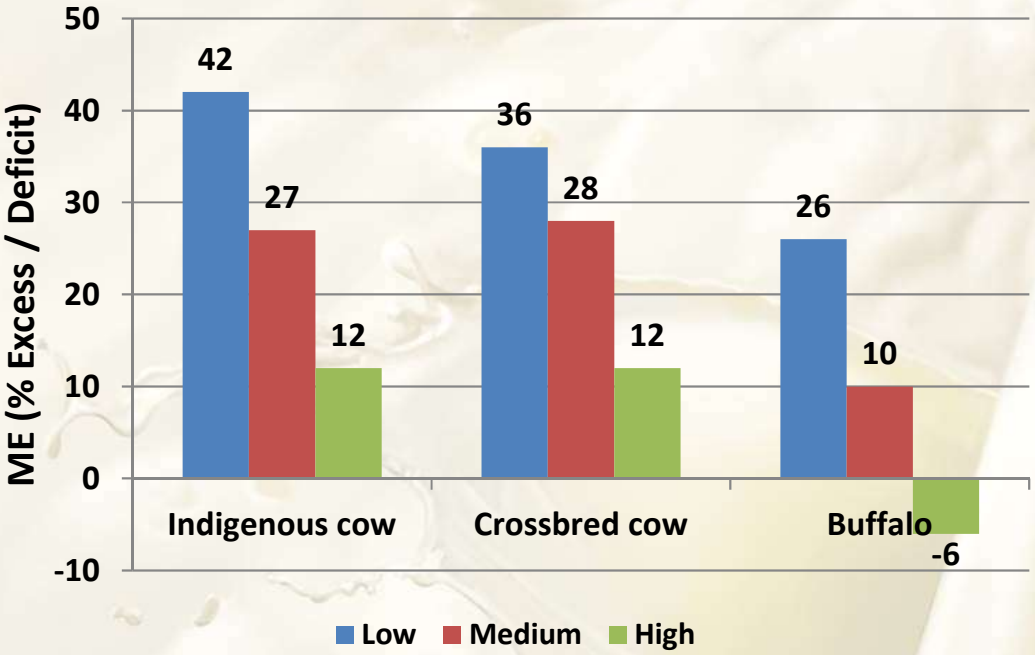
- Lack of awareness & skills among dairy farmers to optimize dairy rations.
- Nutrient imbalance (+20% energy, +28% protein, -20% calcium, -31% phosphorus).

❑ Impact on productivity, economics & environment

- Lower yield of milk & milk constituents
- Higher cost of feeding & less income
- Higher water footprint & enteric methane emission intensity of milk.

Nutrient status on traditional feeding system

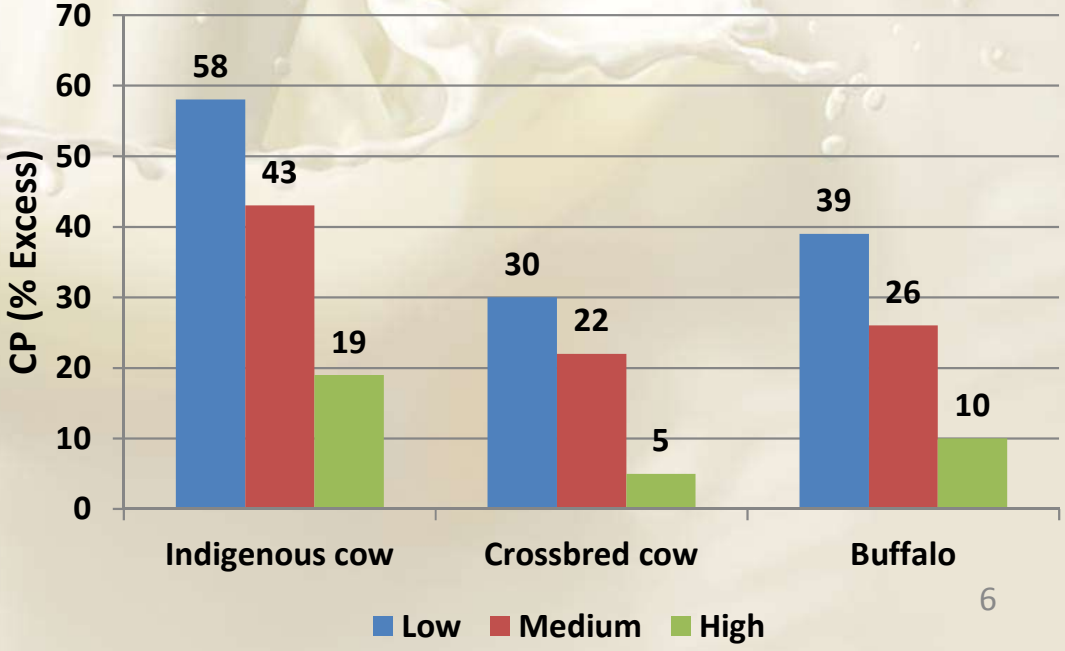
Metabolizable Energy



Indigenous cows (*n*=12,798)
Crossbred cows (*n*=75,525)
Buffaloes (*n*=94,618)

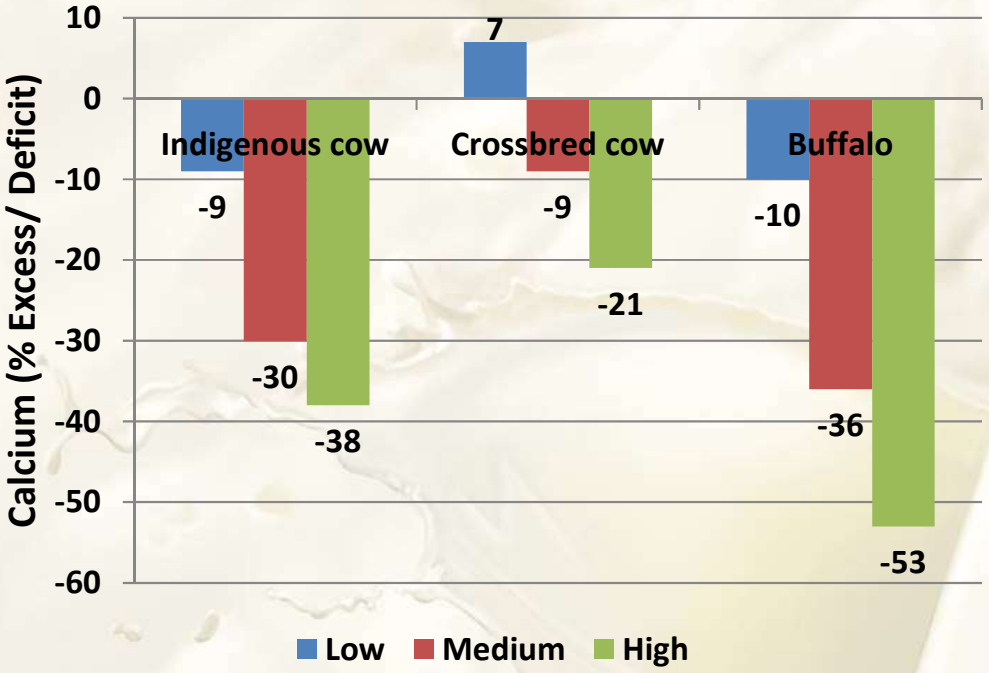
Low yielders (<8 kg/d)
Medium yielders (8-12 kg/d)
High yielders (>12 kg/d)

Crude Protein



Nutrient status on traditional feeding system

Calcium



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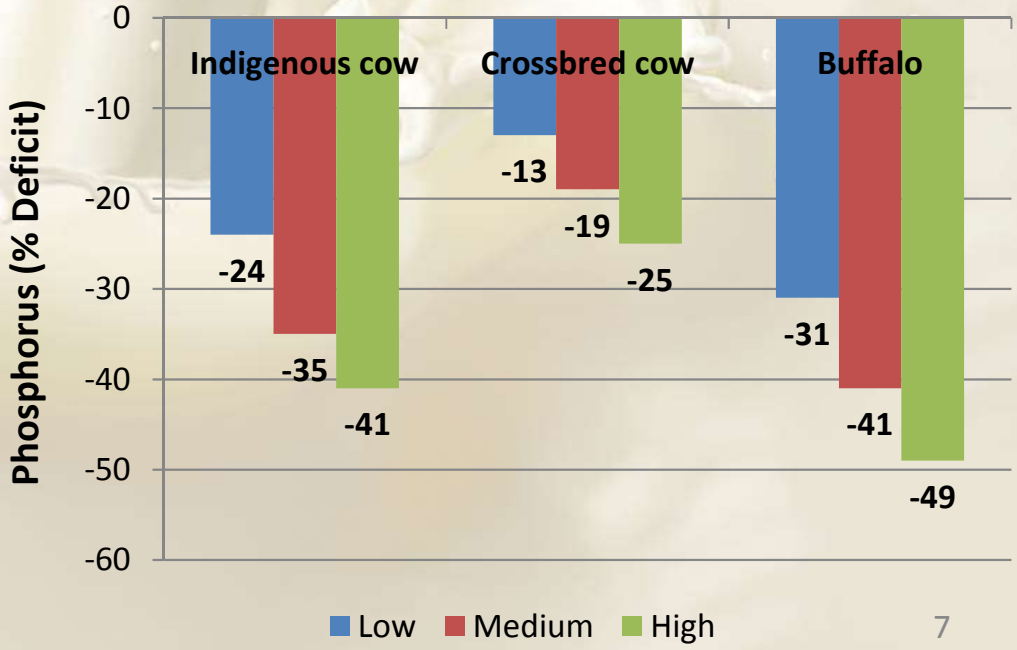
Phosphorus



Low yielders (<8 kg/d)
Medium yielders (8-12 kg/d)
High yielders (>12 kg/d)

Development & Implementation of Strategy

Information Network for Animal Productivity and Health

https://inaph.nddb.coop/

Central Database & Application Server

NDDB

- Analytical Reports
- BV Estimation
- Dashboard to GoI
- Repository for Stakeholders

Internet

Communication Media

Internet

Synchronisation

Netbook/ Mobile

1. Data entry
2. Data validation
3. Updation
4. Local output
5. Synchronisation

Participating Organisations

CEO

AI Delivery

Progeny Testing

Nutrition

Veterinary

Laboratories

Support Staff

Field Staff

AI Technicians	Milk Recorders	Local Resource Persons	Veterinarians
• Registration • AI • PD • Calving • Other Service	• Yield measurement • Sample Collection • Typing • Growth Monitoring	• RB Individual Animal • RB Group of Animals • Feed & Fodder sample collection	• Treatment • Diagnosis • Testing • Outbreak • Other Services

Milk Component Testing Lab

Feed Sample Testing Lab

Disease Diagnosis Lab

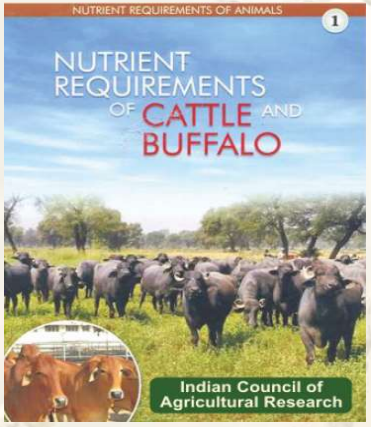
GOPALA

Farmer with animal in a village

Ration Balancing Programme (RBP)

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

Feed data library



Nutrient Masters

Ration Balancing Software

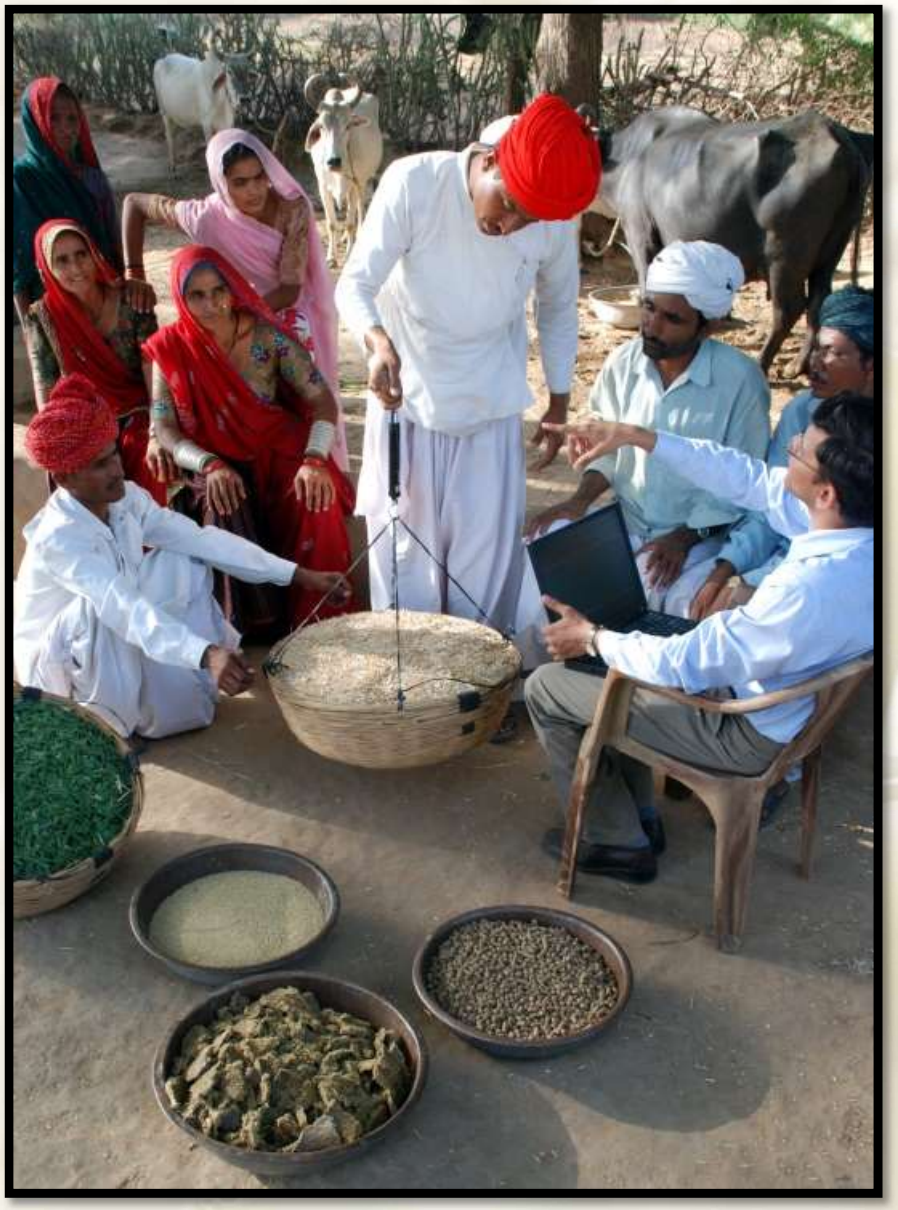
Information Network for Animal Productivity and Health

Judicious use of feed resources

Optimum nutrient supply

Ear tag animal for registration	Assessment of nutrient requirement	Assess nutrient supply from current feeding	Assessment of nutrient surplus/ deficit	Formulation of least cost balanced ration

Ration Balancing Advisory Service



Ration balancing at farmer's doorstep

Coverage of RBP	India	Gujarat
States	18	1
Milk unions, PCs	115	9 MUs
Animals	2,865,763	349,746
Farmers	2,157,497	233,878
Villages	33,374	2,753
LRPs deployed	31,148	3,136

Feeding Balanced Rations

Impact Assessment

Water Footprint Assessment

(Mekonnen & Hoekstra, 2012)

Crop water requirement (ETp)

Effective rainfall at root zone (P_{eff})

Crop water use from rainfall (CWU_{Green})

Crop water use from irrigation (CWU_{Blue})

Total $CWU_{Crop} = CWU_{Green} + CWU_{Blue}$

Economic allocation
(crop residues and by-products)

Indirect water use

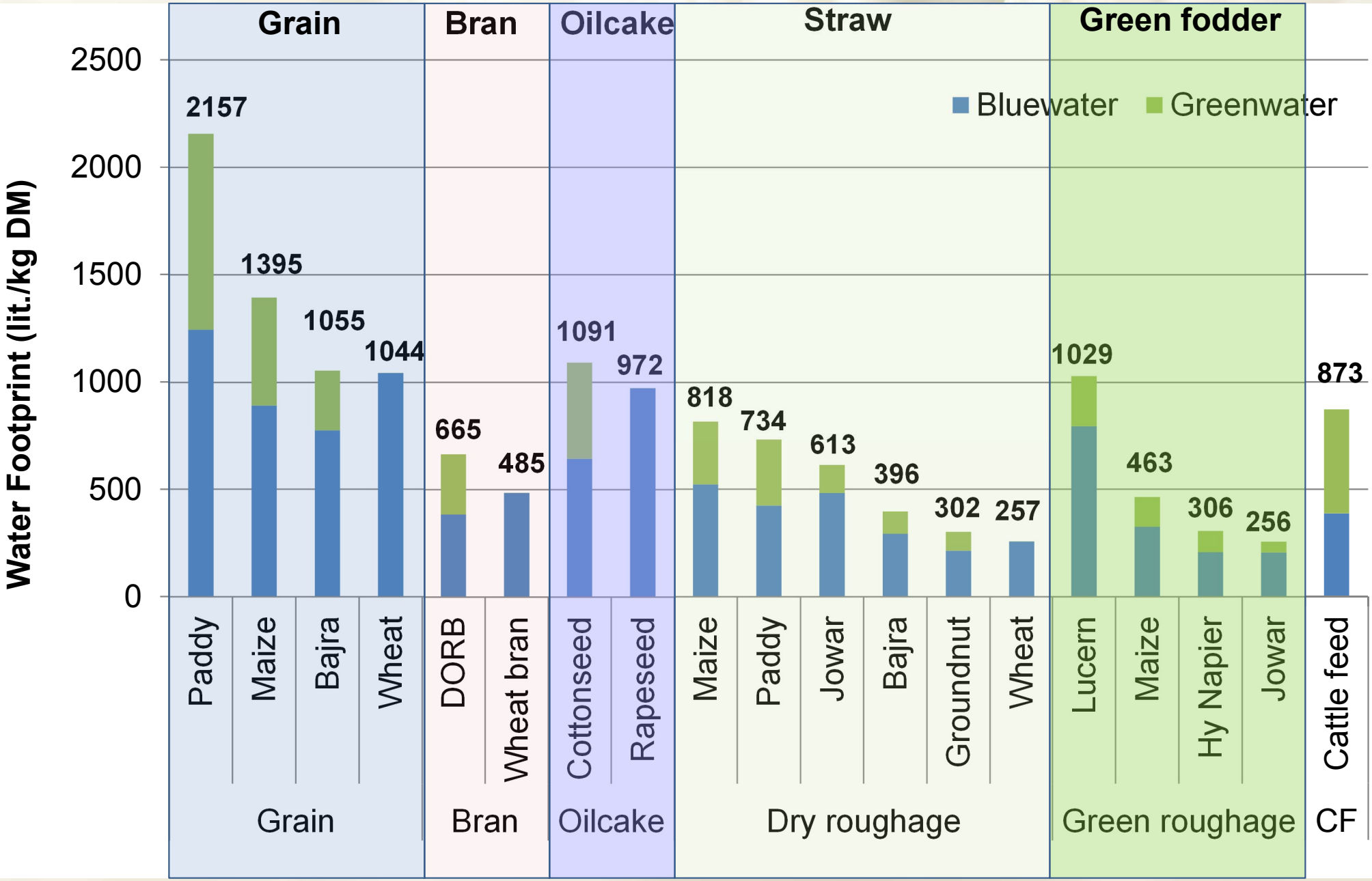
Drinking water intake

Water use for farm services

Direct water use

$$WF_{Milk}\ (lit./kg) = \frac{(Drinking + Bathing + Servicing) + (WF_{Conc} + WF_{DF} + WF_{GF})}{Milk\ production}$$

Water Footprint of feeds (DM basis)



Productivity, Economics and Water Footprint

Particular	Cow (*n*=91,356)		Buffalo (*n*=105,866)	
	Before RB	After RB	Before RB	After RB
DM (kg/d)	14.72^{a}	12.15^{b}	15.28^{a}	13.61^{b}
Milk yield (kg/d)	9.16^{a}	**9.39^{b}**	7.26^{a}	**7.41^{b}**
Milk fat (%)	4.10^{a}	4.20^{b}	6.99^{a}	7.20^{b}
FUE (kg FCM/kg DM)	0.649^{a}	**0.784^{b}**	0.541^{a}	**0.610^{b}**
Feeding cost (Rs./animal/d)	147.55^{a}	126.65^{b}	161.78^{a}	147.28^{b}
Production cost (Rs./kg milk)	18.67^{a}	15.07^{b}	25.37^{a}	22.02^{b}
Net income (Rs./animal/d)	35.92^{a}	**66.44^{b}**	88.03^{a}	**117.22^{b}**
Water footprint (lit./kg milk)	1071^{a}	**908^{b}**	1416^{a}	**1230^{b}**
Water footprint (lit./kg FPCM)	1060^{a}	**892^{b}**	1034^{a}	**890^{b}**

2-3% extra milk **Rs. 30 extra income** **15% lower WF** (P<0.05)

Water saved due to RBP: 87 million m^3/ year

Consumptive water use (lit./animal/d)

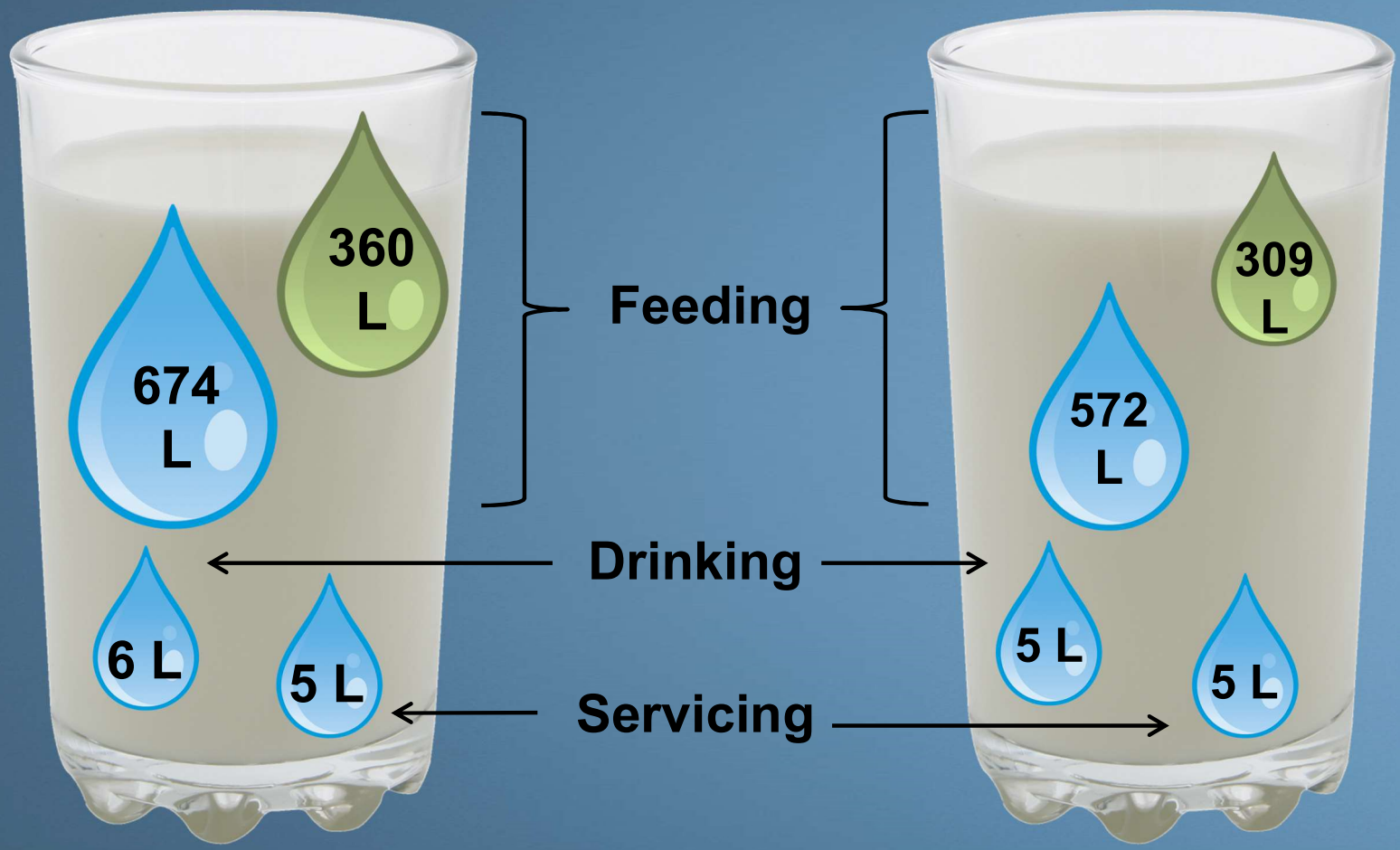
Activity	Cow (*n*=91,356)		Buffalo (*n*=105,866)	
	Before RB	After RB	Before RB	After RB
Feeding (Green)	3788	3266	3194	2888
Feeding (Blue)	5911	5158	6980	6124
Drinking (Blue)	60	54	60	55
Servicing (Blue)	50	50	50	50
Total blue water	6021	5262	7090	6229
Total water use (B+G)	9809	**8528**	10284	**9117**
Milk yield (kg/animal/d)	9.16	9.39	7.26	7.41
Blue WF (lit./kg milk)	658	**560**	976	**840**
Green WF (lit./kg milk)	414	**348**	440	**390**
FPCM yield (kg/animal/d)	9.25	9.56	9.95	10.25
Blue WF (lit./kg FPCM)	651	**550**	713	**608**
Green WF (lit./kg FPCM)	409	**342**	321	**282**

Water Footprint of Mixed Milk

Before RB

After RB

Saving of freshwater (L/ kg FPCM*)



Green water

Blue water

WF: 1046 L/kg FPCM*

WF: 891 L/kg FPCM*

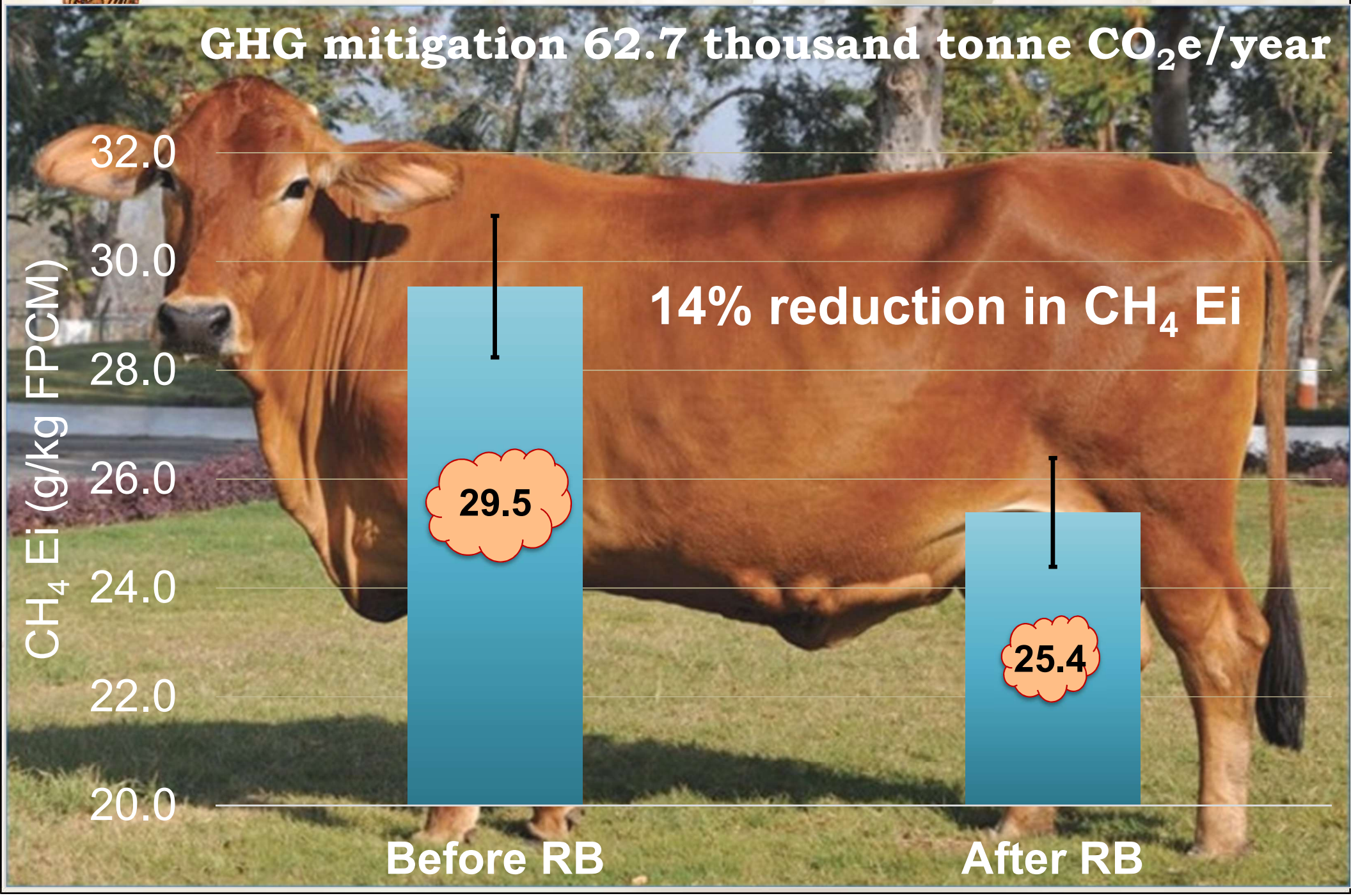
*Mixed milk
(4.0% fat & 3.3% protein)

Ration Balancing (Indigenous Gir cow)

Feed ingredients (kg/ d)	Traditional feeding	Balanced ration	WF_{Feed} (lit./ kg feed)
Wheat bran	1.89	1.5	436
Cottonseed cake	3.57	1.46	982
Jowar fodder	14.58	15.00	43
Jowar straw	7.16	4.56	474
Groundnut tops	-	2.00	438
Mineral Mixture (ASMM)	-	0.102	Change
Total DM intake	**14.27**	**11.60**	
Cost of ration (Rs./ kg milk)	**23.91**	**17.11**	
Water req. of ration (lit/ d)	**8351**	**5770**	- 31%
WF_{Milk} (lit/ kg milk)	**1152**	**796**	

Saurashtra region of Gujarat, Kharif season, BW: 442 kg, MY: 7.25 kg/d, Fat 5.1%.

Enteric CH_4 Emission Intensity of Mixed Milk



Conclusion & Way Forward

- Ration optimization resulted in 15% reduction in water footprint and 14% reduction in enteric methane emission intensity of milk.

- Additional scope: season specific ration advisory using low water footprint feeds, value addition of crop residues, strategic feeding for improving lactation yield and use of high biomass yielding crop varieties, etc.

- Large scale adoption of ration optimization by farmers would help improve socio-economic and environmental sustainability of the dairy sector.


Thank You