

Project Title :

Nano-fluid Based Portable Pail for Cooling Milk From Milking Point

Sparkle ID: SP21C002875

Team Members: Ravi Prakash

Background & Problem Statement



Time lag
≈0.5 h



Milk Transportation to collection centres



Time lag
≈0.5-1 h



Milk Collection at Dairy Cooperative Society (DCS)



Time lag
≈0.5-1h



Cooling ≤10 °C in ≥ 3 -4 h
(at least 500 L)



Total Time Lag ≈ 5-6 h

Practical Time Gap to cool ≤10°C

187.7 MT milk production in India: small scale (0.5-10L/head: 70-80%)

- ≈ 17 million registered dairy farmers : 190,516 DCS in India¹.

- ≈ 3 % milk wasted annually³ (≈ INR 58,478 crore revenue losses per year²) due to poor post-harvest cold chain³.

- Milk Rejection: Low Income : **Farmers**
 - Reduced quality of Milk Products
 - Market Recalls : Low Revenue
- } **Milk Companies**

1. NDDB, Annual Report (2018-19).

2. https://www.yesbank.in/pdf/indian_organic_sector-vision_2025.pdf;

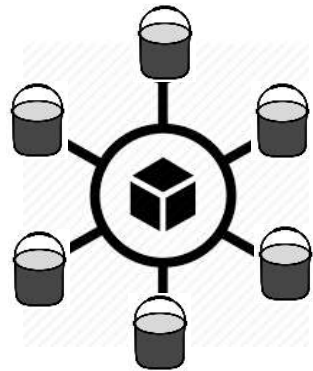
3. <https://www.ibef.org/blogs/digitalisation-of-india-s-dairy-farming>

Anand Pattern : DCS : Three-Tier Milk Procurement and Marketing

Solution



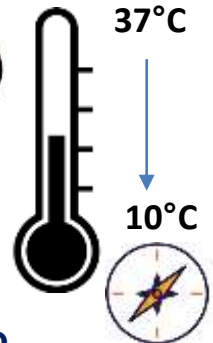
Charging Station in Villages



Distributing Charged Pails among Farmers



Cooling simultaneous to Milking by Nano-PCM



30-40 min



$\leq 10\text{ }^{\circ}\text{C}$: min 4-5h

Cold-chain (maintained) $\leq 10\text{ }^{\circ}\text{C}$

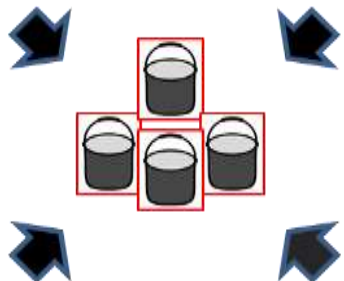
Zero-Rejection



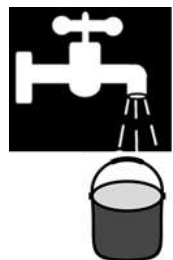
Quality Raw-Milk



Collection Centre/Processing Plant



Discharged Pails



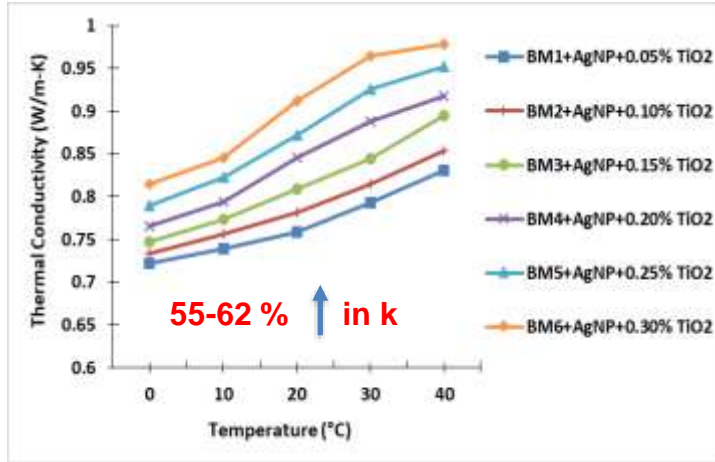
Cleaning/Sanitization



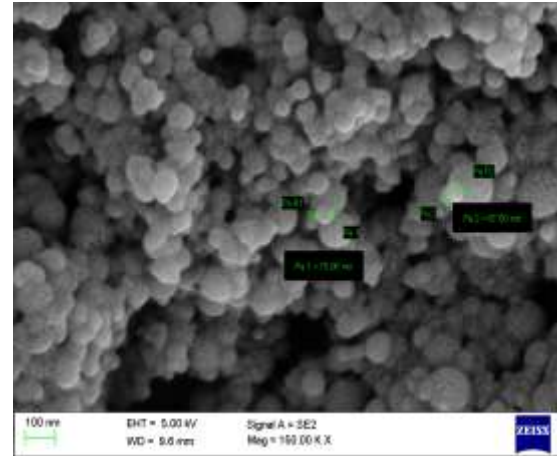
Quality Milk-Products in Market

Innovation

Nano-Phase Change Material*



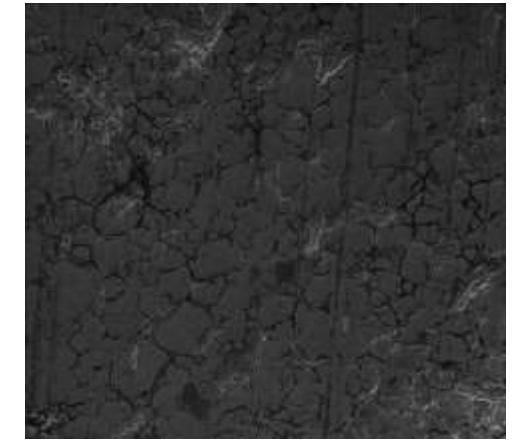
a. Thermal conductivity vs Temp (°C)



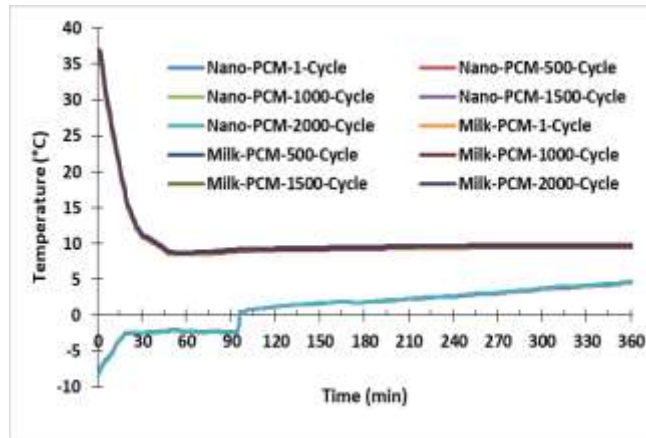
b. SEM-image at 150 KX



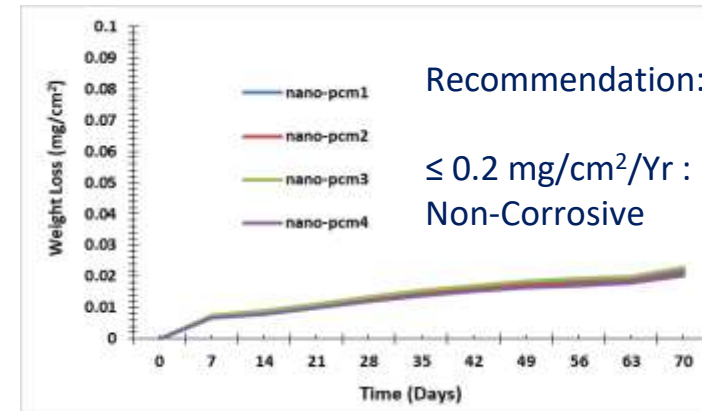
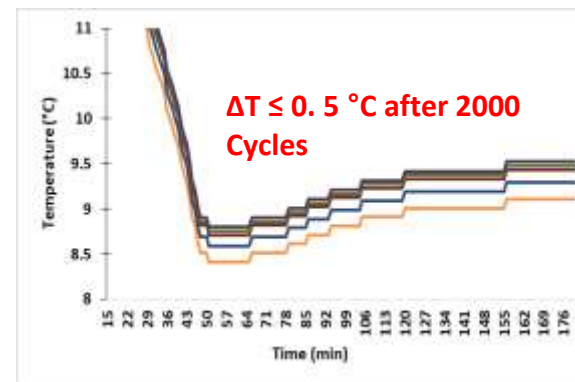
d. corrosion test (Ref: ASTM G1-01)



e. SEM image of SS-304 at 60 days



c. Thermal cyclic test



f. Weight losses (mg/cm²) of SS-304 Sample vs Time (Days)

Challenges:

- Food Grade Chemicals
- Low Cost base fluids
- 25% reduction in Exp. Vol of PCM
- Colour based Indicators

*Developed at ICAR-NDRI, Tested and Characterized at CeNSE, IISc, Bangalore

Innovation



Milking Pail

Charging slot

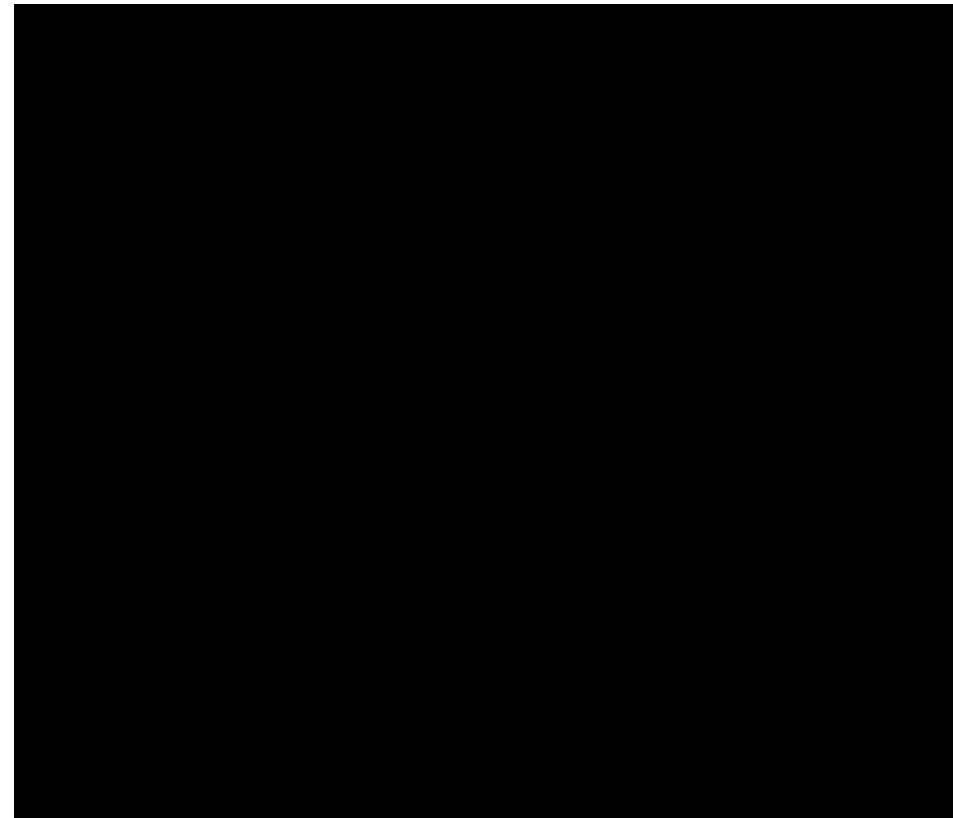
PCM Embedded into Walls



Charger

TRL : 6

- Charging time : 1 h
- Capacity of milking pail : 5 – 10 L
- No. of Pails Charged/day : 20-25
- Effective Price/Pail : 3500-4000 INR
- COP : 3
- Energy Saving in Cold Chain : 25-30 % (from Milking Point to Processing Plant)
- Life-Cycle : Min 5 yr

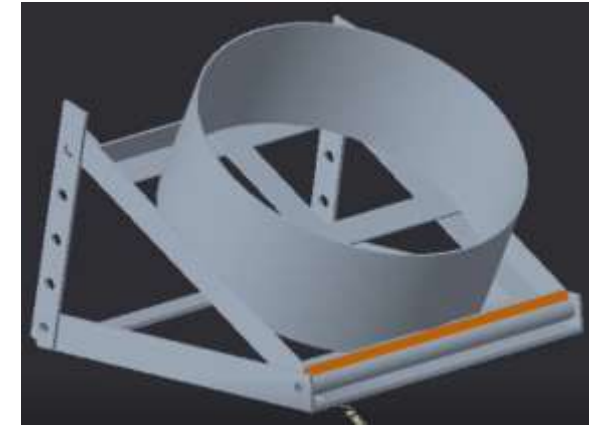


Business Innovation :

Milk Pricing : Rapid Quality Test + Temp. basis

Failure Mode :

Rapid Quality Test of Milk at Reception



Ergonomic stand for Milking Pail



A NEW STRIP BASED TEST FOR DETECTION OF NEUTRALIZERS IN MILK

Rajan Sharma, Priyae Brath Gautam,
Y.S. Rajput and Bimlesh Mann

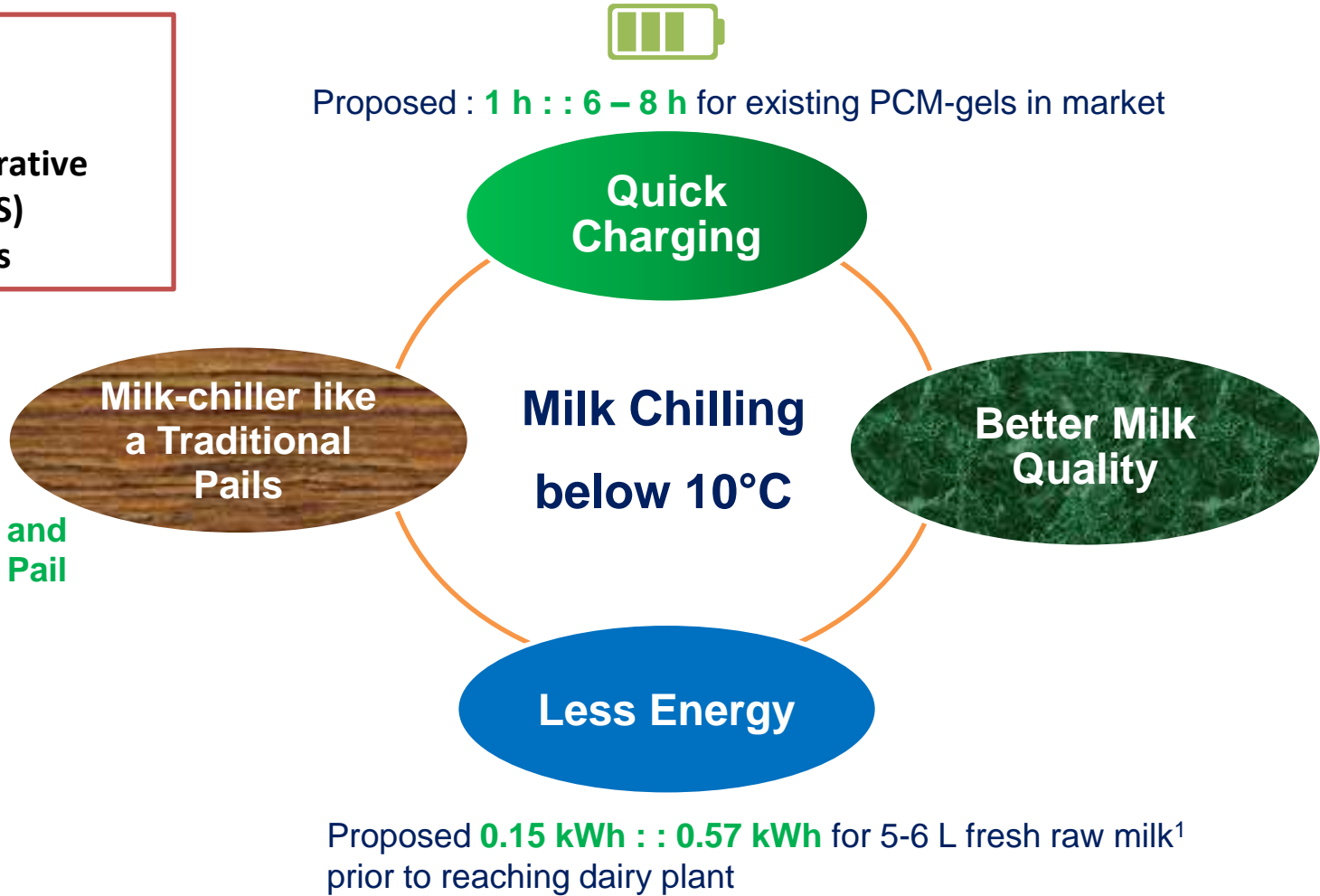
Dairy Chemistry Division

E-mail: rajansharma21@gmail.com,
Phone: 0184-2259532; 9416120181

Customer Value Proposition

- End Users :**
- Dairy Co-operative Societies (DCS)
 - Dairy Farmers

- Customers :**
- Milk Companies
 - State Milk Federations
 - District Milk Unions

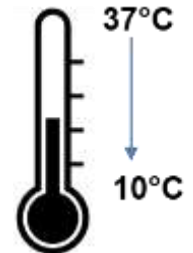


Handy, Portable and Maintained Free Pail



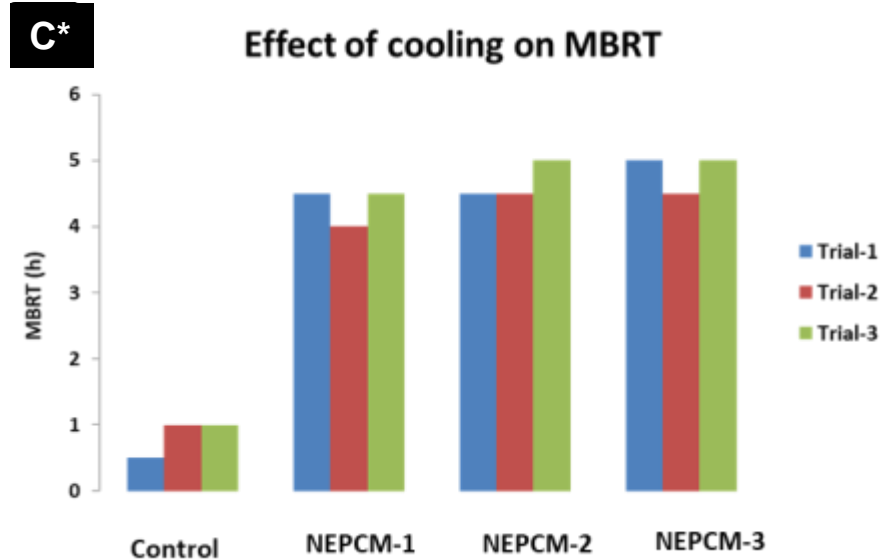
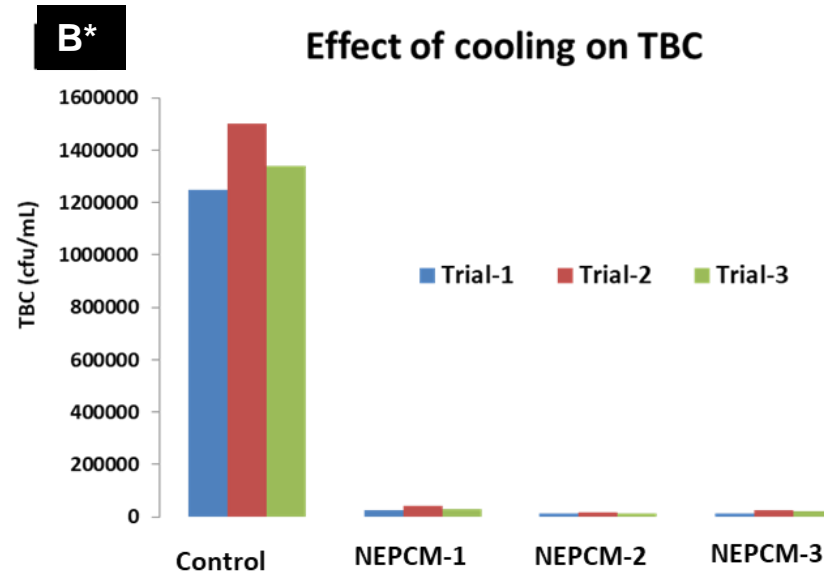
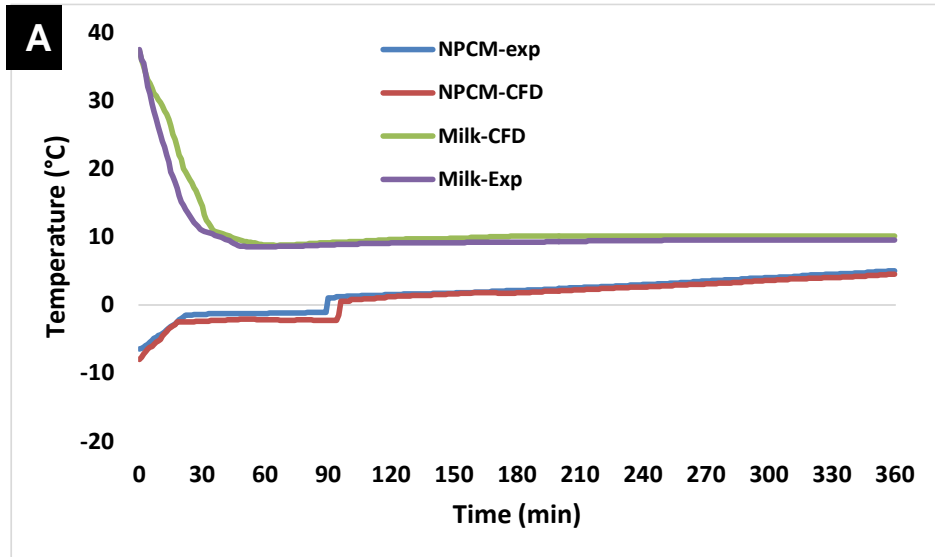
Raw Milk : As good as Pasteurized Milk

(4-5 h of Methylene Blue Dye Reduction Time)²



1. <http://www.fao.org/3/X6541E/X6541E02.htm#REF1>;
2. https://fssai.gov.in/upload/advisories/2019/10/5da6f078f3503Letter_Scheme_Diary_Plants_16_10_2019.pdf

On-Farm testing of the Prototype

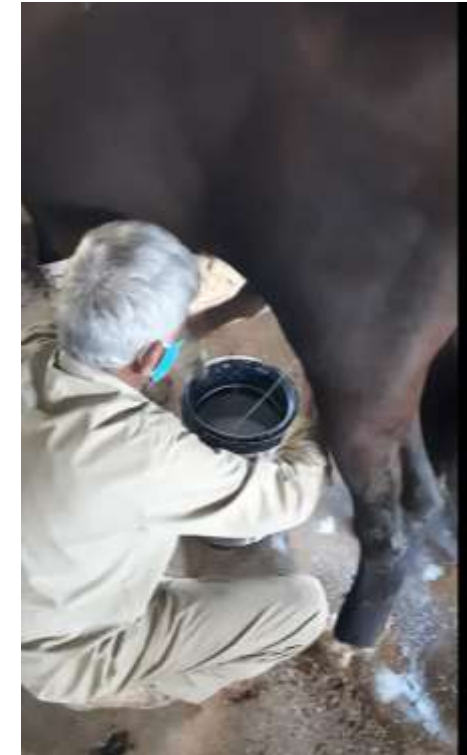


- Milk quantity for testing : 5-10 L

[A] Cooling Performance : 37 to ≤ 10 °C in 30-40 min.

[B] Total Bacterial Count (TBC) of Chilled Milk : 2-3 Log Cycle Less than the **Control (Milk in ordinary pail)**.

[C] Quality (MBRT time) : 4-5 h (Very Good Raw Milk Quality : Equivalent to Pasteurized Milk).



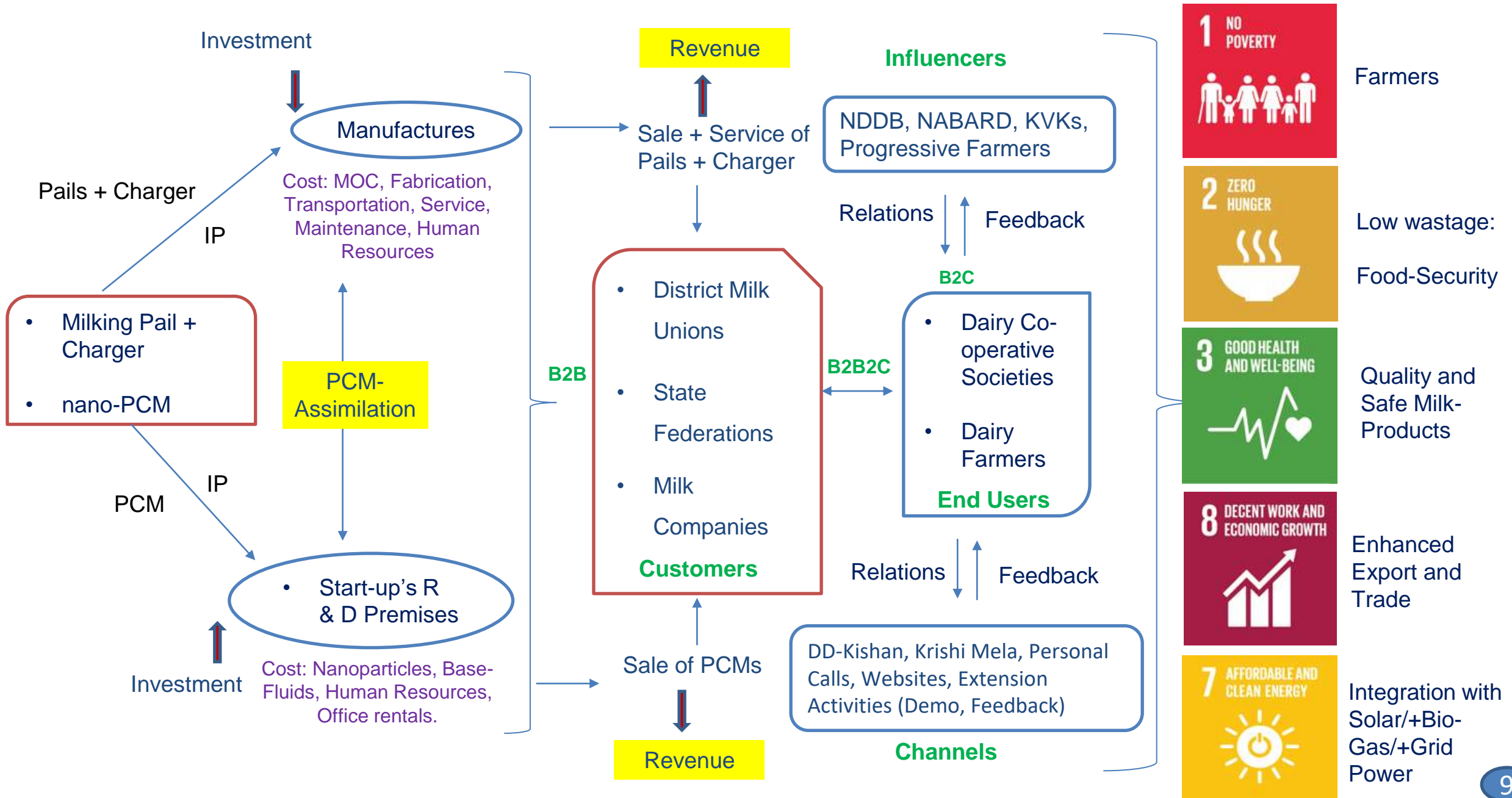
Milk-Cooling test at ICAR-NDRI, Bangalore

Competitive Landscape

	Proposed Milking Pails	Bulk Milk Chiller*	Milking Machine cum Cooler*	Milking Station with Cooler Vat*	Can Immersion Cooler*	Plate Chiller*
Cooling ≤ 10 °C	✓	✓	✓	✓	✗	✓
Rapid Cooling	✓ 30-40 min	✗ 3-4 h	✗ 2-3 h	✗ 5-6 h	✗ 6-8 h	✓ Continuous
Low Vol. Milk Chilling	✓ 0.5 L	✗ 500 L	✗ 100 L	✗ 100 L	✓ 20-40 L	✗ 1000 L
Portability	✓	✗	✗	✗	✓	✗
Quality Preservation	High	Low	Medium	Low	Poor	High
Suitability	Small, Marginal, Commercial	Commercial	Medium, Commercial	Small, Marginal	Small, Marginal	Commercial

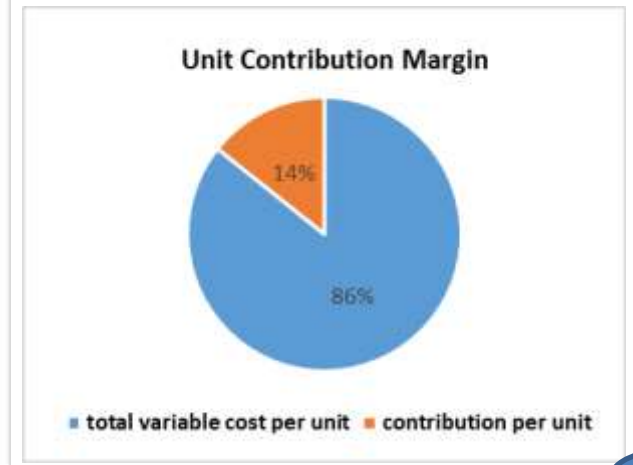
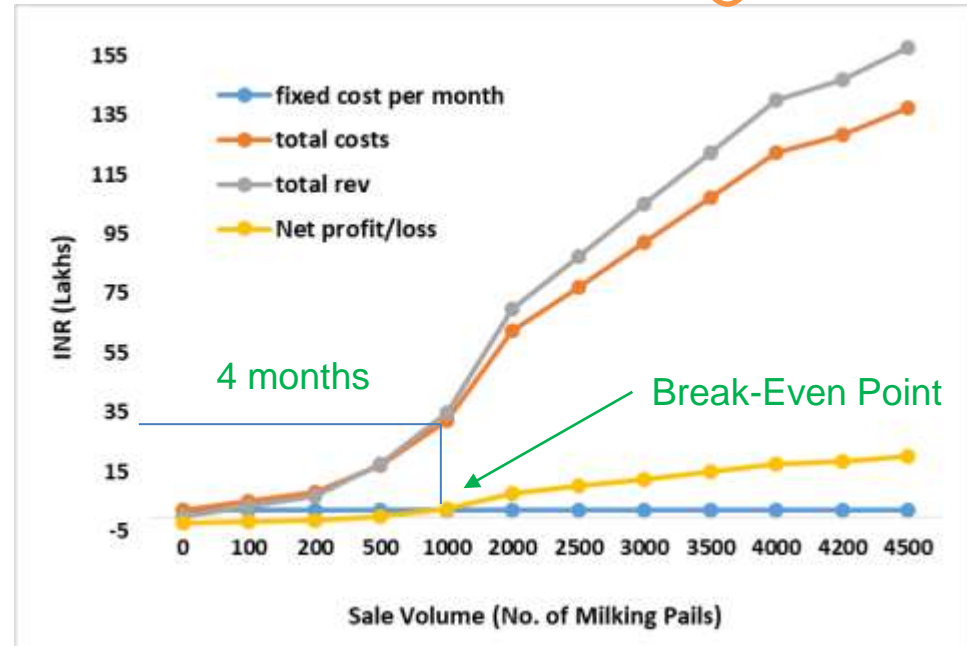
*Ref 1. <http://egyankosh.ac.in/bitstream/123456789/9386/1/Unit-3.pdf>, 2. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=65061>

Business Model : Network

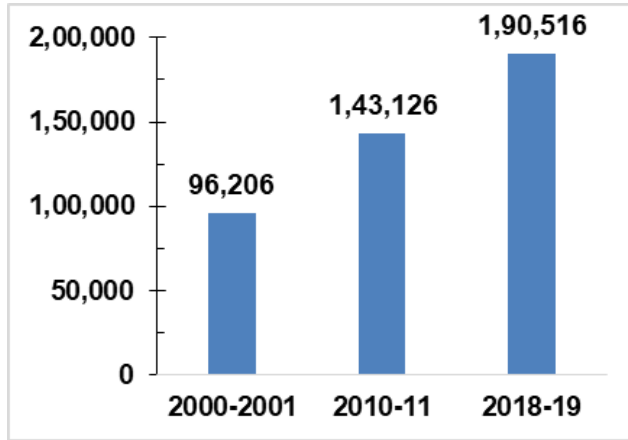


Revenue Model : Break-Even Analysis

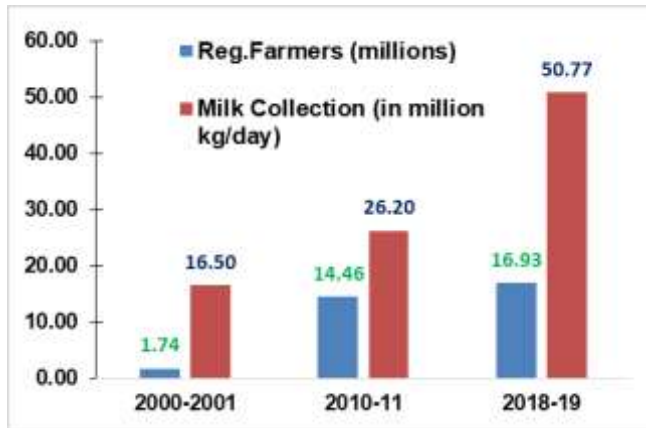
		Amt (INR)	Months	1	2	3	4	5	6	7	8	9	10	11	12
1 Sales	Sale Price per Pail	3500	Units Sold per month	0	100	200	500	1000	2000	2500	3000	3500	4000	4200	4500
	Ave Sale Vol per month	2100	sales price per unit (INR, Lakhs)	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035
	Total Sale Amount	7350000	fixed cost per month (INR, Lakhs)	2.28	2.28	2.28	2.28	2.28	2.28	2.28	2.28	2.28	2.28	2.28	2.28
2 Variable Cost	Commision per unit	100	variable costs (INR, Lakhs)	0	3	6	15	30	60	75	90	105	120	126	135
	Material Cost +Fabrication per unit	1000	total costs (INR, Lakhs)	2.28	5.28	8.28	17.28	32.28	62.28	77.28	92.28	107.28	122.28	128.28	137.28
	nano-PCM	1000	total rev (INR, Lakhs)	0	3.5	7	17.5	35	70	87.5	105	122.5	140	147	157.5
	misc. cost (transport+Tax) per unit	900	Net profit/loss (INR, Lakhs)	-2.28	-1.78	-1.28	0.22	2.72	7.72	10.22	12.72	15.22	17.72	18.72	20.22
	total variable cost per unit	3000													
	total variable cost per month	6300000													
	contribution per unit	500													
gross margin	1050000														
3 Fixed Cost per period	Admin cost (Salary of Permanat Emp)	83000													
	rent	30000													
	property tax	5000													
	insurance	10000													
	misc. fixed cost	100000													
	total fixed cost per month	228000													
	Net Profit/Loss	822000													
Break Even Point (units)	456														



Market : Scalability



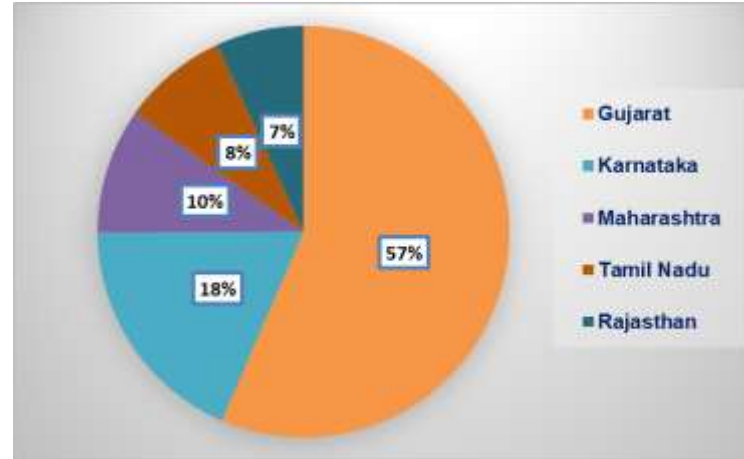
Dairy Co-operative Societies (DCS) in India¹



Registered Dairy Farmers and Milk Collection¹

Sources:

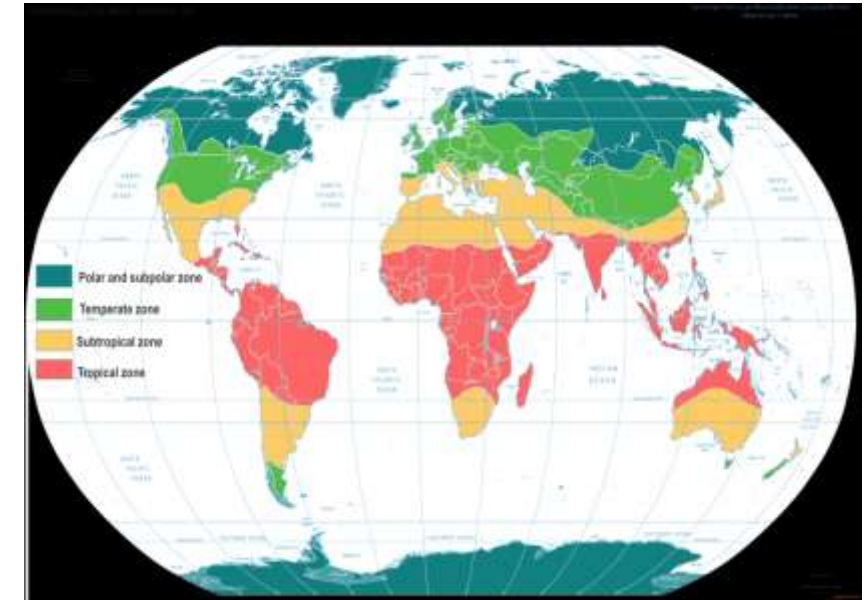
1. NDDB, Annual Report (2018-19)
2. FICCI Paper on Development of Dairy Sector in India, July 2020.



Top Five Milk Procuring States through DCS²

: Handle 80 % Total Milk Procured

- Milk Production : Growth @ 4-5 % per year
- Milk Collection by DCS : Growth @ 6-7 % per Year
- Share of Liquid Milk : 58 % of Total Value (Dairy Industry)



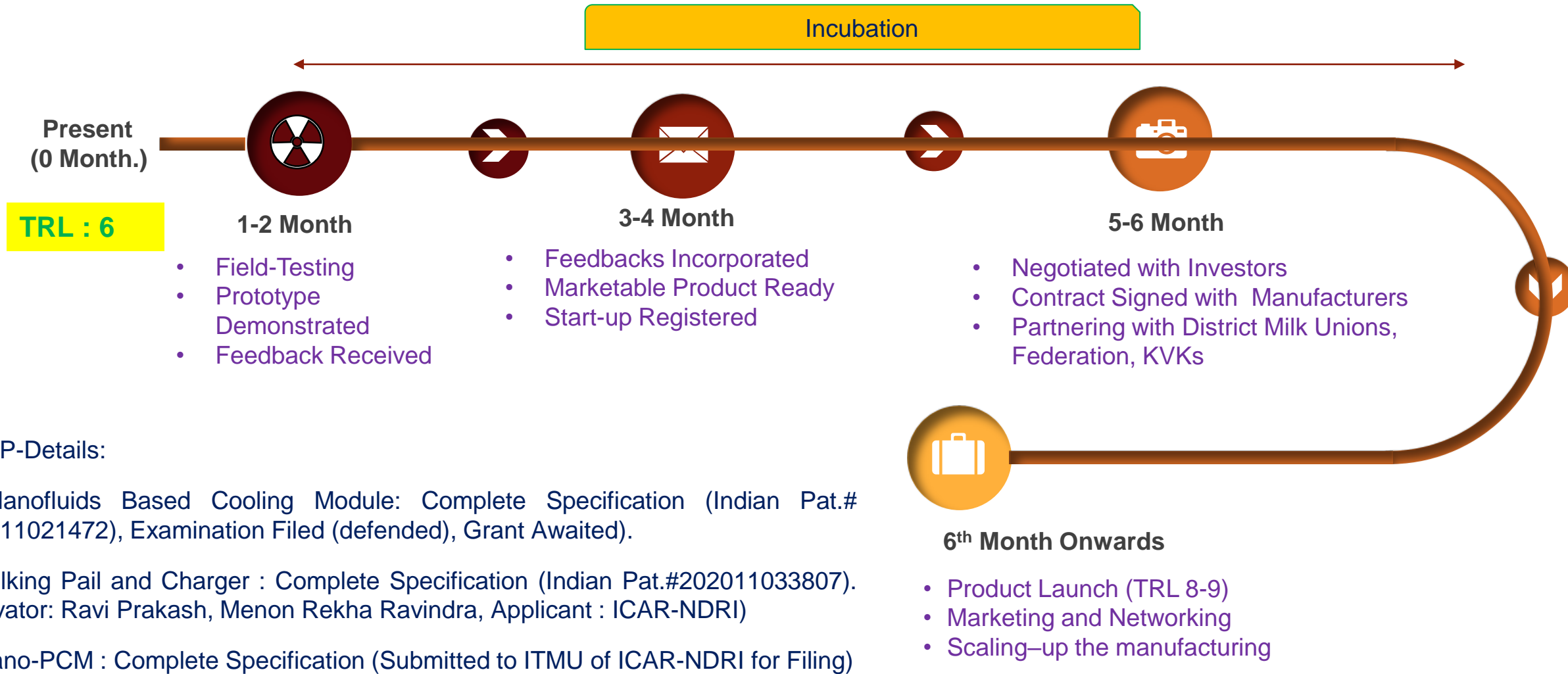
Tropical to Subtropical
Region of the world

: Developing Nations

Horizontal Deployment:

- Neera Cooling
- Siemen Preservation

Present Status and Roadmap : Timeline



Promotor : National Dairy Plan : NDDB, Anand



Awards and Recognitions



Gandhian Young Technological Innovation–Award-2018
: Honourable President of India



BRICS-Young Innovator Prize-2019
: Ministry of Science, Technology,
Innovation and Communication, Govt. of
Brazil



Refcold-India-Daikin's Global Poster
Design Contest-2019
:
Indian Society of Heating, Refrigeration
and Air-Conditioning Engineers



DST-Lockheed Martin-Tata Trust-IIGP-Award-2019



Best Poster Award-Indian Science
Congress-2020

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THANK YOU!