SUSTAINABLE ENERGY SOLUTIONS (SDG7) FOR DAIRY VALUE CHAIN

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SELCO FOUNDATION

About SELCO Foundation

SELCO Foundation seeks to inspire and implement solutions that alleviate poverty by improving access to sustainable energy to underserved communities across India in a manner that is socially , financially and environmentally sustainable.

The organisation's efforts broadly include:

01 Inclusive innovation and implementation of holistic technology-finance-ownership models based on a clear understanding of end-user needs

02 Ecosystem building on aspects of appropriate financing, local skills and entrepreneurship development and practitioner-driven policy for interventions to be sustainable in the long run

03 Incubation of grassroots level clean energy enterprises and local technology enterprises to enable decentralisation of services at the last mile

04 Replication of models and processes based on learnings and sharing of knowledge across regions and contexts.

SELCO Foundation demonstrates the role of clean energy and energy efficiency across areas of well being, livelihoods, health and education.

About the Green Innovation Center (GIC) Programme:

On behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH in cooperation with the Indian Ministry of Agriculture and Farmers' Welfare (MoAFW), Government of India, implements the global programme "Green Innovation Centres for the Agriculture and Food Sector – India" (GIC) in the states of Maharashtra, Karnataka, Andhra Pradesh, and Himachal Pradesh. By disseminating innovative solutions along the value chains of potato, tomato, and apple, the GIC aims at increasing the productivity and income of small-scale farmers. Furthermore, it targets to support the setting up of farmer organisation and boost employment in up- and downstream enterprises of the promoted value chains.

Being part of the BMZ special initiative "ONEWORLD – No Hunger", the Green Innovation Centres are a global programme and were established as a network in 14 countries in Africa, in India and Vietnam.

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Background and Context

1.1 SDG7 and Animal Husbandry

Animal husbandry in India is made up by small, marginal and landless farmers. With only 2.29 per cent of the land area of the world, India is maintaining about 10.71 per cent of the world's livestock. On an average, a farmer in India has two cows across the country, with a cattle population of 302,340,000 according to the 20th livestock census. For such farmers, animal farming integrates well with the family's economic crusade against unemployment. In farms with livestock, animals are used on the field for production activities, their dung goes into the field or is used as a cooking fuel along with firewood. Livestock are the biggest safety net for farmers during a time of crisis acting as the asset or collateral for credit. Livestock is the insurance of the poor.

Indian livestock farmers do not have access to efficient decentralised technological solutions which could help them adapt to climatic variations making them very vulnerable. Technologies at every part of the value chain can act as opportunities in building the resilience of farmers, opportunities in both adaptation and mitigation. Interventions across the value chains can result in holistic outcomes, increased yields and incomes.

1.2 Overview of Dairy

Smallholder livestock keepers, fisherfolks and pastoralists are among the most vulnerable to climate change. Climate change impacts both farmers and livestock directly. With increasing heat stress and variable precipitation, livestock mortality rates, natural resources, feed, production are impacted as a result of which farmers incomes are hit. At the same time, the livestock sector contributes significantly to climate change. In fact, 14.5 percent of all human-caused greenhouse gas (GHG) emissions come from live-stock supply chains. They amount to 7.1 gigatonnes (GT) of carbon dioxide equivalent (CO2-eq) per year. The main sources of emissions are feed production and processing, and methane from ruminants' digestion. The good news is that wider adoption of existing best practices and technologies in animal feeding, health and husbandry, and manure management could help the global livestock sector be more resilient and cut its emissions of greenhouse gases by as much as 30 percent (FAO, 2016). Globally, 430 million people are poor livestock farmers. A shift in the lens of animal husbandry being a key emitter to supporting small and marginal livestock farmers is critical, as they are highly vulnerable to climate change. While developed countries have adopted industrialised large scale production practices, developing countries still have small and marginal livestock farmers in rural regions relying most on livestock for food, income and livelihoods having a direct correlation to nutrition and food security. These traditional systems have been defined on the basis of local natural resource base and availability.

In India, 80% of India's milk production is contributed by small and marginal farmers.

The major share of milk is still marketed through informal channels where farmers sell their milk directly to their neighbours in the village, to restaurants, hotels, sweetshops or tea stalls, or small milk traders who go to the city to sell fresh milk (at higher prices). Official estimates suggest that, while 46 % of the milk production in Andhra Pradesh is retained in the villages for own consumption; 34 % of the milk production (or 70% of the milk surplus) is still channelled through informal channels. Only 7 % and 13 % of total milk production is believed to go to cooperative and private sector processing, respectively.

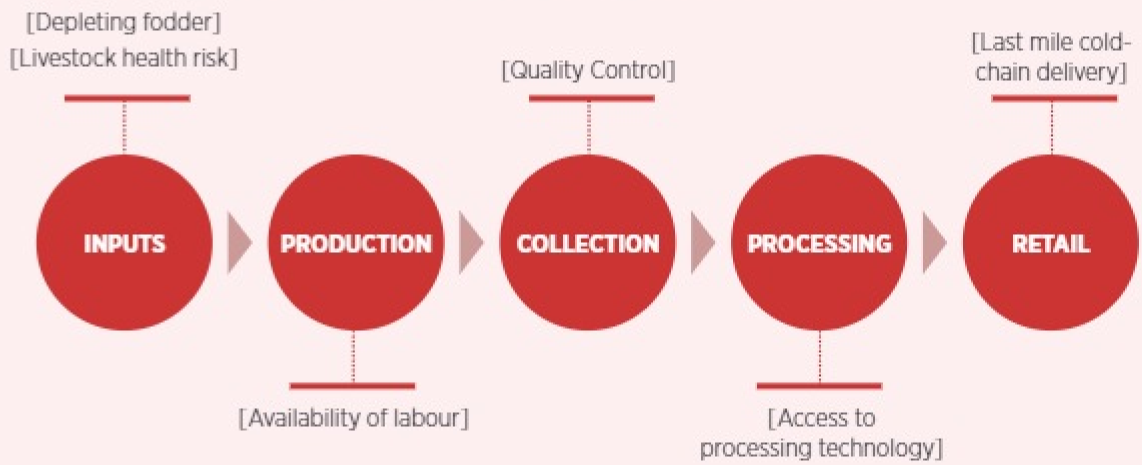
Need and role of Decentralised Renewable Energy (DRE)

2.1 Key Issues

The pursuit of grazing lands for fodder, water and other inputs has pushed the practise of dairy farming towards remote fringe zones. These zones do not necessarily have access to the power grid or even if it's available, the question of reliability and affordability arises. Thus, the income potential of small and marginal dairy farmers are unrealized. Due to fodder and feed deficiency which they could earlier find in their fields, farmers now need to temporarily move to cattle camps to keep their livestock alive during these crucial months. With increasing droughts and lands turning uncultivable, livestock are becoming the lifeline for farmers. However, changing temperatures are also impacting livestock mortality, increasing diseases and reducing productivity which require appropriate technological solutions and best practices to be promoted and adopted.

Indian livestock farmers do not have access to efficient decentralised technological solutions which could help them adapt to climatic variations making them very vulnerable. Technologies at every part of the value chain can act as opportunities in building the resilience of farmers, opportunities in both adaptation and mitigation. Interventions across the value chains can result in holistic outcomes, increased yields and incomes.

Some Challenges in Dairy value chain



2.2 Role of Decentralised Renewable Energy (DRE) for Dairy Farming

In the pre-production stage, there is feed and fodder management, farm management, veterinary services, shed management etc. There is scope for efficiency in every part of this value chain with technological interventions. Let's take an example of fodder production which is a critical part of input management. As mentioned in the above sections, with increasing heat stress and reducing rain falls, in regions where grazing on farm was a possibility, farmers now spend their precious incomes on buying fodder to sustain their livestock. Feed is also critical which is centralised in it's production and travels to remote regions, contributing to emissions. With decentralised technologies such as hydroponics units which consume a fourth of water, barely any land as it is vertical farming, resulting in producing highly nutritious feed. Feed is also critical which is centralised in its production and travels to remote regions, contributing to emissions. With decentralised technologies such as hydroponics units which consume a fourth of water, barely any land as it is vertical farming, resulting in producing highly nutritious feed.

Similarly, in the production stage, dairy sheds which house animals also need to be adaptive to increasing heat and precipitation variations. Higher heat stress amongst cattle influences their yield and thus the farmer's income. By bringing in efficient and optimised cooling solutions for dairy farmers, loss of income due to heat stress and reduced milk yield can be avoided.

Similarly, producing biogas using farmyard manure can meet domestic fuel demands and replace firewood and LPG which are both unsustainable sources of fuel. On-farm production of bio gas in India is easily achievable as families have a minimum of 2 cows which produce enough biogas to meet cooking demands of a household for one year. However, this technology does not reach people and improving accessibility and delivery models are of utmost importance.

In the post production processing stage, storage, milk processing makes up the key activities. Earlier, cows would be brought to collection centres to be milked, the milk would be weighed and tested by the aggregator. However, with supply chain lengths increasing, farmers milk their cows in farms and bring the milk to the aggregation point. With increasing temperatures, the milk is prone to spoilage which leads to losses and emissions which meet no demand. Cooling solutions like milk chillers need to be brought to the source now to secure farmers and reduce wastage. Further, in order to use surplus milk and poor quality milk, post processing technologies can aid farmers in producing value-added products which can be very profitable for them.

2.3 Approach to solution building

The key aspects of the approach to identifying needs, designing and deploying holistic solutions across are outlined below:

Decentralization: Building decentralised productive assets is one of key ways to develop local economies and strengthen last mile resilience and sustainability. Within agriculture, efficient and need-based assets can help reduce drudgery, improve productivity, increase product diversification and contribute to greater wellbeing and higher incomes. Decentralisation presents the opportunity to maintain maximum value at a farm and farmer level. Combined with sustainable technologies at different nodal points, these efforts can strengthen value chains and increase the benefit for small and marginal farmers.

Solution Innovation: Developing solutions (a combination of technical, financial and ownership models) that improve incomes and savings for small and marginal farmers along the value chain.

- **Technology Suitability and Efficiency:** Working with mapped technology partners to implement and modify technologies that can better suit the needs of the farmers. This approach also helps to reach energy efficiency benchmarks thereby reducing energy consumption and energy expenditures.
- **Financing and ownership models:** Based on the nodal point, type of technology and usage, the ownership of the solution can be determined- whether at an individual level, group of FPO level. The energy system cost, business model/expected cash flows and ownership will then determine the financing mix- percentage and terms of loan/credit, gap financing and subsidy support, end-user contribution etc.

Ecosystem building: Strengthening the ecosystem aspects to create conducive conditions for the deployment and sustainability of the solutions.

» **Linkages and capacity building:** Developing partnerships with grassroot organisations and FPOs to strengthen backward and forward linkages and build capacity on other aspects of the ecosystem can ensure optimum utilisation to realise the impact of the technology. These aspects would include awareness on technology, training on usage, backward and forward linkages for the product, market and business development support.

» **Unlocking credit and government programmes:** Proving financial feasibility, learning from the implementations and working actively with stakeholders to enable the creation of appropriate financial products, unlocking schemes and engaging to strengthen existing government programmes that seek to improve the impact for farmers in the tomato value chain.

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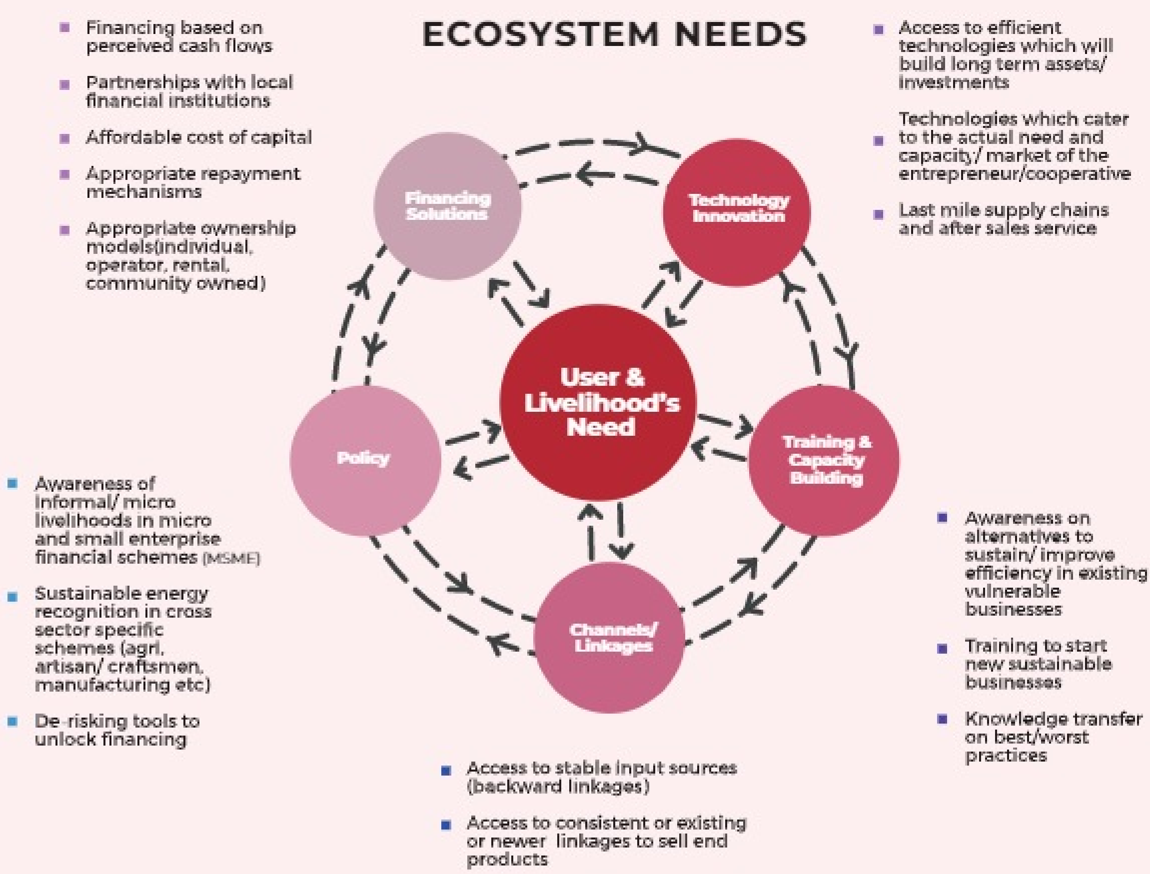


Dairy value chain

3.1 Input stage

Dairy Value Chain - Technology interventions with its respective Stakeholders & Activities

VALUE CHAIN	INPUTS	PRODUCTION	COLLECTION	PROCESSING
STAKEHOLDERS	Feed Supplier Co-operatives Veterinarians Individual Dairy Farmer/Entrepreneur	Unorganised Individual Farmers Individual Farmers with Co-operatives Individual Farmers with Companies	Co-operatives Private Entrepreneurs Milk Collection Center Milkman-Contractor/ Trader	Milk Processing Center Bulk Milk Center Informal Value Added Businesses (eg. local sweet shop)
SDG7 EFFICIENT TECHNOLOGIES	**Fodder Growing** • Hydroponics • Water Pumps **Feed** • Chaff Cutter • Artificial Insemination & Vaccination • Veterinary Hospitals • Vaccine Cold Storage • Vaccine Carriers	**Cattle Breeding & Rearing** • Lighting • Water Sprayer for cattle & shed • Biogas • Water Heater **Milking** • Milking Machine • Milk parlour • Water heater	**Doorstep Collection (Transport)** • Can Chiller **Storage** • Instant Milk chiller • Bulk Milk Chillers **Quality testing** • Weighing Machine • Milk Testing Machine	**Milk Processing & Value dd Milk Products** • Can Chiller **Storage** • Sweet Meat Machine (khowa) • Butter Churner • Pasteurization Unit • Production Unit (Curd, Milk Powder, Cottage Cheese, Cheese) • Ice Cream Making Machine

VALUE CHAIN	RETAIL	CONSUMPTION
STAKEHOLDERS	Wholesaler Milk Shops & Booths Restaurants Milk Bars & Shops	Urban Rural Self Consumption (eg. farmers, local households)
SDG7 EFFICIENT TECHNOLOGIES	**Sales and Value Addition** • Cold Storage/ Refrigeration • Freezer • Mixer/Blenders • Butter Churners • Other:Light, TV, Mobile Charging	**Storage and Value Addition** • Refrigerators • Butter Churner

3.1.1 HYDROPONICS

The Hydroponics system is a viable method of producing fodder for cattle feed for dairy. The solution helps in nutritious fodder production thus enhancing milk production and also brings about qualitative change in milk produced by improving the content of unsaturated fat, Omega 3 fatty acids, vitamins, minerals and carotenoids.

This solution helps to provide more nutrition for the cattle, improves health and increases dairy yield by more than 1 litre per day per cattle. It also contributes to increased fat content in milk resulting in higher income levels per litre.

Typologies implemented with: Hydroponics can be implemented for dairy fodder stations and individual farmers

Technical specifications:

Appliance:

Seed input per rack	Fodder production per rack	Operating Temperature	Power required	Feed/ Cattle/day
<4kgs (4 trays)	25 to 30 kgs* (Depends on seed type)	Up to 50 Degrees	0.1 Units in a month (0.0034 KWH/Day)	7kg/cattle/day

Energy system:

SOLAR	BATTERY	PUMP
40W PANEL, 12V	40AH BATTERY	12V, 40W DC DIAPHRAGM PUMP

Financial impact:

1) **Increase in income:**

Income increase for small and marginal farmers owning 2-4 cattle can be between INR. 23,800 and INR. 46,000 per annum. This is a consequence of two aspects:

-Reduced feed expenditure: The production of green fodder from hydroponics reduces the expenditure on externally purchased feed. Roughly this would result in savings of between INR. 7,800 and INR. 15,000 per annum

-Increased production and quality of milk (increase in fat percentage): Milk production typically increases by about 1 litre per cattle and could be up to 4 litres for each small farmer household. This means an increase in income of approximately between INR. 15,000 and INR. 31,000 per annum.

2) **Savings in time and increased convenience:**

Growing fodder in hydroponics units requires roughly 6-7 days. This reduces the time and effort involved in accessing green fodder from common lands or irrigated lands of other farmers. As mentioned earlier, much of this benefit is seen by women who are primarily responsible for dairy farming activities within the farming household.

Case Study

Background: Gopal Poojary is a rural dairy farmer in Daregudde village, Moodbidri town, Dakshina Kannada district, Karnataka. He has been practising dairy farming for over 20 years. He owns 3 acres of land where he grows organic vegetables and other crops, and has a dairy farm size of 7 cows of which 3 provide milk. He used to milk around 18-20 litres of milk per day and sold them at Karnataka Milk Federation where he made INR 29.5 per litre. Thus made an average income of Rs 531-590 per day.

Key issues: He used the seasonal green fodder and dry hay, which is grown in his land along with locally supplied dry pellets (maize and groundnut based) fodder to feed the cows which cost him totally Rs.43/kg. This feed made the cattle appear gaunt and reduced the quality of milk, affected the heating period etc due to presence of high urea content in the feed.

Impact: The following impacts were achieved through the solution:

- Increased income due to increased quality and quantity of milk: After the hydroponics intervention, he milks 22-23 ltrs and sells at INR 31.5 per litre due to improved fat content. Hence the income has increased to INR 693-725 per day. Also, he invests only Rs.16/kg to buy the maize seeds to grow fodder in Hydroponics.

- Improved quality of milk: The fat content has increased from 4.3 to 5.5 and the lactometer reading also has increased from 25 degrees to 27.5 degrees which indicates the improved quality of milk.

- Improve quantity of milk: Due to the consumption of nutritious feed, the quantity of milking also has increased by an average of 1.5-2 litres per day - Improved health of cows: Improved health among the cattle due to consumption of green fodder.

3.1.2 VETERINARY HOSPITAL AND CLINICS

Livestock productivity is adversely affected by various animal diseases, some of them being zoonotic in nature. The outbreaks of diseases like foot-and-Mouth disease and haemorrhagic septicaemia in cattle and buffaloes, PPR, and sheep are infectious if not taken care of prior. Hence, the most effective way to overcome these losses from diseases and increase livestock productivity is through prevention of diseases using vaccines.

Hence vaccine procurement, storage and transportation plays a vital role in the veterinary hospitals. vaccines storages due to erratic power supplies maintaining of vail/vaccines in controlled temperature is the problem.

Technical specifications:

Energy system:

Powering the vaccine chambers and the other critical appliances are integral to the functioning of the veterinary centres.

Energy system:

Solar panel capacity:	Solar battery capacity:	Solar power control unit:
3.96 kWp	200 Ah, 96 V	4kW, 5kVA, 96 V

Proposed Impact

- Eliminating wastage of vaccine due to spoilage by around 20%
- Energy overheads of such institutions would be reduced significantly (approximately 70-80%)

3.1.3 VACCINE COLD STORAGE WITH VACCINE CARRIER (Passive cooling)

In areas with erratic power supply, effectiveness of vaccines reduces considerably even though vaccine storage is available. Solar Vaccine storage is an effective storage technology in these scenarios. Decentralised cold storage technology helps to maintain constant temperatures at all times. Vaccine Carriers are required for transporting vaccines from healthcare facilities to locations where refrigeration is not available. The vaccine storage capacity of vaccine carriers is between 1 litre to 2 litres

Typologies Implemented:

Vaccine storages have been implemented in the tribal and hilly areas with individual farmers. This technology can be implemented in places with erratic power supply.

Technical specifications:

Appliance:

Vaccine cold storage

Temperature level -
4 degrees C

Holdover period -
4 to 7 days at ambient temperature
43 degrees C

Storage capacity -
27 to 99L

Vaccine Carrier:

Temperature level -
4 degrees C

Holdover period - 6-8 hours at ambient temperature
43 degrees C

Storage capacity -
2L

Energy system:

Solar Module -
235 to 470Wp

Vaccine carrier is a passive cooling technology system, hence, there is no DRE component to the machine.

Case Study

Background: PRADAN, a non-profit organisation, promotes agriculture based and allied livelihoods, as they work in rain fed regions which are not particularly high yielding at Jharkhand. They work across all blocks of Lohardaga, Jharkhand. PRADAN had decided to target 2000 households of 5 panchayats spread across 6 kilometres to implement solutions for livestock vaccination. The targeted group were small scale farmers who are reliant on livestock as their primary source of income.

Key Issues: Vaccination is a critical part for livestock. At present, the blocks in Lohardaga, Jharkhand did not have any cold storage facility to timely administer vaccinations to livestock. Most of the households are dependent on the Animal Husbandry Department. Funds allocated to the Animal Husbandry Department are merged due to which vaccinations are not administered regularly and even when they do the potency of the vaccination is questionable due to poor quality of storage of vaccinations from source to destination. Due to this most households sell their goats at a very early age, at a lesser price. A fully grown, healthy goat could be sold for INR 4000- INR 5000, instead farmers sell them young for INR 2000- INR 3000.

Technology Implemented - Solar powered cold storage

The vaccine storage solution with a capacity of 46 litres. It's a unique technology that guarantees optimal cooling of vaccines between 2 to 8 degrees with no risk of freezing and a hold over time of 8+ days, this vaccine refrigerator needs only 2.5 hours of power per day to operate. It has a digital temperature display as well as internal temperature control for better energy management.

Impact:

After having installed the vaccine storage, as per the Village Organisation and PRADAN baseline the mortality rate has been reduced to 70% with improved savings of INR 35,000 - INR 45,000 annually.

3.2 PRODUCTION STAGE

3.2.1 SHED DESIGN FOR CATTLE WELL-BEING AND COMFORT

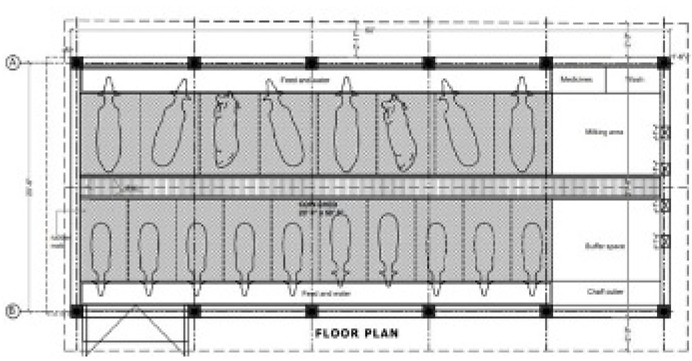
According to the 2012 livestock census, Karnataka has 30.52 million of livestock, comprising 10.50 million of cattle. Karnataka ranks ninth in total milch animal population. In hot dry regions, there is a gap between the summer temperatures and upper critical temperature for lactating dairy cows(25 C) which causes great losses in milk production. The following factors affect the milk output and wellbeing of the cattle.

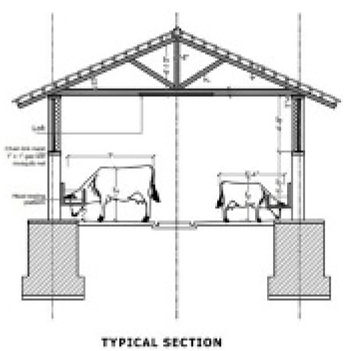
Template design of a cattle shed:

Integrated Cattle Shed Solutions and Services		
Shed Type	**Shed Management Services**	**Energy Solutions**
Cattle Shed - free range or closed type	Manual water feeder (with/ w/o water tank and pump)	Milking machines **For Hybrid** Single cluster - 120w, 12v DC Double cluster - 180w, 24v DC **Fixed type- Indigenous** Single cluster - 1hp, 230v AC Double cluster -1.5hp, 230v AC
Milking Parlour room	Automated water feeder	**Lights and fans**
Storage room	Biogas or Manure Pit	**Chaff cutter** Small scale - 1hp - 230v AC
	Pressure washer and Water heater	**Hydroponics** -24 trays - 3 cows/ -32trays - 4 cows/ -48 trays - 6 cows/ -64 trays - 8 cows
	Silage tank	

Built Environment Solution:

Climate Responsive Building Design and Cool roofing technologies





3.2.2 MILKING MACHINE

An efficient milking machine designed with a DC motor powered by a solar system reduces the milking time by 50% over the manual process. It also leads to hygienic milk collection and reduces the labour cost.

The following are the major issues which directly affect the production and income-

Drudgery: Milking the cattle involves physical drudgery during a specified period of time. This is due to the manual method of milking the cows. The dairy farmer has to sit and milk the cows in order to get the proper amount of milk.

Labour shortage: There are very few or no skilled labourers to this work as it needs skill to do this and not everyone is ready to work. Due to the scarcity of work the cost of labour is also high.

Though there are electric Milking machines available in the market, most of the marginal dairy farmers do not have access to grid electricity. Even with grid electricity the fluctuation in the power can easily damage the conventional milking machines and due to the fact that the grid supply in rural areas is unreliable because of erratic power cuts or power availability for limited time of milking (early morning and evenings). The existing machines are high power consuming with around 0.5 hp to over 5 hp which can also cause health issues to the cattle more often.

Typologies Implemented with: Individual farmer model for community self and trading (hybrid cows)

Technical specifications:

The solar powered Milking machine solution consists of an efficient DC Milking Machine designed for Certain breeds of cows (HF, Jersey, Gir). There are currently two models: single cluster and double cluster machines. The single cluster can milk one cow at a time and is operated from a 12v DC source while the double cluster machine can milk two cows at a time and is operated from 24 VDC source.

Single Cluster Milking machine	
Particulars	Specification
Rated Voltage	12 V DC
Power consumption	120 W
Dry weight of machine	35 kg
Time for milking	4 to 7 min/cow
Vacuum level	350mm Hg max
Pulse rate	72/ min.
Adaptability	One animal at a time

Double Cluster Milking machine	
Particulars	Specification
Rated Voltage	24 V DC
Power consumption	180 W
Dry weight of machine	50 kg
Time for milking	4 to 7 min/cow
Vacuum level	350mm Hg max
Pulse rate	72/ min.
Adaptability	Two animals at a time

Case Study

Background: Mr. Eshwar Gowda is one of the progressive farmers from a remote village in Puttur Taluk. Mr. Eshwar Gowda also does dairy farming for secondary income and has been awarded the "best farmer "award from Karnataka Milk Federation (KMF) in his region for 3 times in a row. Being the secretary of the local KMF collection centre as well as being a progressive farmer Eshwar Gowda was finding it difficult to manage his time for dairy farming and was willing to adopt a suitable technology which could reduce his time and effort as well.

Key Issues: Eshwar Gowda wanted to buy a milking machine but due to erratic power cuts in the region he was little hesitant as the machine may not be useful most of the time and he had to invest additionally for power backup as well. Moreover, the grid UPS system may not be reliable as it may not get sufficient charging time due to erratic power cuts and making the situation worse in monsoon breakdowns due to the remoteness of this place. Hence, he approached SELCO exploring solar options for the milking machine, being a customer of SELCO for lighting systems for many years.

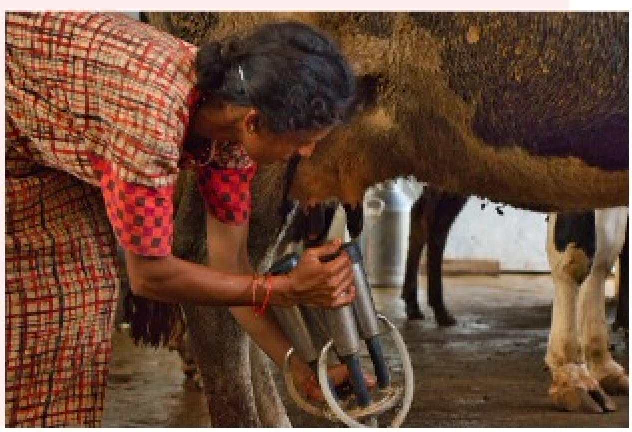
Impact: SELCO provided an efficient milking machine designed with a DC motor powered by solar system. He is able to operate the milking machine 2 hours per day (1 hour in the morning and 1 hour in the evening) independently of the grid.

Time saved: Eshwar Gowda is able to save 50% of time for milking activity alone and at the same time he is able to invest for his responsibilities in milk collection centres and farming activities. Mr. Eshwar Gowda and his spouse both are able to concentrate on farming activities.

Scope for increase in income: With the addition of milking machine technology the entrepreneur plans to invest in additional cows and thereby increase his total earnings. He has already added one cow soon after installation of the milking machine and plans to add a few more.

Reduction in physical drudgery: As milking by hand takes a lot of effort and since the entrepreneur does other livelihood activities, the entrepreneur is able to invest his effort and time in other productive work.

Hygienic milk collection: As the milking machine is considered to be safe and hygienic compared to hand milking it would also avoid any health issues associated with hand milking. Due to his multiple responsibilities and time constraint many times Eshwar Gowda wasn't able to extract the entire milk available. With a solar powered milking machine, he is able to avoid such unnecessary loss of income.



3.2.3 PRESSURE PUMP

Pressure pump is used to clean cattle sheds and cattle. They are also used for cleaning floors in Dairy Farms and cleaning of bird cages in poultry farms. The user-friendly technology uses different mild pressurised water spray nozzles and is completely maintenance free due to simple centrifugal pump design.

Typologies Implemented: They have been implemented with individual farmers.

Technical specifications:

Vaccine Carrier:

Power Consumption:
1 hp, Single gun & 2 hp, double gun

Cleaning capacity:
500 sq. ft in 15 min and 3-5 minutes per cow

Energy system-

Pressure pumps are usually clubbed with a milking machine as powering the pressure washer alone would be expensive.

3.2.4 SOLAR WATER HEATER

Hot water from the solar water heater can be used for cleaning the milking machine, milk cans and Bulk Milk Chillers. Water heater also helps in giving hot water baths to pregnant cows, newborn calves and sick cows.

Typologies implemented:

This technology has been implemented with individual farmers where a combination of milking machine, pressure washer and DC lighting was installed

Technical specifications-

Energy system and Appliance -

Capacity-
100 L - 500 L

Type-
Evacuated Tube Collector (ETC)

Temperature-
60 - 80 degree celcius

3.2.5 BIOGAS

Biogas is the mixture of gases produced by the breakdown of organic matter in the absence of oxygen (anaerobically), primarily consisting of methane and carbon dioxide. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste. The cow dung easily available in the dairy farms can be used as raw material for the production of the biogas. The biogas produced can be used for making khoya sweets on site in the dairy farm. Also, the biogas generated can also be used for cooking and other applications in the dairy farm.

Typologies Implemented: This technology has been implemented with individual dairy farmers for self consumption.

Technology specification:

Manure (L/day)	Number of cows	Biogas production			Biofertilizer production	
		(m^3/day)*	(hr/day)**	Equivalent in LPG (kg/month)	(L/day)	(ha/year)
45	5	1.7	3.3	21	135	4.9
65	7	2.4	4.8	31	195	7.1
90	9	3.3	6.7	43	270	9.9
130	13	4.8	9.6	62	390	14.2
180	18	6.7	13.3	86	540	19.7
260	26	9.6	19.2	124	780	28.5
350	35	12.9	25.9	166	1050	38.3
700	70	25.9	51.8	333	2100	76.7
1050	105	38.8	77.7	499	3150	115.0
1400	140	51.8	103.5	665	4200	153.3
1750	175	64.7	129.4	831	5250	191.6

3.2.6 SOLAR INSTANT MILK CHILLERS

Instant milk chillers reduce milk temperature instantly avoiding milk quality deterioration and bacterial growth. They can be used in conjunction with Bulk milk chillers. They eliminate minimum milk requirements to start the bulk cooling process. In the first pass, milk will flow through IMC and the temperature falls below 7 degrees instantly. Solar PV capacity of 7 Kwp is installed.

Typologies Implemented with: This technology has been implemented as a co-operative dairy model as well as in the desert and high heat stress regions.

Technical specifications:

Appliance:

1. 500 L instant milk chiller for camel milk with ice bank technology
2. Capacity: 250 litres per batch
3. Production of 55 litres hot water in every cycle for cleaning of the milk chiller unit

Appliance:

1. Solar solution: 3.9 kWpv
2. Solar battery: 200 Ah, 48 V, 4 Nos.
3. Solar inverter: 3500VA/48V PCU inverter

Case Study

Background: The pilot intervention of solar powered instant milk chillers for camel milk value chain in Bikaner, Rajasthan, would build evidence for replicable models of developing decentralised sustainable energy powered solutions for camel value chain across similar contexts in India and Sub Saharan Africa.

Key Issues: One of the key activities in the dairy value chain that plays a critical role in keeping quality of milk intact is cooling of milk before it gets processed. Innovative and faster instant milk chilling technology that chills milk at shorter time would reduce spoilage, retain quality, and increase shelf life of the milk collected at the collection centres and hence thereby increase income of dairy farmers. Milk being a highly perishable product needs to be chilled to ~4°C at the earliest to arrest bacterial growth and retain its quality.

In Rajasthan, the scattered camel herders and farmers face challenges from the lack of local collection centres with appropriate cooling solutions. With just around 3 hrs of shelf life, camel milk would really benefit from decentralised cooling infrastructure. Thus, with the opportunities to decentralise cooling, especially powered by solar energy in these areas with abundant sunshine and unreliable electricity, SELCO Foundation has partnered with Urmul to strengthen smallholder camel farmers/dairy entrepreneurs by reducing the transaction costs and wastage of milk.

Technology: Solar Powered Instant Milk Chilling systems – To chill the milk at the source - thereby reducing spoilage, retaining quality, and increasing shelf life before it is transported to processing units. MilkoChill Instant Milk Chiller can chill 250 litres of milk instantly in one hour. The solution is based on a unique thermodynamic design. Keeping in mind the non-reliable electrical grid supply in remote villages, the system is designed with a thermal storage mechanism which stores energy whenever electricity is available. The system is connected with solar energy. This eliminates the need for diesel generators, or grid electricity, thus reducing operating costs.

3.3 PROCESSING STAGE

3.3.1 SWEET MAKING MACHINE (KHOVA)

Khova or mawa is dried evaporated milk solids and forms the base for almost all sweets. Both khova making and pedah making requires constant stirring attention which can be a drudgery driven task. Solar powered motor to stir the milk continuously, helps reduce the drudgery and improves the quality of Khova.

Various models of the machine

S No	Khova making machine model	Motor Capacity	Per batch processing capacity
1	110 L LPG Gas model	0.5 hp,24 Vdc	30-35L/batch
2	110 L biowaste model with blower	0.5 hp,24 V & 30 W blower	30L/batch
3	200 L LPG Gas model	0.75 hp, 48 V	50L/batch
4	180 L biowaste model with blower	0.75 hp, 24 V & 50 W Blower	40-50L/ batch

Typologies implemented with: Individual farmers/ entrepreneur model for trading.

Case Study

Vilas Hakke, Individual entrepreneur, Khova making machine, Maharashtra

Background: Vilas Hakke is a home-based individual Khova making entrepreneur for 2.5 years from Korati village, Pandharpur taluka, Maharashtra.

Pandharpur taluka is a well-known pilgrimage town, with lots of demand for khova peda as prasad. Hence, all the sweet making shops in taluk sell khova peda. Vilas Hakke collects milk from nearby dairy farmers and makes 40Kg khova/day and delivers it to local sweet shops and makes Rs. 15000 - Rs. 20000 as monthly revenue, which includes operational cost of Rs. 1500-2000/- for firewood & transportation & Rs. 2000 to 2500/- for diesel. Thus, making an average profit of Rs.13000-15000/-

Key Issues: -Vilas Hakke used a firewood operated Khova making model with a vessel capacity of 190 litres. Due to erratic power supply in the area (4hr daily for 15 days a month) he lost his daily earning and also had to invest in a Diesel generator for the machine operation, for which he had to invest Rs.2000 to 2500/- per month on the diesel.

- The unpredictable power cuts during the Khowa making cycle leads to spoilage of the complete batch of the Khova.
- In addition to this, the neighbours & the family of entrepreneurs found it difficult to bear the noise caused by DG set.

Technology: 4 hours Solar Backup for running two motors of 0.5 HP and 0.25 HP, one for rotating vessel and another for air blower has been adopted on an individual model.

Impacts:

Reduced overheads: Reduced operational cost for firewood by Rs.1000/month

Improved well being: Reduced noise pollution in working area of DG set

Diversified farm income: Increased income by Rs 2500/month with the production of khava.

Overall dairy combination case study

Background:

Manjunath Degavi engaged in dairy farming as a secondary occupation with 4 cows and average monthly income of INR14,800 through made sales to a local cooperative. He was reliant on manual practices and methods of milking and employed 2 workers. In 2016, he invested in a milking machine. With improved efficiency and significant rise in earnings, he was able to further invest in two more milking machines, chaff cutter, khova maker and biogas digester in 2019 to diversify and increase his income levels. He now owns 22 cows and with the cumulative addition in income he was able to buy 4 acres of land for marigold farming.

On an average generates 200 litres of milk for which he charges Rs. 22- 32 per litre based on the season and demand. Additionally, by adopting the Khova maker he has added value to his existing venture. On an average 30-50 kgs of khova is made twice a month. The khova maker has an output of 5kgs for 1 litre of milk. The khova is sold to sweet shops in nearby towns. With the support of a bank loan from KVGB bank, Manjunath was able to acquire both DC milking machines and khova making machines. He has successfully repaid a loan of 700000 in a period of 2 years. Further with improved income and savings, Manjunath was able to Self-finance biogester and additional two milking machines.

Amboli is a remote unelectrified and drought prone village situated 25 kms from Dharwad town in Karnataka. The village is home to 17 Gowli Maratha families who are traditional cattle rearers and own 250 cows and buffaloes. The community sells milk in neighbouring villages which is their primary source of income.

Key Issues:

Inadequate fodder led to malnourished cattle due to the community capacity to only provide dry fodder. The cattle were hence producing less quantity and quality of milk. The high cost of procuring fodder also eats into a majority of household income. Households buy dry grass/ hay worth Rs. 40,000 for 3 months. The hydroponic system installed required 1/5th the land and at a ratio of 1:5 of seed to fodder. Additionally, a solar powered pump was installed. Due to this intervention, fodder grown by one family can be fed to 17-20 cows.

Impact:

By-product of production: The community depended heavily on firewood for cooking and water heating. With restrictions from the forest department and the abundant waste from the cattle, an intervention with biogas for cooking and for khova making was introduced. The system output was equivalent to 2 LPG cylinders of gas per month. 1 kg of kawa requires 5 litres of milk where each litre in the market sells at Rs 22 per litre

QR code for video

3.4 Conclusion

These interconnected nodal points along the dairy value chain- input, production and processing- can be powered with an array of clean energy powered livelihood technologies. This report captures the key interventions and provides an insight into the technology, ownership models and the expected impact of these solutions.

The interventions discussed in this document can play a key role in strengthening the overall value chain and increasing the value capture for tomatoes at the farm level and for end-user groups . They can help in building safety nets for farmer groups by increasing incomes and enabling product diversification. They also contribute to strengthening the climate adaptation capacities of last mile farmers in this drought-prone region, and reducing CO_2 emissions from current and potential on-farm and processing activities. The larger goal is to build on the learnings and evidence from these solutions to blanket the value chain and transform income earning capacities from these value chains in the region.

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