

TECHNOLOGY INFRASTRUCTURE

AS A

CATALYTIC AGENT

FOR ERADICATING

RURAL POVERTY



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Identifying Frontier Technologies Globally for Poverty Eradication

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Amit Saha

ABSTRACT

The digital revolution has integrated the world as one platform for implementing the global development agenda now like never. Though it is quite well known that poverty is a manmade crisis – crisis in the midst of plenty – sustainable solutions to this menace has not clicked till now due to complex range of factors. There is no dearth of solutions aka ‘jugadh’ technologies to solve social issues like poverty. From hi-tech to the most recent disruptive, technologies have in fact revolutionized our lives in many ways. The issue lies in taking it to the masses professionally using feasible means and optimal process. This paper investigates an innovative approach to identify and understand global technologies in dairy farming sector. The approach called frontier approach has been widely used in economics to benchmark productivity but has been limited in use. This paper tries to focus on the principles, method and implementation of the identified technologies having optimal impact for local issues using case studies and examples of relevant technologies in different sectors used by the FoGS network to solve food, health and livelihood issues having direct linkages to poverty at grassroots level. The paper also suggests a roadmap to use this innovative approach to benchmark sustainable technologies for poverty elimination at grassroots level at social, economic and environmental levels.

Keywords: Frontier, Benchmark, Technologies, Poverty, Development

I. INTRODUCTION

Agriculture is the number one employment source for the masses in India. The share of GDP has been significantly declining over the years from agriculture. This clearly shows

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the reduction in income from agriculture, which in turn means more people are under poverty dependent on agriculture as livelihood. One of the main concern and also a dilemma with the policy makers is the root cause and the policy support for the masses. Is it lack of technology or a policy that dictates supporting labour intensive technologies on the pretext of protecting livelihoods? These are some questions and prospective solutions to address this very preemptive issue to eradicate poverty that is glaring in present India.

II. BACKGROUND TO THE STUDY

India is an agrarian economy with Agriculture as the base of 300 million farmers, about 50% of working population though the GDP share is only 16.5%. Annual spend on agriculture development and infrastructure is only about 5% of the total budget (Economic Times (2020). The defense budget is almost double (IBEF 2020). India is however, beginning to take the right steps to develop agriculture sector like the Agriculture Infrastructure Development Fund of INR 1.4 lakh crore is promising. However, to ensure that sustainable growth happens it is necessary to ensure that the amount is spent in the right direction in the right capex. This will then ensure that there is sustainable progress in the Animal husbandry sector as a case, in terms of National herd productivity indicator or milk formal organisation share increase towards global competitiveness levels.

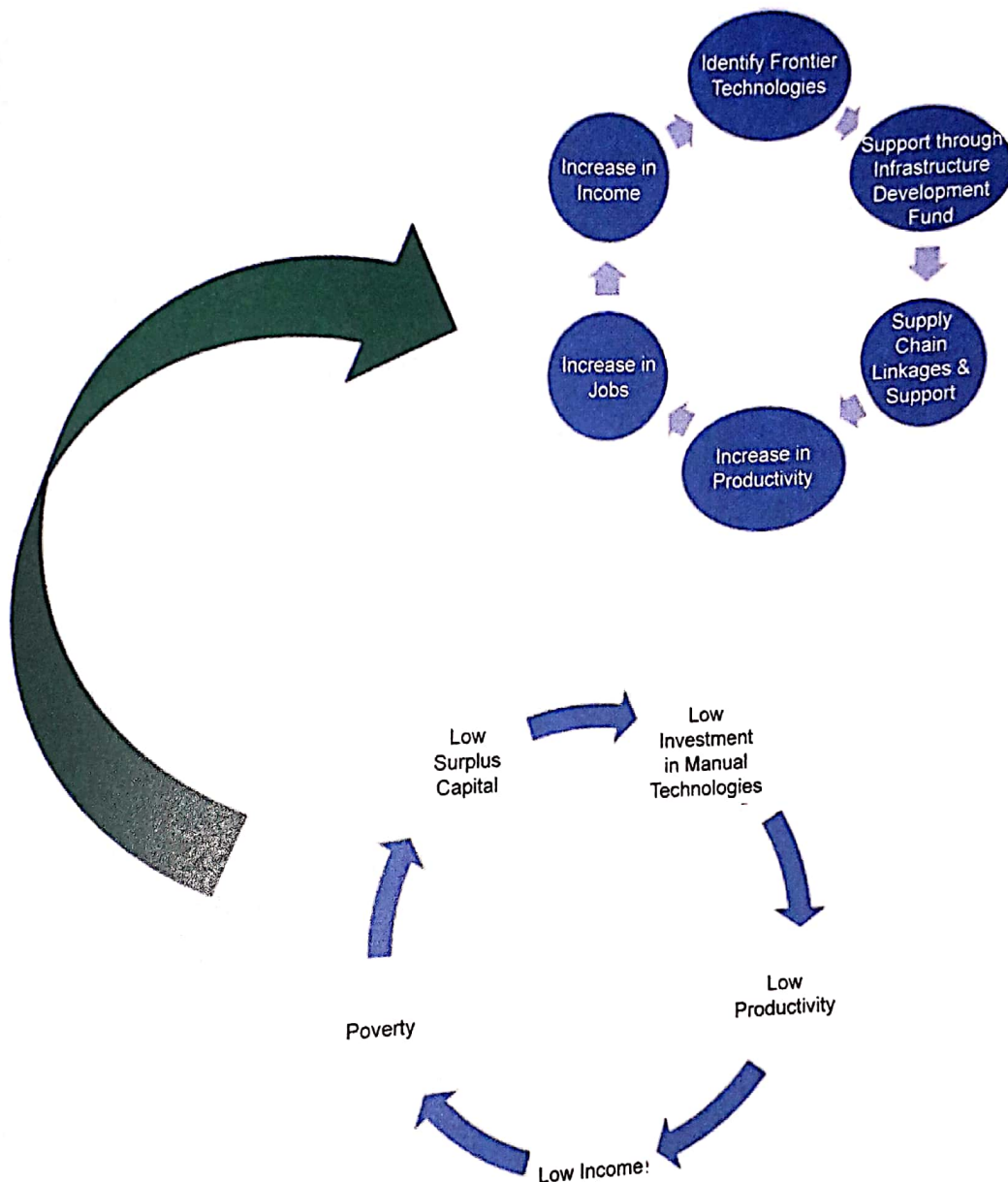
Consider the case of dairy animal productivity, while the average production per cow per day in USA is close to 30 kg per cow per day, India stands at 5 kg (FAOSTAT 2018). In the milk marketing, only about 20-25% of the milk is handled by the organized sector, while remaining is home consumed or handled by unorganized sector (MoAH&D 2019). Close to 70 million litres per day of the 400 million litres produced is procured and processed by the formal sector and most of it about 40% by Amul (BT Research and Equity 2017).

Hence, there is a greater role to increase the formalization of the dairy sector while ensuring that jobs are created and farmers are able to access the resources needed for capital expenditure to improve their productivity levels. Poverty is both the cause and the effect of low productivity. This can be understood by the poverty cycle and how Technology infusion can break the cycle through direct and indirect impact (figure 1).

III. CASE STUDY OF DAIRY VALUE CHAIN

The backward and forward linkages in the dairy farm operations relate to four important management areas as shown in the figure 2 graphical illustration below. These are Feeding,

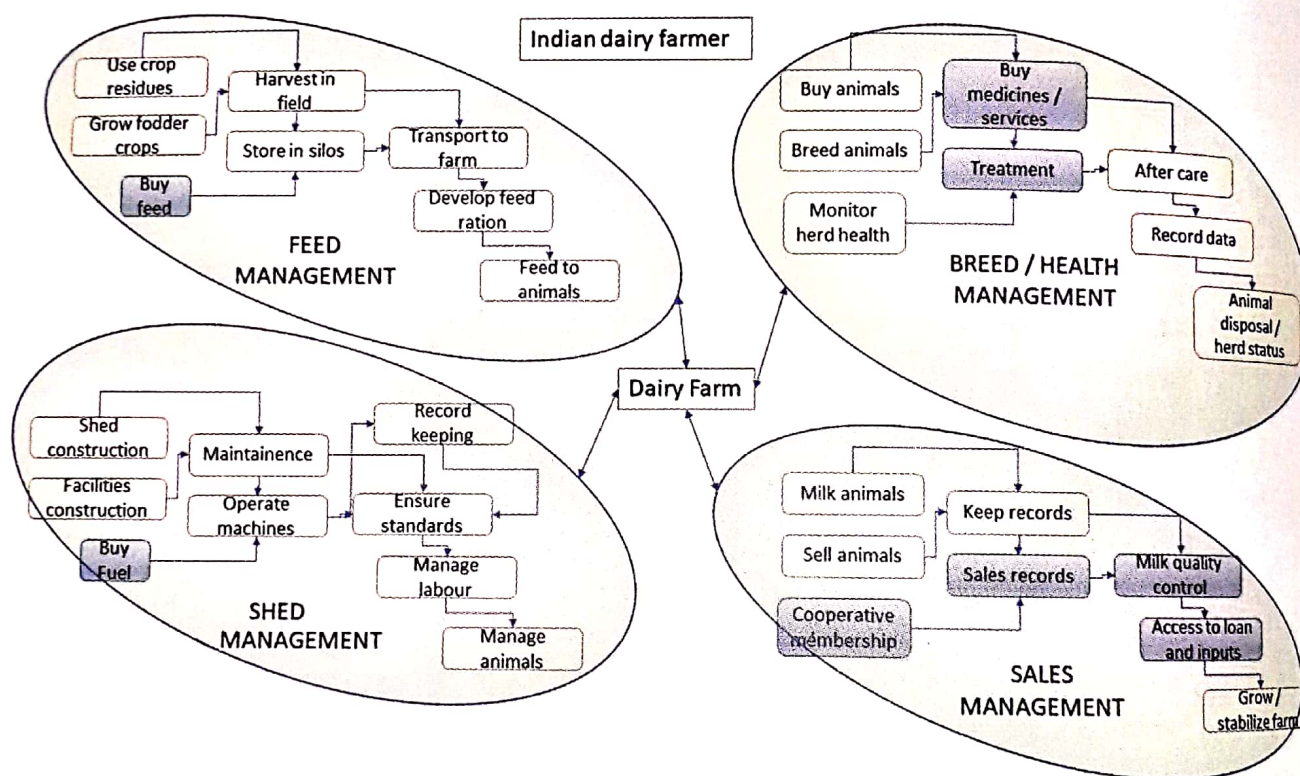
Figure 1. The poverty cycle and the Investment model



Shed, Breed and Health and Sales. As can be seen, most of the operations in the chain are unorganised using minimal of technology or stakeholder intervention. The dairy farmer is able to manage the operations based on his ingenuity and skill gained by performance. However, is this efficient approach? Could be arguable, that this enables the farmer to reduce his costs and also provide him with job to keep him employed with. However, most of the Studs go against this logic, especially in modern intensive farms, where most of the operations are mechanised and highly intensive.

It could be possible that these unorganised operations are able to create much more jobs and hence local livelihoods while the farmers' uses his time to expand his herd operations and do what he does best, manage the herd operations more efficiently. To analyze this logic, let's dissect each of the management areas and the type of job opportunities and technology generations possibilities under present rural scenario.

Figure 2. The complex dairy value chain and its organization



Codes: Highlighted blue cells refer to organized sector linkages.

Shed Management Innovations

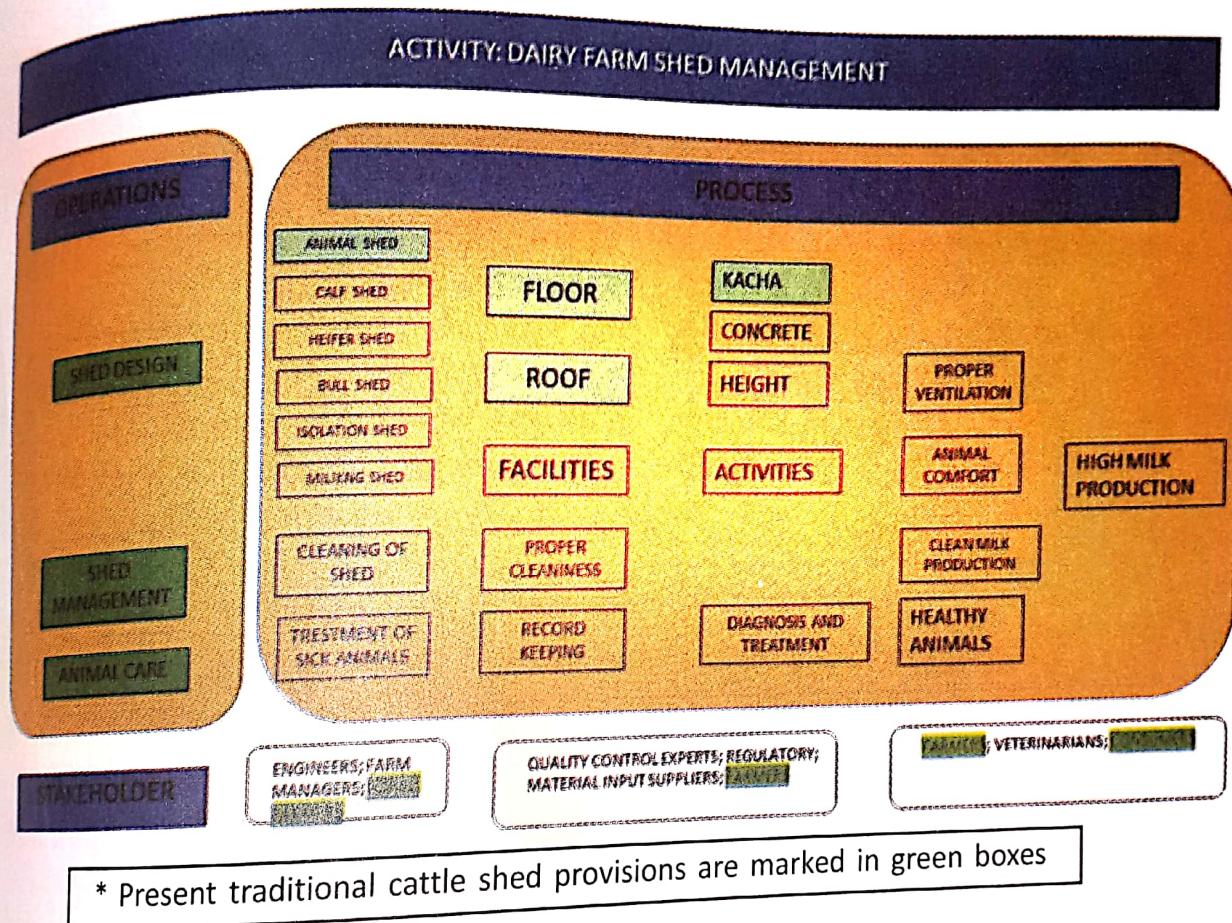
Presently, most of sheds in India are makeshift facilities, mostly common sharing with human habitation (figure 4). There lies a tremendous scope to develop and commercialize this set of operations in the dairy farm. Once developed properly, there will be job generation not only in the manufacture of these facilities but also training jobs for the upkeep of the ground equipment, and facilities.

To understand the organisation level of cattle shed management, the whole activity of cattle shed management is dissected into its operations and process. As can be seen in the figure 3 below, most of the operations and the processes are mostly based on the farmers' own discretion and primarily 'jugad' based.

IV. METHOD DEVELOPMENT

Let's consider some real case Studies where shed innovations have already been introduced and it's potential to commercialize such technologies.

Figure 3. Overview of dairy farm shed management presently and future provisions



Existing Traditional Cattle Sheds

The traditional cattle sheds for 10-20 cows build a shed using traditional methods and local construction workers who do not specialize for cattle specific needs. So, normally, they use the similar methods and design as for human residences with cost as the prime consideration. As can be seen in the figure below, normally, these farms make use of a shed and an open area. The open area is considered as the area in which the animals are kept during the day while the shed is cleaned. The flooring is mostly concrete or just mud kaccha floor. There is normally no provision for shade in the open area.

Normally, there is no separate housing according to age or category of animals. The calves are kept in a makeshift house nearby from birth onwards for up to 5-6 months of age. After that they are kept in the same shed as the cows.

The need for change in the 'Jugaad system'

Traditional cattle shed systems face two key issues linked to the basic purpose of a good animal housing system (figure 4). These are (a) Good welfare to cows for clean and hygienic production and (b) Protection from hostile climatic conditions like extreme temperatures and weather conditions.

In the traditional sheds, the farmers are mostly producing in the range of 200-500 litres of milk per day. The farmers do not have the expertise or the necessary knowledge to design efficient farm sheds by themselves especially in terms of structural design and choice of materials. Also consideration of local climatic conditions, breeds and future expansion provisions are also not considered.

It is a well-known fact that an increased temperature in the shed has a negative effect on milk production. Any temperature above 27 degree Celsius is likely to cause mild heat stress and above 37 degrees to a severe heat stress. With temperatures in India ranging from 25-45 degrees in most parts of India, consideration for cow comfort should be the primary consideration in building sheds. Studies have clearly shown that in those sheds where cows lie comfortably for at least 12-14 hours per day produce more and for every hour the cow spends uncomfortably standing due to heat reduces milk by a litre (Berg, 2016). Hence, proper shed design and comfortable resting provisions are the prime necessities for a modern shed with high yielding animals.

Proposed innovations in the professional cattle shed design

Behind any designing in a modern and professional manner stands simplicity, affordability, feasibility, availability of resources, sustainability, quality and cows' welfare and longevity. The designing of cattle housing systems for 10-20 cows have four goals or factors under consideration:

1. Increase quality and quantity of milk production by lower heat stress
2. Make cows comfortable by climate control system and better resting provisions
3. Increase profitability of farms
4. Ensure future shed expansion provisions through barn design

The present designing of shed considers to keep 10 lactating cows expandable to 20 with 10 pregnant heifers and cows. So, initially with space for 20 animals expandable to 40.

Shed Design and Construction

The "face to face" design with two linear mangers running parallel to each other and the cattle line up face to face on both sides in two rows (figure 4). A 2.5 metre wide brick

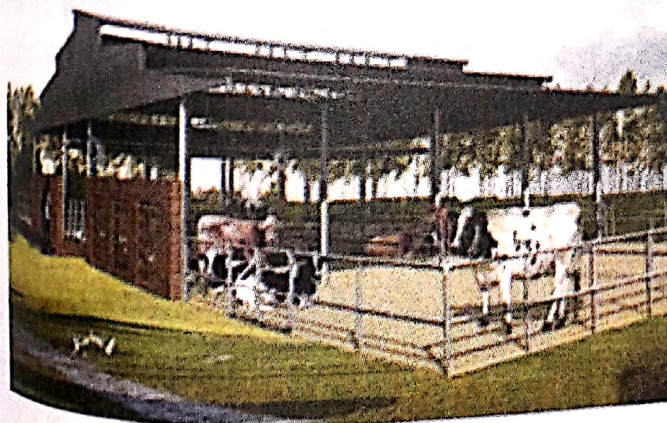
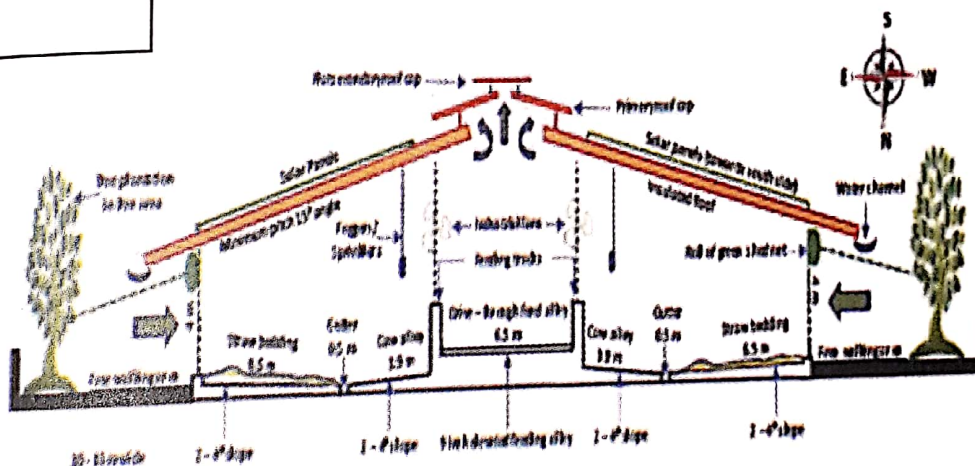
Figure 4. The transition from traditional to a professional organised animal shed and its management



Traditional cattle shed using local resources and jugad technology -> High cattle stress -> lower production



Professionally designed shed considering cow needs and local resources Eweg et al. 2017



Optimized cattle shed (Bagha 2010) using formal resources organization and cow care-> higher productivity, health and quality milk with more jobs

paved floor runs in between the two mangers for easy movement and convenience in putting fodder and feed in the mangers on both sides. This also will facilitate easy animal inspection for health checkup and surveillance. Suitable cattle enclosures using mild steel round pipes will ensure that proper animal management is possible like high yielding cows, pregnant cows, heifers and low yielding cows. Cows are given the freedom to move in their respective enclosures or even sit in open area depending on the climatic conditions and the animal health condition.

The height and depth of the shed are deliberately increased to protect them from the long hot summers and to keep interiors cool. Adequate cross ventilation provisions through primary and secondary roof caps or vents as shown in figure below will ensure that hot and light air underneath the ACC sheet roofing gets exhausted upwards through these vents attracting cool and heavy air from the vegetated surroundings at lower level. The convection current thus created will help to reduce the summer heat significantly. Shed orientation is kept in the North South direction with the top triangular ends facing east-west direction. This is done intentionally so as to allow the morning sun soothes the cows from the open eastern side. Provision of green shade nets, brick net screens in the southern side, plantations in the western and northern side around the shed will ensure flow of cool air into the shed. The enclosures have largely been kept kutcha with sand filling. Only 4.00 metre wide strip along the manger has been made pucca with brick-on-edge flooring.

Provisions in the cattle shed

1. Power Facilities

- a. Provisions to fit rooftop Solar panels to meet the farm energy needs will ensure sustainable green energy utilization. Diesel Genset- 10-25 kva, Electricity point, Manure biogas generator are the other power provisions in the shed.

2. Lighting

- a. Proper LED lighting arrangements in the shed will enable efficient power utilisation and labour functioning with proper safety and hygienic considerations.

3. Ventilation

- a. Two industrial fans are fitted on either side of the manger path to ensure flow of cold air in the shed.

4. Animal Cooling Facilities

- a. A system of automatic showers and high velocity fans has been installed above the feeding point. This system runs automatically for 3 to 6 minutes at feeding time to bring down the body temperature of cows by evaporation.

5. Water Facilities

Water troughs with stop valve arrangement have been provided at appropriate locations so that cattle can drink water whenever they feel like.

6. **Other Provisions** for proper feeding, cleaning of the sheds, safe milking, animal resting and cleaning are also the hallmark of a professional animal shed.

Demand Estimation of Professional Cattle Sheds In India For 20 Cow Family Farms

The potential herd size group for future sustainable milk production is obviously the 5-20 dairy animal family farms. Obviously, the dairy farm development in this group has the highest potential for success. A shed with about 20 dairy cows has to have the provision to keep about 40 animals including heifers, calves and replacement stock. An estimated 3.8 million farms are in this category (Annex 1). If we assume a mean herd size of 10 cows in this group, we need to develop sheds for at least 20 cows in this category.

V. ANNEXURE 1

Table 1. Estimated dairy farm structure in India

Herd size group	000 farms	000 cows	000 Ton milk	% milk share
0-5	70558	104352	79021	47%
5-20	3788	30178	59054	35%
20-75	214	5879	28701	17%
75-500	6	594	2575	2%
Total	74566	141003	169351	100%

Source: Own estimations

Assuming that about 90% of the farms in this group are still traditional farm structure, there is potential to develop at least 3 million such professional farm sheds with modern sustainable structure in the near future in India. With a potential to expand by at least 10% every year, would mean a market of developing 30 lakh sheds in a year. To estimate the job generation potential from each 20 cow professional shed, we use the following table calculations as in Table 1.

Table 1. Job creation potential from professional dairy shed management operations in India

Table 1. Job creation potential from process shed management for a 10 animal shed										
ACTIVITY	SHED MANAGEMENT FOR A 10 ANIMAL SHED									
OPERATION	PROCESS	MATERIAL	Cost per ton/\$ q. Ft/ no.	Quantity per shed	INDIRECT JOBS		DIRECT JOBS	TOTAL VALUE ADDED	For 0.3 million sheds per year	
					Manufacturing	Sales			Services	per shed (INR)
SHED CONSTRUCTION	FLOOR and WALL DEVELOPMENT	Concrete MT	4000	40	0.12	0.20	10	165684	4971	3.10
		Bricks	1250	20	0.06	0.10		25092	753	0.05
		Sand	400	50	0.15	0.25		20229	607	0.12
		Straw	5000	2	0.01	0.01		10009	300	0.00
		Stone	500	20	0.06	0.10		10092	303	0.05
		Drainage grill	50000	0.5	0.00	0.00		25002	750	0.00
		BODY STRUCTURE	Steel pillars	70000	1	0.00		0.01	5	72755
	Plastic		250000	0.25	0.00	0.00	62501	1875		0.00
	CEILING	ACC sheets per sq ft	300	1000	0.06	0.10	300092	9003		0.05
	BOUNDARY	Grill framing sq feet	10	4000	0.12	0.20	40184	1206		0.10
	SHED FACILITIES	POWER FACILITIES	Solar panels no.	2500	4	0.00	0.00	0.25	10138	304
Diesलगenset- 10-25 kva no.			50000	1	0.00	0.00	0.15	50083	1502	0.05
Electricity point			1000	1	0.00	0.00	0.2	1110	33	0.06
Manure biogas generator			350000	1	0.00	0.00	0.2	350110	10503	0.06
LIGHTING		LED Sq feet with fitting	20	50	0.00	0.00	0.25	1140	34	0.08
VENTILATION		Dairy fans per piece	20000	2	0.00	0.00	0.25	40138	1204	0.08
ANIMAL COOLING FACILITIES		Foggers / sprinklers per feet	350	100	0.00	0.01	0.25	35142	1054	0.08
WATER FACILITIES		Cattle water trough per piece 6 feet	20000	1	0.00	0.00	0.1	20055	602	0.03
		Automatic water bowl	500	20	0.00	0.00	0.1	10056	302	0.03
FEEDING FACILITIES		Concrete trough- 10 piece	1000	10	0.00	0.00	0.1	10055	302	0.03
CLEANING FACILITIES		Cowshed cleaning pump	18500	1	0.00	0.00	0.1	18555	557	0.03
SAFE MILKING FACILITIES		Anti kick bar	10000	1	0.00	0.00	0.25	10138	304	0.08
		Sewage mud pump	10000	1	0.00	0.00	0.1	10055	302	0.03
ANIMAL RESTING FACILITIES		Rubber mat	500	20	0.00	0.00	0.15	10083	303	0.05
ANIMAL CLEANING FACILITIES		Cow washing brush	1000	2	0.00	0.00	0	2000	60	0.00
SHED CARE	CLEANING	Contractual	5000	1	0	0	2	5000	150	0.60
	MAINTAINENCE	contractual	5000	1	0	0	2	5000	150	0.60
	REPAIRS	Contractual	5000	1	0	0	2	5000	150	0.60
TOTAL					0	0	2	5000	150	0.60
								1325497	39765	7.5

Thus, from the above table, we can see that just getting one of the activities of the dairy farm, i.e. cattle shed management organized through formal stakeholders in the industry, will generate about 7.5 million jobs at national level and gross revenue both direct and indirect of over 40000 crores. The farmer expenses for the capital infrastructure set up is about INR 13 lakhs, which can be easily breakeven through the increased benefits of higher dairy productivity, energy and labour savings and environmental benefits. Suitable national dairy infrastructure development schemes can be made to ensure that farmer is able to finance the initial capital costs for the whole setup. With a corpus fund of 30000 Crores per year for this scheme of shed modernisation from the Agriculture infrastructure development fund will help to not only modernize India's dairy sector but also create 7.5 million jobs as spillover effect thus overcoming poverty.

The documentation of the processes in cattle shed design gets complex as we expand the dimensions for decision making. For instance, Animal type, breed, Material options, Climate and topography, availability of water, power, Space availability, number of animals, costs of materials, service availability and so on.

As the dimensions are explored further, we need tools to identify the best options for a particular farm in a given region. Frontier analytics using DEA approach is an excellent tool to identify the best sustainable option considering multiple criterion of optimization like costs, cow welfare, environmental concerns, labour considerations, etc. FoGS Global Consulting is working in this direction to ensure that farmers are able to make the right technological choice with the stakeholders involved to ensure that they meet their economic, social and environmental goals.

For more details, please visit, <https://sustainablefoods2050.com>

VI. CONCLUSIONS

Future Directions and Conclusions

There is need to formalize and make the whole dairy value chain organized. This could include the dairy activities like feeding, breeding, animal health care, milking, credit management and milk sales management. Use of available and disruptive technologies like AI, block chain, IoT, e-commerce will go a long way to ensure that the farm sustainability and global competitiveness is maintained, while at the same time farmers is using the technological advantages to come out of the poverty cycle. All the stakeholders involved in the dairy supply chain including government should work together to ensure that the transformation of the dairy supply chain at the farm level is smooth and not

rigged by risk and uncertain outcome of the investments made. In addition, a very important consideration is availability of skilled labour to do the farm construction. Normally, when we need large number of workforce in million, the government or other training bodies should introduce focused training course or diplomas to meet the specific needs for such jobs. Hence, proper planning and logistics is very essential to ensure successful implementation of such large scale projects in a wider geographical domain.

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