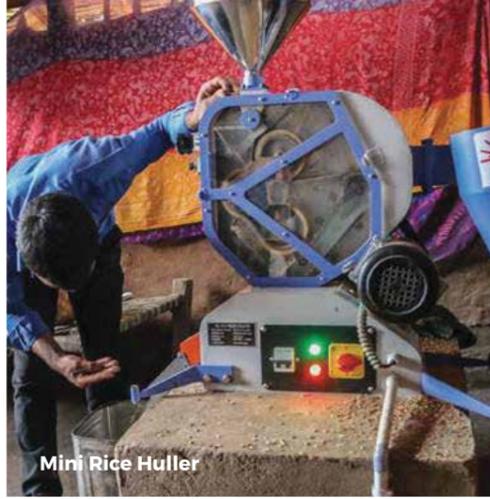


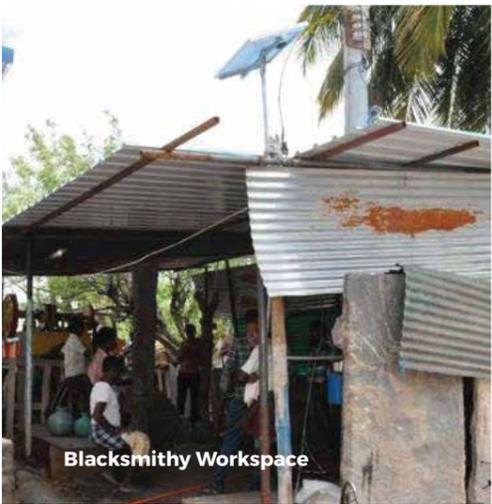
Air Compressor



Mini Rice Huller



A Dairy Farmer's Workplace



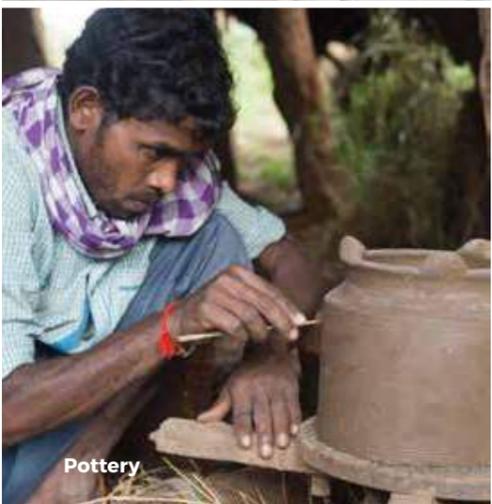
Blacksmithy Workspace



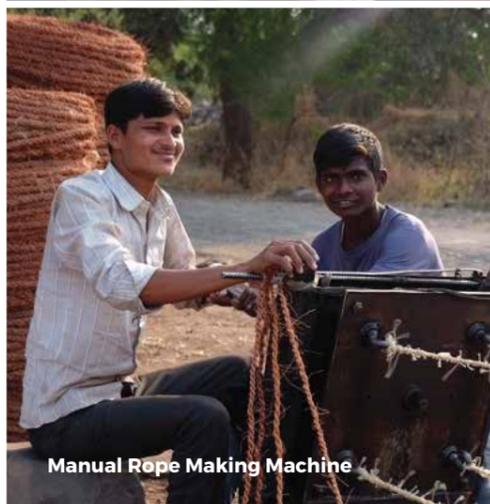
Mobile Livelihood Centre



Carpentry



Pottery



Manual Rope Making Machine



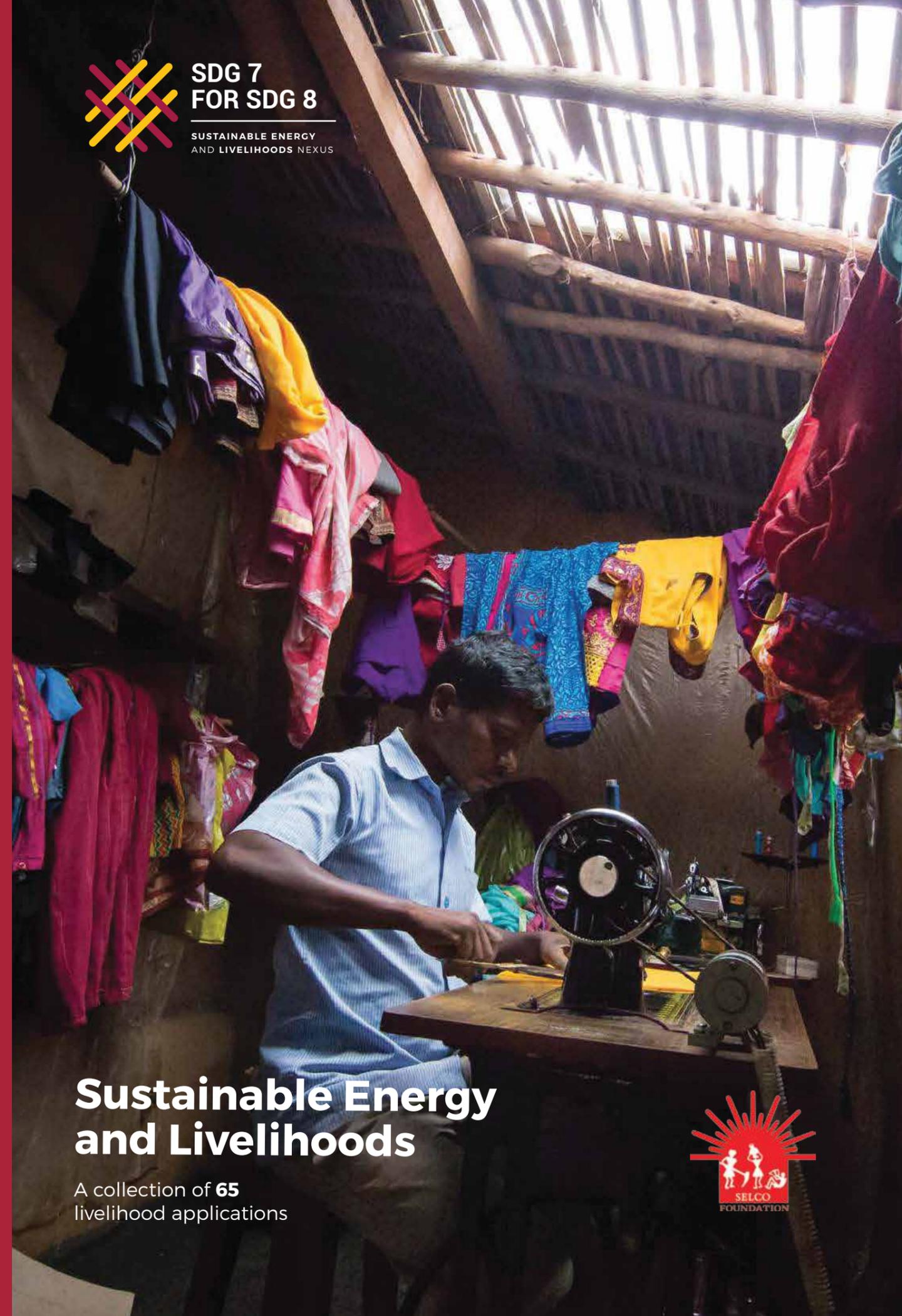
Tailoring Entrepreneur



SDG 7  
FOR SDG 8

SUSTAINABLE ENERGY  
AND LIVELIHOODS NEXUS

SELCO Foundation



Sustainable Energy and Livelihoods

# Sustainable Energy and Livelihoods

A collection of 65  
livelihood applications



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# Sustainable Energy and Livelihoods

A collection of **65** livelihood applications

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.

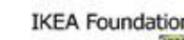
SELCO Foundation demonstrates the role of clean energy and energy efficiency across areas of wellbeing, livelihoods, health and education.

\*All pictures in this document are from SELCO Foundation implementation sites unless otherwise stated

INNOVATION PARTNERS



REPLICATION PARTNERS



TATA TRUSTS



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# ROLE OF SUSTAINABLE ENERGY IN SCALING [ECOSYSTEMS FOR] INNOVATIONS IN LIVELIHOODS

Poverty and climate risk are the two most important issues that are increasing social unsustainability and leading to more disparities across geographies. Both are man-made and solvable using sustainable energy as a catalyst. Replicable eco-system processes, banking on sustainable energy that encourage various income generating activities for the marginalized populations can help solve the poverty and climate crisis.

Today, more than two billion people live under \$2 dollars a day, either in poverty or extreme poverty\*. And many of them lack access to reliable energy, that could have enabled them to explore options of increased incomes. More than 80% of this group lives in sub-Saharan Africa or in the developing economies of Asia. The relationship between energy gap and livelihood opportunity gap is very visible. There are ways these gaps or problems can be solved.

In recent times, majority of the innovations in livelihood and productivity have been focused on a centralized industrial scale- whose benefits do not trickle down and the ownership does not transfer to the poor. Innovations for the poor have to be decentralized and customized. At the same time, **'innovation' often focuses on technology alone, and not on processes around ownership models, financial models, supply chain and service delivery models; that allow for sustained impact from the design and deployment of the technology.**

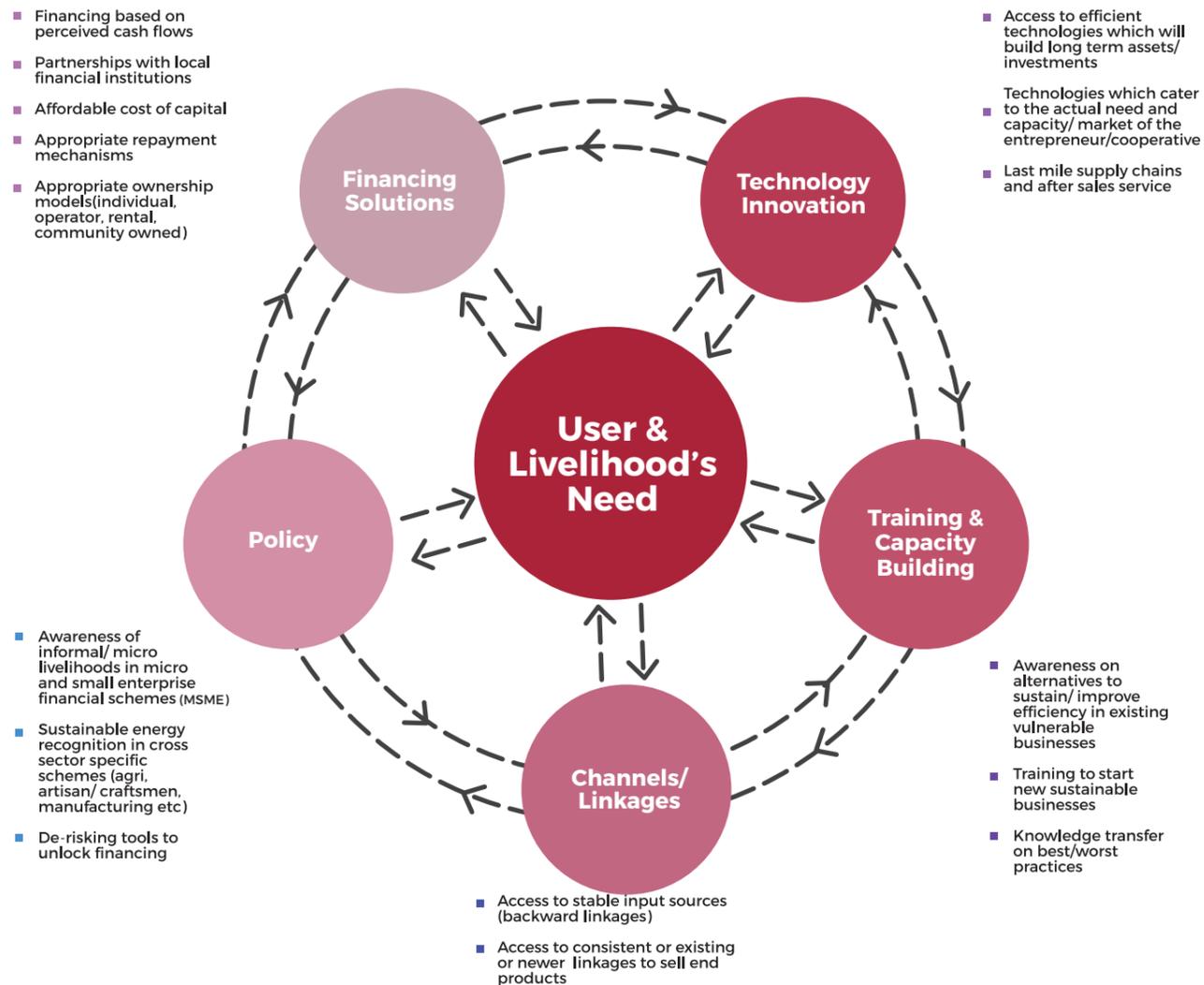
For e.g.:

Design, development and deployment of a solar powered highly efficient tailoring machine that is optimized for a particular tailor's level of productivity is needed, however this alone will not create the desired impact if the tailor does not have the skills to make market ready products or the market to sell his/her products.

Further, for low income micro entrepreneurs, it is imperative that the precious profit margins are spent to build assets and cutting down on operational expenses. Thus, business modeling to understand cashflows, and tailor financial products also need to be considered providing the sustainable technology solution.

(more details on the sewing machine ecosystem under the textile section in the following pages).

## ECOSYSTEM NEEDS



\*www.worldbank.org/en/topic/energy/overview

**SELCO Foundation's focus and uniqueness lies on scaling up the enabling eco-system factors that lead to the successful delivery of income generating assets at the doorstep of the end user.**

This allows for end users and communities to not just move out of poverty but also reach a level of social security, such that if there are sudden shocks or stresses (climate change, financial, health crisis etc) one is not plummeted back into poverty, diluting hard-won gains.

**These processes have to become the core upon which, society needs to build relevant programs and policies.**

Over the past 5 years, SELCO Foundation piloted and scaled numerous livelihood-based interventions for the poor using sustainable energy. These interventions encompass technology innovations, efficiency of appliances, new financial products and catalyzing market channels for the poor. A typical livelihood solution is often approached as a suite of options for new and existing entrepreneurs,

cooperatives or hybrid ownership models; within various contexts which include, un-electrified, under-electrified and electrified scenarios. In each of the scenarios, financial savings, removal of drudgery, enhanced productivity and time efficiency lead to better income opportunities and sustainable growth for rural and tribal livelihoods.

The need of the hour is to catalyze and enhance these missing ecosystem factors in order to demonstrate the linkage between sustainable energy and development: thus, demonstrating the capability of decentralized energy to transform communities.

	STAKEHOLDERS	KEY SUPPORT AREAS
<b>Financing Solutions</b>	<ul style="list-style-type: none"> <li>Nationalized Banks</li> <li>Credit Cooperative Societies and Cooperative Banks</li> <li>Rural Regional Banks</li> <li>Micro-Finance Institutes</li> </ul>	<ul style="list-style-type: none"> <li>Financial Institute (FI) training and awareness programs</li> <li>Target setting with Financial Institutes (Circulars/ MOUs)</li> <li>Developing loan products with FIs</li> <li>Financial Innovation for unlocking loans (Risk fund/ guarantees/ Interest subvention for vulnerable livelihoods)</li> </ul>
<b>Technology Innovation</b>	<ul style="list-style-type: none"> <li>Vendors or Suppliers for efficient need based technologies</li> <li>Last mile delivery enterprises or system integrators</li> <li>Grassroot research and development labs focused on efficient livelihood solutions</li> </ul>	<ul style="list-style-type: none"> <li>Research and development capital, capacity building</li> <li>Purchase agreements with vendors and suppliers to meet minimum orders stipulated by vendors</li> <li>Working and expansion capital for technology/product vendors or dealers and last mile sustainable energy enterprises</li> <li>Incubation and training of sustainable energy enterprises/ system integrators</li> </ul>
<b>Training &amp; Capacity Building</b>	<ul style="list-style-type: none"> <li>Industrial Training Institutes</li> <li>Vocational Training Schools</li> <li>Agriculture Training Centers</li> <li>NGOs for Skill Building</li> <li>Microbusiness/Grassroot Incubators</li> </ul>	<ul style="list-style-type: none"> <li>Demonstration facilities for efficient productive appliances</li> <li>Training modules on technology usage, business planning, access to finance, product diversification and marketing</li> <li>Trained personnel mentoring and supervising knowledge transfer</li> </ul>
<b>Channels/ Linkages</b>	<ul style="list-style-type: none"> <li>Vendors/ Suppliers/Enterprises/ Institutes/</li> <li>End Users providing input and output channels</li> <li>Producer Companies</li> <li>Aggregators</li> <li>E-commerce platforms</li> </ul>	<ul style="list-style-type: none"> <li>Providing access to relevant networks and connections with stakeholders.</li> <li>Exposure visits, expert mentorships, workshops</li> </ul>
<b>Policy</b>	<ul style="list-style-type: none"> <li>State and National Level Government Bodies</li> <li>Apex banks</li> <li>Rural and tribal ministries</li> <li>Councils and Departments</li> </ul>	<ul style="list-style-type: none"> <li>Broadening scope of skill development beyond wage employment to cover innovation and entrepreneurship/ enterprise</li> <li>Incentives and targets for micro and small grassroot businesses to adopt energy efficient and sustainable-energy driven solutions.</li> <li>Tax policies designed to encourage sustainable value chains</li> </ul>

SELCO Foundation, in partnership with numerous experts and practitioners, have developed over 65 livelihood technologies and over 100 processes across these livelihoods around financial and social models. In the past 5 years, itself, SELCO has worked with 2257 micro entrepreneurs, out of which 1434 micro entrepreneurs have improved access to sustainable energy driven livelihood solutions in just the financial year April 2018 - March 2019.

**Out of these, about 40% are micro entrepreneurs who have diversified and expanded their businesses, particularly shops by adding services that were not accessible to them and their customers due to lack of energy.**

(Refer to Digital Services in the Services and Retail section)

**30% have been small scale vulnerable entrepreneurs who were suffering from opportunities lost, due to time consuming manual processes, or unavailability of expensive labour. Majority of micro entrepreneurs in this category have moved from a manual to a technical solution for the first time.**

(Refer to section on Blacksmithy, Rope Making and Milking Machine)

**While a huge potential lies in enhancing and decentralizing agriculture value chains through energy, financing has been a barrier to scaling. 9% of the solutions were implemented for agri related livelihoods.**

(Refer to the section on Agriculture)

**For long term effective solutions to evolve, customized ecosystems have to be established and innovations need to happen in technology, finance and delivery models. The following sections demonstrate some of these processes built in partnership with micro-entrepreneurs and eco-system stakeholders for 65 critical energy-livelihood links identified.**

**It is our endeavor to document these interventions in a manner that demonstrates how parts of the ecosystem can be pieced together contributing to a more asset based solution. More importantly, that the reader can adopt or adapt these various parts to replicate and scale similar interventions in other contexts.**



# Textile

# TEXTILE

Revolution in seeds, farm practices, advanced ginning and never-ending developments by the Indian and global spinning machinery sector have been making the entire cotton value chain believe that India can take the global lead in cotton by 2020.

However, large-scale mills with large scale machinery, hybrid long staple cotton and private players now dominate the sector which was earlier a decentralized hand spun sector whose history is embedded in the freedom struggle in India. **Being a skill-based, labour intensive industry even today, handlooms are the second largest employer provider after agriculture,**

**providing livelihood opportunities. Most weavers belong to poor and marginalized communities who are at the verge of being wiped out due to large scale mills and powered machinery- machineries made for centralization of manufacturing processes.**

After studying the cotton sector in-depth from picking of cotton by farmers to the cloth woven and stitched, it was concluded that there is a need for decentralized machinery powered by renewable energy to resuscitate the sector, develop innovative technology while trying to revive the skills and crafts involved in this space.



Photo: Cotton Picker solution being tested by users in Bailhongal, Karnataka

## 1. Cotton Picker



### LACK OF LABOUR

Presently, cotton picking is largely practiced manually in farms where daily wage labourers are hired to carry out the task.

Harvest season for Cotton

**Nov-Jan**

### TIME CONSUMING, DRUDGERY PRONE AND RISK OF INJURIES

This manual craft requires labourers to individually hand pick every cotton bud on each plant in any given size of field. This process involves a lot of drudgery due to posture, high load of picked cotton and abrasion of fingers by the sharp points of dried bracts and sharp tools used.

Avg. Collection of Cotton

**45-50 kgs**  
per day per person

### UNRELIABLE POWER SOURCE

Cotton picking machines require batteries to be charged which becomes an issue in unelectrified and areas with poor quality of power.

Operation Hours per day per person

**6-8 hours**

### TECHNICAL SOLUTION

- Solar powered hand held cotton picking machine with a collection bag which will directly collect the picked cotton.
- A mounted LED on the device for better visibility.
- 12V storage battery with a carrying pouch that can be hung on the shoulder and strapped around the waist.

Picking per person per hour

**+ 25%**

### COTTON PICKER WITH 2 LED LIGHTS

<b>Energy System</b>	SOLAR MODULE (Wp)	15
	BATTERY (Ah)	84
<b>Motor</b>	TYPE	DC Motor
	CAPACITY (W)	11
	RPM	54
	BACKUP HOURS	6



Photo: Cotton Picker solution being tested by users in Bailhongal, Karnataka

## IMPACTS

NUMBER OF DAYS PICKERS TAKE TO COMPLETE ONE CYCLE OF PICKING **3**

NUMBER OF TIMES COTTON IS PICKED PER SEASON **4**

INCREASED AMOUNT OF COTTON PICKED BY 1 LABOURER EVERY 7 HOURS (KGS) **15-20 kg**

% Increase In Amount Earned Per Day **30-40%**

## AUTOMATES AND SPEEDS UP THE PROCESS OF PICKING COTTON

With the additional speed, there is a reduction in labour and the time spent by each labourer. A considerable reduction of fatigue compared to manual picking as this enables them to harvest for a longer time at a stretch without stress and lesser breaks. There is also a reliability in power due to the device being solar powered.

## REMOVE THE HANDS ON DIRECT CONTACT ELIMINATING ANY CHANCES OF INJURIES

There is a reduction in chance of potential injuries as the labourers are subjected to frequent cuts and pricks from plant matter. With the mounted LED on the device for labourers who pick cotton pre-dawn, there is better visibility which increases the ease of usability and reduces the chances of injuries.

## TECHNICAL SOLUTION

A solar powered DC energy efficient small scale ginning machine which can support short staple (desi cotton) farmers and weavers.

Manual Ginning

**2-3 kgs**  
per day per person

AC Ginning Machine

**6-8 kgs**  
per day per person

## GINNING MACHINE

Energy System	SOLAR MODULE (Wp)	1200
	BATTERY (Ah)	7200
	SPCU (kW)	2 kW 48V
Motor	TYPE	AC Induction 1 phase
	CAPACITY	1 HP
	RPM	1440
	BACKUP HOURS	3

## IMPACTS

### VALUE ADDITION

For desi cotton farmers, this ginning machine brings value addition in the form of by-products which are not accessible to them through centralized ginning.

The by-products of this ginned cotton i.e. seeds and lint can be used either through direct sales, re-sowing the cotton seeds, pressing the seeds for oil or to make cotton seed cakes. This allows for greater returns on the processed cotton.

Direct Sales

**INR 45**  
per kg of cotton pods

Value added cotton

**INR 150-200**  
per kg of lint cotton

Percentage increase in sales price: Raw Cotton pods vs Processed lint

**+20%** per kg of cotton processed

Increase in income by sales of by-products like cotton seeds

**+22%** per kg of cotton processed

### ACCESS TO SMALL SCALE MACHINERY

Access to ginning machinery for short staple cotton farmers and weavers as opposed to manual ginning. Time and money spent on traveling to mills by farmers will also be conserved.

### ENCOURAGING LOCAL VARIETY COTTON FARMERS

Availability of decentralized machinery can encourage farmers to grow more of short staple cotton (desi cotton) which is more sustainable and less water intensive which can benefit farmers especially in severely drought hit and drought prone areas.

### SELF SUSTAINABLE UNITS

To build self sustainable units where the entire value chain from pre-processing of cotton to weaving and stitching can all be done and directly sold.



Photo: Ginning Machine

## 2. Ginning Machine

### LACK OF DECENTRALIZED MACHINERY

Today, ginning is an entirely centralized process being done through large scale machinery. The machinery is designed to support long staple cotton i.e. genetically modified cotton which has dominated the cotton market in the country. Short staple cotton (desi cotton) is not being cultivated as much due to lack of market demand and the ones growing it are having to manually gin the cotton due to lack of machinery which is very time and labour intensive.

Water used by BT cotton for every 1 kg cultivated **22,000** litres\*

### WASTAGE OF BY PRODUCTS

The seeds and the by-products of the long staple ginned cotton is of no use and is discarded.

Percentage of seeds for every kg of raw cotton pods **30%**

### GEOGRAPHIC CONSTRAINTS

In villages geographically distant from mills, farmers have to incur heavy transportation cost for ginning their cotton.

Avg. distance travelled to a centralised mill **100-200** kms



Ambar (Solar) Charkha at a pilot site in Karnataka

### 3. Solar Charkha

#### LACK OF TECHNOLOGIES

Charkha, a symbol of resistance during the freedom struggle has been used to spin cotton fibres into yarn for centuries. However, there has not been any technological improvements in the design.

Year of manufacture of the most commonly used machine  
**1965**

#### DRUDGERY & FATIGUE

Using the charkha involves hard labour work and is very challenging for the spinners, as most spinners in the country are elderly women.

Rotations of hand for every 1000 m of cotton spun

**300 Rotations**

#### LOW PRODUCTIVITY AND INCOME

The hand shaft rotates at varying values of about 35-40 rpm, which results in low productivity resulting in low income

Production of spun cotton per day manually

**25**

#### TECHNICAL SOLUTION

The efficient ambar charkha intervention has two models:

- 10 spindle ambar charkha with a PMDC motor and solar system
- A retrofit model for the older 6 and 8 spindle ambar charkhas where the PMDC motor can be plugged in and supported by a solar system
- Flexibility to increase the speed up to 75 rpm with a speed controller resulting in increase in production

Production per day **40-45 hanks**  
(1 hank = 1000 m)

#### GINNING MACHINE

<b>Energy System</b>	SOLAR MODULE (Wp)	250
	BATTERY (Ah)	1920
	CHARGE CONTROLLER	20A 24V
<b>Motor</b>	TYPE	PMDC
	CAPACITY	80 W
	RPM	1500
	BACKUP HOURS	8

#### IMPACTS

##### REDUCTION IN DRUDGERY

There is complete elimination of drudgery and fatigue as the spinners do not need to spin the wheel for long periods of time

##### INCREASE IN PRODUCTIVITY AND INCOME

Considerable increase in productivity as it allows a single spinner to use two charkhas at the same time.

##### VARIETY OF COTTON

With the speed controller, varying speeds are available allowing the spinners to use different types of cotton yarn and counts.

##### CREATION OF EMPLOYMENT

With ease in usage, this can be adopted by many women as a home-based livelihood opportunity creating more employment.



Ambar (Solar) Charkha in use at a pilot site in Karnataka

Percentage increase in production amounts **+80%** No. of hanks Spun

Increase in total income earned by a spinner per day **+157%** Using two charkhas



Manual Efficient Loom installed in Karnataka

### 4. Green Looms

Weaving is one of the most wide spread home-based livelihood practices in India across almost every state with weaving clusters steeped in textile traditions. There is a wide variety in the raw materials used, method of weaving, type of looms used, designs on the fabrics etc.

Woven fabrics are an intricate study in warp and weft. Although the end product is a masterful craft creation, making each hand woven piece a physically

arduous process that is repetitive and unyielding. Other factors also include low wages, imported cotton goods, increased price of yarn and insufficient supply of quality raw cotton.

Cotton weavers are mainly limited to Government run societies, due to lack of availability of a supply chain and highly centralized pre-weaving processes, which has led to a decline in number of individual cotton weavers in recent years.

## EXTREME DRUDGERY

In the form of heavy stress and strain experienced by the skilled weavers due to the monotonous repetitive movements causing early fatigue, knee issues, shoulder issues, back pain etc.

Drudgery in weaving one Indian sari **18,000** limb movements for 25 kms of thread

## LOW EFFICIENCY

In case of the hand loom there is low efficiency coupled with intensive physical intervention, resulting in low productivity and lower income levels.

Production per day manually **1 metre**

## A DYING VOCATION AND SKILL

The number of skilled weavers in the country is diminishing rapidly due to them resorting to unskilled labour work as it pays more. The current generation is also not interested in adopting the skill due to its tedious physical involvement and disproportional lower incomes.

No. of handloom weavers replaced by a centralised power loom **8**

# 5.Yarn Winding Machine

A yarn bobbin is a collection of string or material that is wrapped around a cylindrical piece and used for multiple purposes in the textile industry. The targeted end users are groups who bridge the gap between larger yarn bobbin suppliers to create smaller yarn bobbins which can be sold for a variety of uses to different market groups such as garland makers.

The larger bobbins are placed onto a locally fabricated 4-spindle device. This device is manually powered and functions to unravel 1 large bobbin which is turned into a smaller bobbin in a single cycle. Most of these devices can capacitate a maximum of 8 bobbins at a time. The identified end user had fabricated their own device which had capacity for 8 larger bobbins, creating 8 small bobbins simultaneously.

## LACK OF EFFICIENCY DUE TO DRUDGERY

Yarn winding machines are currently all manually operated, and function by turning the flywheel which sets the machine in motion, inflicting a large amount of drudgery. The average person is able to only maintain an efficient speed for a fixed period of time which limits the output produced.

## TECHNICAL SOLUTION

To solve this issue, a motorised solution was provided to the end user by mounting a 0.25 HP AC motor directly on the frame of the machine. The motor is connected via a belt to the flywheel and a speed controller is used to control its speed.

Yarn winding is a niche market, however the same problem of manual operation exists among many other end users.

Further efforts are being made to design and fabricate an efficient version of this device which runs either on an AC motor or DC motor depending on the need of operational time.

## IMPACT

The switch from manual to automated leads to a boost in income due to the autonomy of the machine, as it is able to run for 10 hours continuously at a higher RPM in comparison to a manual operated machine.

By working for 7 hours per day, for 27 days a month on an average a user can earn INR 25,000 per month. This equates to an hourly working rate of INR 132 per hour. With 3 hours of back up, an extra INR 396 per day is earned. However the true value addition is in the quantity of the output produced and income generated as it is likely to be much higher than a manual process as the end users are able to run the new motor at a higher RPM .

- The machine is locally fabricated by a fabricator.
- 0.25 Hp AC motor with back up time of 3 hours.
- The machine has the provision to be manually wound as well.

## TYOLOGIES OF TECHNICAL SOLUTIONS

### MANUAL EFFICIENT LOOM

An innovative custom designed manual efficient loom where instead of four motions, one motion is done for one pick.

- The machine comes with an iron body which makes it more sturdy and easy to maintain.
- Fly Wheel integrated with the loom which provides energy in the working stroke and absorbs energy in the idle stroke conserving energy on a whole expended by the weaver.
- It comes in different sizes based on the requirement of the weaver and the size of the cloth.

### SOLAR EFFICIENT LOOM

The manual efficient loom, in which the one motion is powered with solar energy.

- The PMDC motor is connected to the flywheel through a flat belt drive due to which the weavers do not need to apply any force.
- Speed controller is integrated with the system to give the weaver flexibility to adjust the speed according to the type of fabric woven.

### DRIVE BY WIRE LOOM

A solar powered loom which retains all the four limb motions allowing flexibility for the weavers.

- The four motions are powered by a small retrofit motor which can be attached to any existing traditional wooden frame looms as well.
- This allows the weavers to dictate the loom and in the process keeps their artistry alive while minimizing the drudgery.

## SOLAR EFFICIENT LOOM

Energy System	SOLAR MODULE (Wp)	400
	BATTERY (Ah)	3840
	CHARGE CONTROLLER	20A 48V
Motor	TYPE	BLDC
	CAPACITY	850 W
	RPM	3000
	BACKUP HOURS	8

## IMPACT

In case of the manual loom, the four limb motion and the two pedal motion causes immense drudgery leading to low productivity and income. Post intervention, the income and productivity has a two-fold increase with ease in operations.

Percentage increase in production amounts and income earned per day **+87.5%**  
No. of metres weaved

# 6.Beam Winding/Warping Machine

Beam winding is one of the weaving activities which has to be carried out before the weaving process starts. The beam warping machine is used for this process and is a basic locally fabricated highly geared large machine, designed simply to wind large stretches of material into a roll.

Power loom operators give dyed yarns in the form of continuous hanks, bundle of yarn, to be wound on the

warping beam for the weaving process. The end-user dries it, and winds it on the drum roughly by hand. This process takes one day and on the second day, they use a highly geared motor to wind the yarn from the drum to the warping beam at a speed of roughly 5 to 6 rpm through a 1440 rpm, 0.5 HP, AC 1 Phase motor.

## TECHNICAL SOLUTION

Due to regular power cuts, the weaving work comes to a standstill for 2 to 3 hours, forcing them to make the time up in the night or the next day, delaying the entire weaving process and leading to inconvenience and low productivity.

An inverter based solution, providing backup for 3 hours was provided so that production is maintained even during power cuts, preventing them from having to make up the loss of production at inconvenient times.

A DC based solution with 8 hours backup was provided as well for those communities who do not have to depend on grid connection and want a higher backup of the product.

The end users are earning an average of INR 16,500 per month with this solution by working 25 days a month, with only 15 days of effective usage of the machine, at 8 hours a day. One beam takes 2 days and for each beam they get paid INR 1000 - 1600 depending on the material wound like polyester silk, pure silk, etc.

By providing 3 extra hours of backup, it can be concluded that this will equate to an additional INR 6210 per month.

- Back up time of 3 hours and 8 hours
- Gear arrangement converting low torque high rpm to high torque low rpm output

Percentage increase in production due to automation

**38%**

India is the second largest producer of silk in the world. It produces four types of silk- Mulberry, Tasar, Eri and Muga. Silk processing is one of the most widely performed activities by the people of India, across all geographies, especially the north-east. The entire silk production chain is a livelihood opportunity for millions owing to high employment oriented, low capital intensive and remunerative nature of its production.

The very nature of this industry with its rural based on-farm and off-farm activities and enormous employment generation potential has attracted the attention of the planners and policy makers to recognize the industry among one of the most appropriate avenues for socio-economic development of a largely agrarian economy like India.

### SILK REELING & SILK RE-REELING

<b>Energy System</b>	<b>SOLAR MODULE (Wp)</b>	<b>60</b>
	<b>BATTERY (Ah)</b>	<b>70</b>
	<b>CHARGE CONTROLLER</b>	<b>10A 12V</b>
<b>Motor</b>	<b>TYPE</b>	<b>PMDC</b>
	<b>CAPACITY</b>	<b>15 W</b>
	<b>BACKUP HOURS</b>	<b>5</b>

## 7. Silk Reeling, 8. Silk Spinning

## TECHNICAL SOLUTION

Due to regular power cuts, the weaving work comes to a standstill for 2 to 3 hours, forcing them to make the time up in the night or the next day, delaying the entire weaving process and leading to low productivity.

An inverter based solution, providing backup for 3 hours was provided so that production is maintained even during power cuts, preventing them from having to make up the loss of production at inconvenient times.

A DC based solution with 8 hours backup was provided as well for those communities who do not have to depend on grid connection and want a higher backup of the product.

## SILK SPINNING & RE-REELING

<b>Energy System</b>	<b>SOLAR MODULE (Wp)</b>	<b>60</b>
	<b>BATTERY (Ah)</b>	<b>70</b>
	<b>CHARGE CONTROLLER</b>	<b>10A 12V</b>
<b>Motor</b>	<b>TYPE</b>	<b>PMDC</b>
	<b>CAPACITY</b>	<b>15 W</b>
	<b>BACKUP HOURS</b>	<b>5</b>



REELING MACHINE



SPINNING MACHINE



## 9. Sewing Machines

Photo: A tailor in Karnataka using a Sewing Machine with a Solar Powered DC Motor

Tailoring is one of the most important livelihoods in India. Traditional tailors who generally serve local customers in small cities and villages use a manual sewing machine. The scale of tailoring operations can vary depending on the demand generated in the market for their service.

Local tailors also serve institutional demands like that of schools and other peak season demands. To compete on the existing textile market and achieve higher productivity, traditional manual powered machines have been replaced

by motorized sewing machines. In places with little or no grid, it is difficult to meet the increasing demands.

There is another segment in the tailoring industry which practices tailoring on a large scale. Bigger size heavy-duty industrial sewing machines are commonly used for such purposes. The output from them, generally do not serve the local market but exported to other markets. The industrial sewing machines vary in size and complexity and cater to different needs of the market.

### LOW PRODUCTIVITY AND INABILITY TO DIVERSIFY

It takes a lot of time to stitch one product when stitching in a manual machine which leads to low productivity and lesser income or fewer orders. As work moves very slowly, it is difficult to engage in alternate business activities.

**2** HOURS

Time taken to stitch one blouse

### POWER CUTS

There are a lot of power cuts which make it difficult to use AC machines as they cannot be depended on independently.

**5000** INR

Amount lost per month due to lack of power

### HEALTH ISSUES BY USING MANUAL MACHINES

Physical drudgery is involved in using of manual sewing machines and it affects the health of the user.

**1000+**

No. of repetitive leg movements per meter of straight stitch

## TYOLOGIES OF TECHNICAL SOLUTIONS



### HOME BASED

#### TYPE OF STITCHING

Normal tailoring with straight stitching

#### TYPE OF MATERIALS

Cotton, silk, synthetic, nylon, polyester

#### PRODUCTS MANUFACTURED

Clothes, alteration of clothes



### SHOP BASED

#### TYPE OF STITCHING

Normal tailoring with straight stitching

#### TYPE OF MATERIALS

Plastic, cloth

#### PRODUCTS MANUFACTURED

Clothes, bags



### COTTAGE INDUSTRY

#### TYPE OF STITCHING

Industrial tailoring with high speed straight stitching

#### TYPE OF MATERIALS

Leather, denim, plastic, cloth, jute

#### PRODUCTS MANUFACTURED

Bags, uniforms, denims, gunny bags

#### MARKET LINKAGE

Individual orders and orders from shops

#### MARKET LINKAGE

Individual orders and bulk orders from centres which is passed on to home based tailors. Takes market linkage risk

#### MARKET LINKAGE

Direct bulk orders from retailers which is given to the tailors employed at the centre

60 W PMDC Motor

80 W PMDC Motor

High speed Universal AC Motor

### SEWING MACHINE MOTOR (60W)

Energy System	Parameter	Value
Energy System	SOLAR MODULE (Wp)	60
	BATTERY (Ah)	720
	CHARGE CONTROLLER	10A 12V
Motor	TYPE	PMDC
	CAPACITY	60 W
	RPM	3000
	BACKUP HOURS	8

### SEWING MACHINE MOTOR (80W)

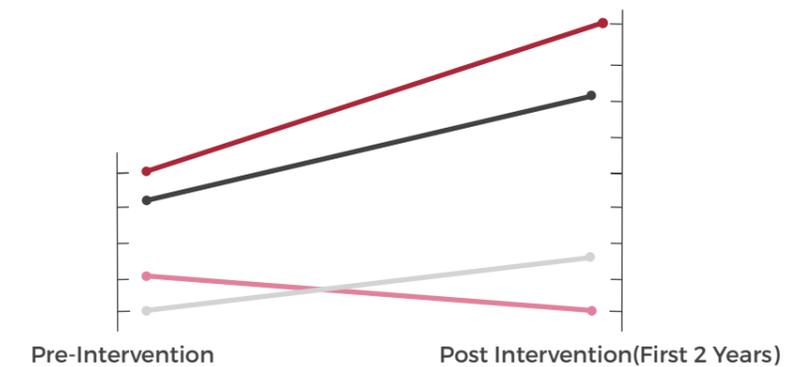
Energy System	Parameter	Value
Energy System	SOLAR MODULE (Wp)	75
	BATTERY (Ah)	900
	CHARGE CONTROLLER	15A 12V
Motor	TYPE	PMDC
	CAPACITY	80 W
	RPM	3000
	BACKUP HOURS	8

## FINANCIAL SOLUTION

Multiple financial approaches are taken based on context specific cases. Various approaches include credit from nationalized banks, leading banking correspondents, Micro Finance Institutions and Cooperatives.

An EMI range of 12-15% is fixed with an average tenure of 2 years and a 20-25% margin money support. Post the intervention, the net income has almost doubled including the offsets from EMI payments. This increase is sufficient to service the EMI. The solution becomes affordable to the end-user.

	BEFORE	AFTER
NUMBER OF HOURS WORKED PER DAY	6	8
NUMBER OF ITEMS STITCHED PER DAY	4	8
OVERHEADS (INR)	200	0
INTEREST RATE (REDUCING)	NA	12 %
DOWN PAYMENT	0	20% of Total Cost
EMI AMOUNT (INR)	0	642



**Net Earnings**  
Increases considerably

**Operational Costs**  
offsets from EMI for a 2 year period

**Overheads**  
100% Reduction

**Gross Earnings**  
Increases by double

## IMPACTS

### INCREASED INCOME, SAVINGS AND DIVERSIFICATION

Income has doubled due to efficiency increase, reliability on uninterrupted power, and the ability to meet orders on time. With the double income and EMI payments, savings have also increased. In the case of adoption of fashion stitch and industrial sewing machines, the entrepreneurs have been able to diversify the kind of materials used and products made.

### INCREASE IN INVESTMENTS

With increase in income, it has been observed that the entrepreneurs have been able to invest in household assets, ability to pay for their children's education, enrolment in insurance or other welfare programs and more involvement in community participation.

### IMPROVED WELL BEING

With the reduction in drudgery, poor impact on health has drastically reduced. With increase in efficiency, there has been a lot of time saved which has reduced the amount of stress and fatigue allowing the beneficiary to focus on other aspects of life as well without it affecting the income levels.

## CASE STUDY

# Porgai

Sittilingi Tailoring Institute

Porgai, a tribal craft initiative, undertaken by THI, aims to create a livelihood option by reviving the traditional craft of Lambadi, one of the tribes in Sittilingi. THI has set up a tailoring centre for the women of the Lambadi community, where they make a variety of garments and accessories, for both men and women. They do the traditional embroidery on products which are marketed with the help of THI. Power failures were very common in the Sittilingi valley area, due to which the women were finding it difficult to complete their orders in a timely manner, thus, access to energy was identified as a key factor in hampering further livelihood advancement for the women in the centre.

Seven solar powered sewing machines were installed in the centre where seven to eight women, from the nearby villages, work. They are paid as per the work they complete, on a pay per piece basis. The women reported that solar powering the machines has helped them to complete more work and they are able to earn more. The completed products are sold through exhibitions and Porgai's online store.



All entrepreneurs reported that there is a substantial increase in their daily earnings, since the solar system has been installed. This money is often used to clear off financial liabilities they had incurred previously, to improve living conditions by purchasing household items or renovating the house. Most of the entrepreneurs view children's education as a priority and reported that they would like their children to complete their studies, and use the extra earning to support their education.

Some of them have started investing small amounts of money in chit funds or other recurring deposit schemes run by their own community members as depositing money in formal financial institutions is not very common.

## CASE STUDY

# Rukmini

Tailor

Rukmini, age 30, lives in a rented home in Hosayellapur village near Dharwad city. She is a widow and has 2 children who are doing their schooling. She was in distress after losing her husband and mother-in-law, who were a support to the family. RAPID NGO supported her and motivated her to continue her tailoring business. She took embroidery training from RAPID NGO and has been doing tailoring since 10 years. She has 3 machines, a high speed sewing machine, a pico-fall machine and a straight stitch sewing machine. She is the sole bread earner for the family and pays a rent of INR 2000 per month.

She used to face power issues as the owner had asked her to not run a powered motor as it would have a negative impact on the electricity bill. She manually peddled on a daily basis which became a time consuming task due to which she was unable to supply the orders on time. Through a RAPID NGO workshop, she found out about the solar powered sewing machine motor and displayed interest in installing one as it would help her work without being dependent on grid electricity.



Due to having an outstanding loan in Syndicate Bank, she decided to approach Bank of India whose bank manager agreed to provide her with the loan as the machine would help her increase her income.

She even had good repayment history with the bank which helped convince the manager. The loan was sanctioned immediately within a day. She earns INR 300 per day on an average and stitches only ladies clothes. A margin money support of INR 5000- INR 8000 bracket was provided, considering her situation as the entrepreneur had potential.

After the loan approval, within two days, the installation was done. Initially through manual peddling, she used to stitch only 2 blouses and now is able to stitch 4 blouses without much fatigue. The light provided with the system has helped her a lot during power cuts in the evenings. Despite of so much struggle at such a young age and overcoming it all, she is a source of inspiration to many others.

## CASE STUDY

# Ramsingh Kabadi

Tailoring Entrepreneur

Ramsingh Kabadi is a 35-year-old male entrepreneur from Badchatrang village in Kalahandi District of Odisha. He used a manual sewing machine and was unable to keep up with his orders, especially during wedding and festival seasons. Even though Ramsingh had electricity at home, he did not want to shift to a motorized sewing machine because of the erratic and poor supply of the grid and instead, wanted to get a solar system installed.

Ramsingh needed financial assistance to get the system installed and it was challenging for him as he did not have a bank account. The team facilitated a loan for him from MUDRA (Micro Units Development and Refinance Agency) bank loan from Syndicate Bank, a financial product focussed on financing small businesses. He recollected that approaching the bank for getting assistance and completing the formalities itself was overwhelming for him as it almost took about five months to complete the whole process.

Today, Ramsingh is able to meet the seasonal demands and keep up with the orders, resulting in



higher income. Increasing his productivity by 1.5 times per hour, Ramsingh has seen an immediate increase of INR 2500 per month. His earnings are expected to go higher during the festival season. Further, a solar light in his shop allows him to work through later in the evenings as well thus, allowing him the flexibility to take large number of orders. Six months after the intervention, Ramsingh has been paying his monthly instalments on a regular basis. Recently, he has also approached the bank for a second loan to construct and expand his current tailoring shop, buy another machine so his brother can join him in his tailoring shop.

Apart from the financial gains, the whole experience of installing the solar system helped Ramsingh to be more confident and outgoing, with his interactions with formal financial institutions.

## CASE STUDY

# Parvin Bhanu

Tailor

Mrs. Parvin Bhanu is an entrepreneur from Shivamogga. She is a widow & the only earning member of the family. She approached SELCO through another entrepreneur, Chaitra, who supported the initial pilot test of the 80 W sewing machine. She collects the raw material from Mrs. Chaitra and supplies back the finished plastic bags. She helps Chaitra in meeting demands from the market and is being paid for this as well. After her husband's demise, it was really hard to meet her family expenses so she used to book functions at nearby hall and was also involved in collecting rents for which she was paid commission. She used to stitch ladies fashion wears and is involved in this since the last 10 years. After intervention, she has plans to only concentrate on sewing bags. Due to frequent power cuts, she faced problems in meeting daily demands from supplier so she decided to switch to DC sewing system.



She wanted a higher capacity machine to meet the market demand as 60 W system was not convenient for her usage so 80 W was installed instead. She has plans to engage fulltime in this business and supply directly to the market through line sale. As she is paid very less by middle man, she produces 3000 bags/month and is paid INR 2 to 3/bag while the same bag is sold at INR 35/bag. Her elder daughter also supports her and has further plans to expand and grow.

## CASE STUDY

# Mahanthesh

Weaver

Mahanthesh hails from Chadchana village and works a day job with a Karnataka Handlooms Development Commission centre. KHDC pays him on the basis of a meter of finished fabric at the end of the day. He also weaves at his home in the evenings for additional income. Earlier, he used to take 2 months to finish weaving 200 metres of yarn using a Frame loom but after switching to the efficient loom, he is able to finish weaving the same yarn in 1 month, effectively improving his productivity and also the quality of the fabric.



## CASE STUDY

# Nazir

Weaving Entrepreneur

Nazir ji is a master handloom weaver in Belgaum, Karnataka. A solar loom was installed at his workshop in November 2015. At the time Nazir ji had an order to produce a large number of 1.5 meter towels. In a 8-9 hour shift he was able to make 10-11 towels and a profit of Rs. 200 per day.

In the first 3 months after the installation of the solar loom he was able to make the same number of towels per day on the solar loom. After the third month there was a gradual increase in his rate of production and by the sixth month he was able to reach the optimal rate of 20-21 towels per day thereby doubling his productivity and income.

Moreover, the loom also comes with a solar light allowing him to work even past sundown. This gives him more time in the day to do his pre-loom operations such as reeling and warping.



## CASE STUDY

# Weaving Collective in Gillesugar, INGRID

Two looms were installed in Gillesugar, a refugee settlement in the premises of INGRID. It was to provide an alternate employment opportunity to the women who work as daily wage labourers in agriculture or construction. A nine-month training was given to ten women under two master weavers with a stipend. Now, these women are able to manage the procurement of yarn and production of fabric by themselves. These women have become self-sufficient by weaving sarees, shirts, towels, stoles and earning more than their previous daily wages.



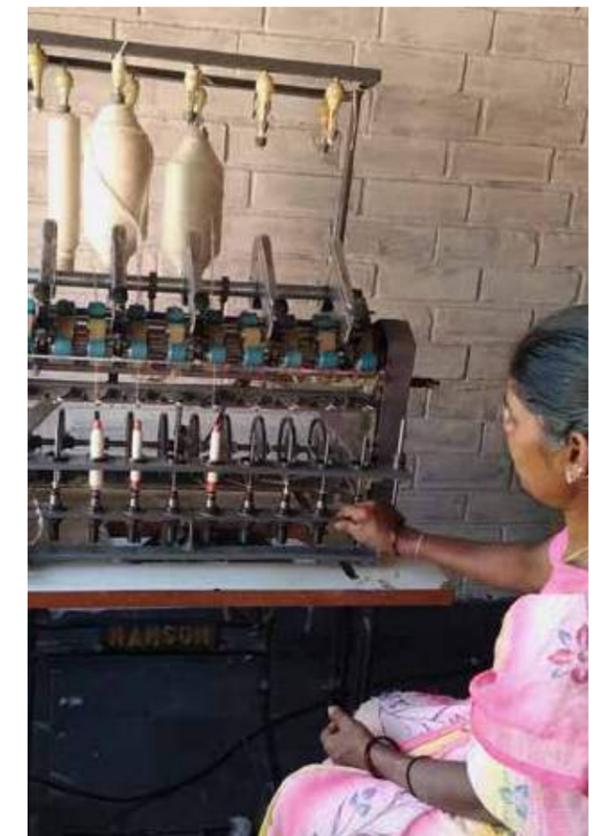
## CASE STUDY

# Mangala

Melkote's traditional spinners

Melkote is a village in Karnataka where weaving was the primary occupation. Traditional weaving had been carried out by the hundreds of weavers housed there and also had a popular item of clothing called the "Melkote lungi." From sourcing of cotton, ginning, spinning, weaving, natural dyeing to finishing of the cloth would all be done out of this village. In a village with 500 households, each home had at least one spinner. However, due to poor and irregular wages, drudgery, unsupportive government policies, there were no spinners left in Melkote.

Janapada Seva Trust, a Gandhian khadi organization based out of Melkote decided to revive spinning in the village by adopting the solar charkha. The first one was given to one of the JST members, Mangala, a housewife with no source of income. Post adopting the solar charkha, she is now able to earn INR 6000 per month and also take care of other household activities very comfortably. After this intervention was introduced, five more women are coming back to spinning using the solar charkha.





# Agriculture

# AGRICULTURE

Agriculture practices in many developing countries, including India, continues to rely on animal and human energy. This can often be due to lack of reliable modern energy, as well as lack of affordable technology, innovated for the last mile small and marginal farmers. This significantly hampers the potential gains in agricultural productivity.

Human work has a limited output, and an array of tasks are still done manually, or are centralized - either resulting in loss of potential gains in productivity or through value added products; or because of high transportation costs and emergence of middle men.

As per Registrar General of India & Census report 2011 the total farmers or cultivators population of India is 118.7 million (2011) & 144.3 million agricultural workers/labourers which consists 31.55 million of the total rural population

Monkey Repeller installed high on top of a coconut tree in Karnataka

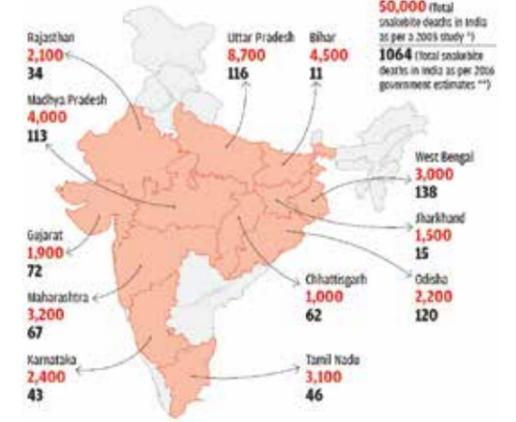


## Pest Management

10. Snake Repeller, 11. Monkey Repeller, 12. Solar Fencing 13. Elephant Repeller

### Huge gaps

The figures for snakebite deaths as given by independent researchers and government estimates are poles apart



www.downtoearth.org

In parts of India, and across the world, farmers struggle to save their crops from animals such as elephants, monkeys and blue bulls- some responsible for destroying 60-70% of the crops in regions where they thrive in abundance.\* While several technologies can be used by farmers, energy is often a gap. In farmlands, where these technologies are required, specifically in or near forested regions, grid power failure or intermittent power is also a common occurrence.

\*<http://pub.jkii.bund.de/index.php/DKA/article/viewFile/1567/1899>

- Crop loss for farmers mean loss in investment, because of which they employ varying unsustainable measures
- Farmers change cropping patterns to evade the animals
- To combat the menace, farmers have used conventional techniques like electrocution to keep the animals away. In some cases, farmers resort to shooting or killing the animals as well.



## HARVESTING & ON FARM

**CROP PROTECTION**

**Energy Intervention**

Monkey, Snake & Elephant Repellers, Solar Fencing

**IRRIGATION**

**Energy Intervention**

Solar powered, surface, submersible and portable pumps

**PRE-HARVESTING & HARVESTING**

**Energy Intervention**

Rubber Tapping Machines, Headlamps for Mogra Cutters, Fishing Lights and Rubber Tapping Machines, Lac Sprayer & Pruner

## AGRO PROCESSING

**POST HARVEST**

**Energy Intervention**

Paddy Threshers, Rubber Rolling and Chaff Cutter

**MILLS**

**Energy Intervention**

Dal(Pulse), Rice and Millet Mills; Rice Huller, Polisher and Cracker, Tamarind De-seeding



### Auditory Repellents

Are marked as either ultrasonic, sonic or biosonic calls which makes the targeted animals uneasy



### Tactile Repellents

The principle behind this devices is they create painful or uncomfortable stimulus upon contact - Mild Electric shock



### Olfactory Repellents

Using the general principle of odour detection to repel or stimulate olfactory mediated behaviour. - Eg. Fish Oil



### Visual Repellents

The principle behind these devices is that usage of flashing lights or large movement of objects - is found to effectively repel wild animals like elephants, boars etc.

## 10. SNAKE REPELLER

The solar powered snake repeller device utilises ultrasonic pulses every 30 seconds that sends vibrations through the ground in a 10 feet radius. Snakes are sensitive to these lighter vibrations and are often deterred from the source. As a result, farmers can strategically place these devices within their fields (depending on size) and can completely deter snakes from entering their fields.

## 11. MONKEY REPELLER

Market research for monkey repellents found solutions that primarily used Ultrasonic Sound Repellers. These repellents were not tested scientifically on monkeys in India; and local tests with farmers showed it to be ineffective. Studies have also shown that monkeys develop immunity to ultrasonic repellents over a period of time. Thus, the solution developed looked at a combination of tactile and olfactory repellents- built to incorporate decentralized solar energy so it can be used in remote farmlands and forested areas as well.

- The Ultrasonic Sound Repeller emits frequencies between 0-60 kHz to cause a mental disturbance in the monkeys.
- Motion sensor triggered audio sounds scare the monkeys away.
- Mechanisms to affect their olfactory system by the use of water force, smell and light were also added.

### SNAKE REPELLER - 400-1000 Hz

<b>Energy System</b>	<b>SOLAR MODULE (Wp)</b>	4
	<b>BATTERY (Ah)</b>	800 mAh 1.2V

### MONKEY REPELLER - 0-60 kHz

<b>Energy System</b>	<b>SOLAR MODULE (Wp)</b>	40
	<b>BATTERY (Ah)</b>	10 Ah 14.8V



## 13. ELEPHANT REPELLER

Human-elephant conflict is rising across India with human settlements expanding to the migratory path of the elephants. This conflict is a result of habitat loss and fragmentation. When elephants and humans interact, there is conflict from crop raiding, injuries and deaths to humans caused by elephants, and elephants being killed by humans for reasons other than ivory and habitat degradation. Every year, 100 humans (in some years it may be 300 people) and 40-50 elephants are killed during crop raiding in India.

Such hot spots are where human-animal conflict are most as traditional habitats have seen land use change, leading to clearing of forests and converting them into farm lands. The unintended consequences are the ever increasing loss to farmers who find themselves crossing paths with elephants, leading to loss of life and crops - resulting in loss of incomes.

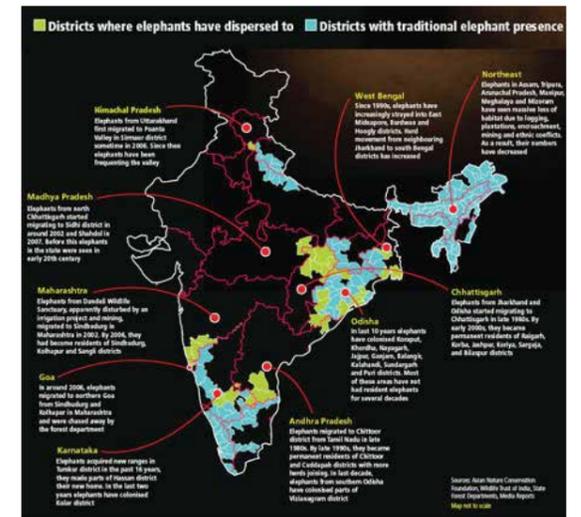
As a result the farmers suffer a loss in income which is barely compensated for by the government. Additionally any efforts made to repel elephants are often thwarted by animal rights entities who claim the farmers are using improper and cruel methods.

### ELEPHANT REPELLER

**LED SPECIFICATION** 4 LED's (1W & 3 W)

**BATTERY** 13Ah 3.7V

The Elephant repeller light is a simple passive lighting solution placed at the periphery of a village or field to repel elephants from a safe distance. It functions by emitting flashes of bright light at irregular intervals, which mimic the reflective iris of predators seen by elephants in the night.



www.downtoearth.org

Correct placement of the light varies - the rule of thumb is to mount it on a wooden pole at a height similar to elephants and place it at entrance points (village and farms) and ensure that it is within the elephant's field of visibility. Another is not required unless the field of visibility is blocked.

- Durable and 4-sided face allowing for light to be dispersed at 360 degrees.
- The small panel has been mounted on the roof of the device. All electrical components have been internalised, with the device waterproofed, to prevent breakage.
- Lastly the bottom of the device converges into an entry hole, allowing it to be mounted on a pole of any height.
- The device costs only 9000 INR and hence the cost of the unit would prove viable even when compared to single crop loss accident which can be upwards of INR 5,00,000.

## 12. SOLAR FENCING

Electric fencing is used to avoid damage of agricultural produce by animal attacks- It works on the presumption that, a short safe pulse of electricity creates a psychological barrier, training the animals to stay away from the fence.

Solar fencing is mostly seen in remote forest areas that are devoid of any power connection. The farm owners are usually not able to charge the battery due to the irregular or complete lack of power supply in such areas. They are frequently attacked by animals that in worst case scenarios can destroy an entire farmland- resulting in huge losses in the farmer's income.

- The system passes a safe electric shock when a conducting material (human/animal) nears the loop by touching the fence and the ground simultaneously. The electricity passes through the animal, into the soil and to the ground rods (earthing rods) which are connected back to the fence energizer.
- The main components of a solar fencing system are the power source (solar energy system) and the energizer.
- The energiser can have further modifications such as a built-in alarm system to alert the farmers.
- The fence energizer connected through a DC voltage regulator decides the amount of energy released per pulse and hence one has the choice to double the shock or more depending on the various situations.

### SOLAR FENCING

<b>Energy System</b>	<b>SOLAR MODULE (Wp)</b>	40
	<b>BATTERY (Ah)</b>	60Ah 12V

A portable solar pump in use at a shallow tank in Karnataka



## 14. Portable Solar Water Pumps

As a country dominated by the agricultural sector, which employs about half the population, India has the largest irrigated area in the world. There are more than 26 million groundwater pumps that have improved agricultural productivity in the country.\* To ameliorate the current situation, portable solar pumping systems are most conducive in specific geographic areas where high water table and availability of surface water, but access to water for irrigation poses a challenge.

\*www.greengrowthknowledge.org

- Addressing inefficiency in water and energy supply in rural India that hinders crop productivity and depletes groundwater.
- Those farmers who rely on the grid-based power to run the pump sets suffer from lack of mobility at times of power outages or transformer outages. Those relying on diesel pump sets experience fuel shortage.
- Over 67% of India's farmlands under marginal farmers have smaller landholdings (less than 1 hectare). High upfront investment to access the electric pumping systems or ever increasing rental in case of fossil fuel-based pump sets make it unviable for them.

## TECHNICAL SOLUTION

The portable solar pump was designed to respond to the site context. The aim was to offer a modular and simplified operating mechanism, which will be durable and sustainable in the long run.

### PORTABLE SOLAR PUMP

**Energy System** SOLAR MODULE (Wp) 900

**Motor** TYPE PMDC

CAPACITY 1 HP

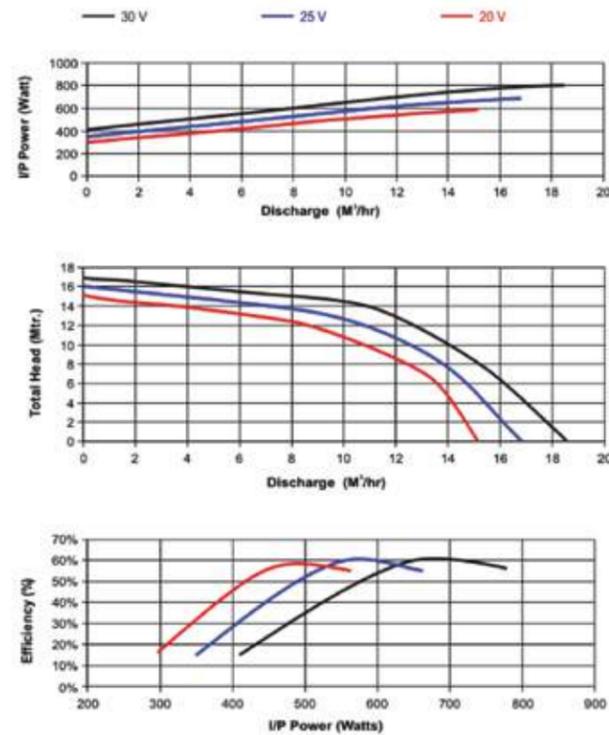
RPM 3000

The following graph shows the discharge capacity of the pumps which are rated at 0.5 - 1 HP, and can pump the water in the range between 15,000 - 60,000 liters per day which is sufficient to irrigate between 2-3 acres of farmland. Availability of such a solution affords them flexibility to grow variety of crops ranging from food crops to commercial crops with assured irrigation. The proposed solution was found to have application in both surface and drip irrigation.

Large number of poor/marginal farmers across diverse agro - climatic regions hire diesel pumps for which considerable expenditure is incurred and when unavailable, it adversely impacts standing crops. The major advantage of having such a solution would be considerable savings.



A solar pump in use in Karnataka



## 1. NARROW BEAM

LUMENS 400-450

### USER TYPOLOGIES

Rubber Tappers  
Snake Catchers  
Banana Farmers  
Coconut Farmers  
Silkworm Rearers  
Medical Practitioners

## 2. DIFFUSED WIDE SPANNING LIGHT

LUMENS 400-450

### USER TYPOLOGIES

Mogra (Jasmine Flower) Cutters  
Shepherds  
Rose Cutters  
General Household Purposes

## HEADLAMPS (SET OF 3)

**Energy System** SOLAR MODULE (Wp) 20

BATTERY (Ah) 180

CHARGE CONTROLLER 15A 12V

**LED** INBUILT BATTERY 2.6Ah 3.7V Li ion

CAPACITY (W) 2W x 3

BACKUP HOURS 6

A flower cutter using the headlamp to cut flowers in the early morning hours



Head lamps in use as home lighting systems at night in Maharashtra

## 15. Head Lamps

Several farmers engage in farming activities in the early hours of the morning or late in the night when there is lack of natural lighting- for example Mogra (Jasmine) Cutters in Maharashtra and Rubber Tappers in Tamil Nadu. Many farmers use their phone lights or poor quality headlamps. However, the light quality is often insufficient, and the headlamps of poor quality are not meant for rough usage on the farm.

## 16. Fisherman Lights

In order to maximize their catch in the night, small scale fishermen use loose LED's that are attached to bamboo or wooden sticks, as a bait to attract and direct fish to specific areas in order to harvest them. These lights function in two ways- bringing the fish to the surface of the water as well as attracting insects which in turn attracts larger predatory fish. However, these lights are poorly made - low quality, lack of waterproofing meaning that the lights have to be replaced once every few months leading to cost addition in the long run. In addition, it cannot be submerged - limiting maximum effect. In order to maximize their catch in the night, small scale fishermen use loose LED's that are attached to the bamboo or wooden sticks, as a bait to attract and direct fish to specific areas in order to harvest them.

In Loktak lake, Manipur for lake fishing - The lights with higher luminosity attract insects to the surface of the water, which in turn attract more fish. The inbuilt lithium ion battery meant allows an easy attach/detach mechanism. A housing was built for the lights for them to be waterproof and durable.

In Colachel coast, Tamil Nadu for near coast fishing -Due to near coast fishing, the luminosity of the lights have to be very high. The battery back up also has to be on the higher side as the fishermen have to fish for 12 hours from evening to morning. The lights designed were retrofitted on the existing system on the boats which involved fitting it to a PVC tube on the side of the boat.

For both solutions, the functionality of the solution was highly visible. The fishermen claimed that this would remove a large amount of the drudgery that was involved in the trade. For e.g. in Tamil Nadu they would no longer have to lift such heavy batteries and in Manipur they wouldn't have to spend as much time mounting the lights.



## FISHERMAN LIGHTS

<b>Energy System</b>	<b>SOLAR MODULE (Wp)</b>	<b>75</b>
	<b>BATTERY (Ah)</b>	<b>148</b>
	<b>CHARGE CONTROLLER</b>	<b>5A 12V</b>
<b>LED</b>	<b>CAPACITY (W)</b>	<b>10</b>
	<b>BACKUP HOURS</b>	<b>12</b>

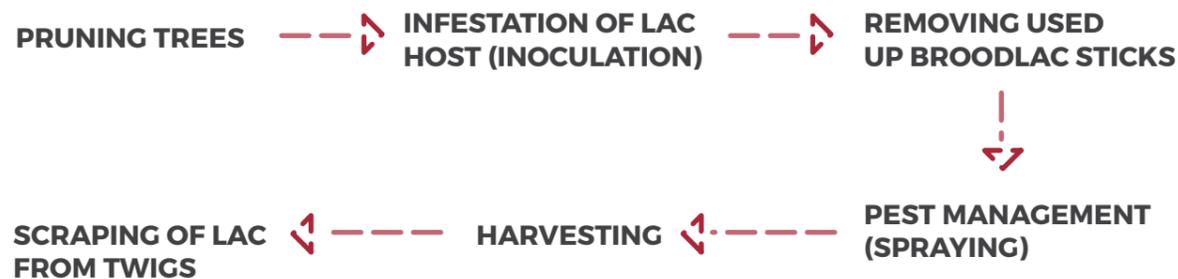


# Lac Cultivation

Lac is a natural, biodegradable, non-toxic, odourless, tasteless, hard resin which is non-injurious to health. Lac is, in fact, a resinous protective secretion of a tiny insect, Kerria lacca (Kerr.). The lac insect is a pest on a number of plants both wild as well as cultivated.

India is a major producer of lac, accounting for more than 50% of the total world production (as of 2015-16). In the

domestic market, lac was used for making bangles, toys and in the furniture industry. Overseas, lac is used mainly in the consumer goods industry. Today an average of about 20,000 tons of stick lac (raw lac) is produced in the country per year, nearly 75% of this is expected to be exports. Most of the lac produced in India is from homestead land and wasteland. Usually host trees standing on rayyati lands are used for lac cultivation and in some areas, trees on Government land are taken on lease or rental basis.



## 17. LAC PRUNER

Lac production is highly labour intensive process and provides employment to both men and women dwelling in forest and sub-forest areas. It is a highly remunerative crop, paying high economic returns to the farmers. (Source <https://iinrg.icar.gov.in/Lac%20Statistics.pdf>)

Pruning at proper time is one of the important operations where the branches/ twigs are cut in order to get the maximum numbers of succulent shoots to facilitate feeding of the lac insects. It refers to the act of cutting/trimming the branches of the trees at a suitable period of time before inoculation.

### PROBLEMS ASSOCIATED WITH PRUNING

- Most of the lac cultivators use traditional instruments like axes for pruning purpose and this often leads to breakage or splitting of branches leading to damage of trees.
- Pruning has to be done in a specified time period and if not done, will lead to loss.
- A significant amount is spent by the lac cultivators in engaging wage seekers who are paid INR 200 - 250 per day and with labour shortage in critical harvesting season, it can affect his/ her livelihood.
- The process of pruning is laborious and at times hazardous as cultivators have to climb trees which are very tall at times, making the task very arduous. This is compounded by the fact that in majority of instances the task of pruning is undertaken by women.

### LAC PRUNER

<b>Energy System</b>	<b>SOLAR MODULE (Wp)</b>	<b>250</b>
	<b>BATTERY (Ah)</b>	<b>240</b>
<b>Motor</b>	<b>CAPACITY (W)</b>	<b>165</b>

- To ensure availability of good / healthy / and succulent (tender) shoots.
- To ensure availability of large number of shoots (area for lac).
- To provide rest to host trees for maintaining its potential.
- To remove dead/ diseased and broken branches.

### AUTOMATED SOLUTION AND ITS IMPACT

To overcome the challenge, a solar powered battery operated pruner has been implemented. It is a long-handled pruner saw with a curved blade at the end and sometimes a clipper which is used to prune small trees.

#### Reduces operational cost

There is a 41% reduction in the operational expenses, mainly wages paid to labourers- which results in savings of INR 540. For e.g. taking an aggregate, a farmer with 60 lac trees can potentially save up to INR 16,800 annually. This being a cyclical process.

#### Reduces drudgery

Due to the use of the pruner, the risks associated with climbing of trees that are 5-12 feet in height, is no longer present. Earlier, the lac cultivators used to climb the tree and use an axe for pruning or harvesting. This has also enabled both genders to be having an equal opportunity to perform the task.

#### More trees pruned in less time

To a certain extent, the task can be performed in less time, thus resulting in more trees to be pruned. In the first cycle for harvesting, only half a tree could be harvested without the machine but post intervention, the farmer can complete harvesting one tree/day whereas, in the second cycle of pruning, he is able to prune 4 more trees per day.

INTERVENTION BOTH HARVESTING & PRUNING	BEFORE (INR )	AFTER (INR )	NET SAVINGS (INR )	PERCENTAGE SAVINGS (INR )
OPERATIONAL EXPENDITURE - WAGES/ FEE CHARGES FOR CLIMBING TREE	1300	760	540	41.53%

## 18. SPRAYER

A sprayer is a device used to spray a liquid, commonly used as weed killers, crop performance materials and pest maintenance chemicals.

For agriculture, a sprayer is used to apply as herbicides, pesticides, and fertilizers on agricultural crops. Sprayers range in size from man-portable units (typically backpacks with spray guns) to trailed sprayers.

The spraying of insecticides on the trees, especially ber trees having a height of 5-6 feet, is a process that is done for preventing the infestation of the lac encrustations by various pests. Spraying is carried out twice normally. Once one month after inoculation and the second time one month after the first spray.

The farmers have to keep various environmental factors in mind while spraying. Eg. if it rains just after the application of the pesticides, another cycle of spraying becomes necessary. Spraying is done by a small spray pump, while water+insecticide mixture is placed in a small drum. The operation is manual and time consuming since it requires continuous supply of water. It requires a minimum of 2 people to carry out the task.

LABOUR ENGAGED

### Manual Sprayer

2-3 member team

DRUDGERY

Cranking of sprayer involved

TIME TAKEN

Preparation Time: 15 mins

### Electric Sprayer (18 litres)

1 person only

There is no cranking. Transportation is easier because of compactness.

Preparation Time: 2-5 mins

## 19. Chaff Cutter

Nutrition is the foundation of livestock production system and proper nutrition is imperative for achieving high and sustained livestock productivity. The success of animal reproduction and health programmes rests on proper nutrition. The cutting of crop residues into small pieces helps feed the cattle, thereby increasing the consumption and palatability of feed, and reducing the wastage. Each cattle is fed at least 2 times a day in order to maintain their health. On an average a cattle consumes around 18-20 kg/day.

Animal feeding thus becomes a very important aspect of livestock husbandry. It is very necessary to have effective utilization of available feed sources as well. Chaff is the hay cut into small pieces for feeding the livestock (Mohan and Kumar, 2004). A chaff cutter is a mechanical device for cutting this straw or hay into small pieces before being mixed together with other forage and fed to horses and cattle. This helps in animal digestion and prevents animals from rejecting any part of their food.

Traditionally, the fodder is cut manually by the operator which becomes a physically demanding job as it requires energy and postural requirements of the labour and hence regarded as a source of drudgery (Kumaret al., 2004). In addition to that, when fodder is cut manually, the cutting is not uniform and when fed to cattle, can cause bodily harm (meaning injury to mouth).

In addition to the above, there are farmers who also have electric powered chaff cutter but face erratic power supply which disrupts their work routines and delays the timely availability of fodder for the animals.



### TECHNICAL SOLUTION

Due to the constraints in the chaff cutting machine, solar chaff cutter has been designed so that it helps fill the gap in the shortage of labour, reduce the drudgery of manually operated chaff cutter operations and also be a solution to power cut issues.

#### FISHERMAN LIGHTS

Energy System	SOLAR MODULE (Wp)	600
	BATTERY (Ah)	400
	INVERTER	2kVA 24 V
Motor	CAPACITY (W)	730
	BACKUP HOURS	1.5

## 20. Rubber Tapping

Rubber tapping is the process used to collect latex from a rubber tree. The latex is harvested by slicing a groove into the bark of a rubber tree at a depth of a quarter inch with a hooked knife and peeling back the bark.

It involves using a sharp edge blade to shave the bark of the rubber trees and extract the latex in order to produce rubber. The task can involve a lot of manual effort and drudgery, considering the farmer aims to shave a large number of trees in a day.

### TECHNICAL SOLUTION

The technology introduced was designed as a replacement for the manual shaving done using a knife. No training or special skills were required to use the technology.

Percentage increase in tapper's income

20%

### Rubber tapping machine

350-400 trees a day (depending on the skill of the tapper) vs 420 trees a day (minimum)

TREES PER DAY

POWER CONSUMPTION

24 watts

OPERATING VOLTAGE

12 V

## 21. Paddy Thresher

Transplanting, weeding, harvesting and threshing are the five labour intensive operations in rice cultivation. Threshing is an integral part of post harvest activities for cereal and legume crops. In many developing countries, threshing is carried out manually by farmers that lead to low quality of paddy rice and grain loss. When the rice cropping area increases, consequently the manual threshing becomes arduous.

Threshing consumes 25% of the total energy utilized in paddy cultivation (Kathrivel and Sivakumar, 2003). Some farmers use multipurpose threshers that chop the paddy chaff into small bits and render them unfit for cattle fodder. Also, farmers cannot sell the cut pieces of straw and lose out on additional revenue.



Increase in production compared to manual

135%

### TECHNICAL SOLUTION

A very portable machine that can be transported easily to different terrains and difficult to access areas. It weighs 75 Kg and can be easily transported using a small transport vehicle. 2 to 3 people can thresh paddy simultaneously using this machine.

- Is cost-effective and more efficient
- Is twice as fast as manual threshing
- Reduces scattering losses & use of manual labour

CAPACITY

1 HP

WEIGHT

75 Kg

NUMBER OF PLANKS

12

SPIKE LENGTH

6 cm

### Paddy Thresher



## Agro - Processing

Agro - processing is now regarded as the sunrise sector of the Indian economy in view of its large potential for growth and likely socio-economic impact specifically on employment and income generation. The importance stems from the fact that India is one of the key food producers of the world and has access to several natural resources. Diverse agro-climatic conditions and wide-ranging raw material base adds to the huge advantage of a large untapped domestic customer base.

After production, the produce undergoes series of post-harvest unit operations, handling stages and storage before they reach to the consumers. One of the

major hindrances faced, is lack of appropriate farming technologies across the value chain specifically for small and marginal farmers, either severely lacking in terms of access or completely missing from value chain of products, services and systems available to farmers in India.

For small and marginal farmers growing diverse crops in accordance with agro-climatic conditions, to realise the value of their products some processing has to be done. Even with the advancement of technology in agro-processing technologies there are still wide-ranging tasks which are manually done like pounding which are laborious. At times they are incurring high transportation cost if produce is taken to mills.

**India produces more than 200 million tons of different food grains every year - 209.32 million tons in 2005-06. India produces all major grains - rice, wheat, maize, barley and 12 millets like jowar (great millet), bajra (pearl millet) and ragi (finger millet)<sup>1</sup>. The major segments within Grain Processing are Oil Milling and Pulse Milling & Flour Milling<sup>2</sup>.**

Optimised agri-processing solutions are clearly absent from the market which meets the needs of small and marginal farmers. To be economically viable the machines have to cater to a sizeable community of farmers.

**COMMONLY AVAILABLE MACHINES**

Power Consumption Between  
**3 HP - 20 HP**

- It is also seen that high market incidental costs are being incurred by farmers who are forced to take their produce to nearby mills for processing.
- High energy costs incurred by modern/traditional mills such as electrical charges are passed on to the users of the services.
- Marginal and small farmers are not able to allocate high capital and operational costs to agro-processing machinery - thus, resulting in emergence of middle men, and transfer of the actual value from the farmers.

## TYOLOGIES OF TECHNICAL SOLUTIONS

### PULSES



Mini Dal Mill



#### CROPS

Pulses Pigeon Pea, Green Gram, Black Gram, Chickpea Etc

#### PROCESSES

a) Cleaning, b) Grading of grains  
c) Polishing

#### OUTPUT

125 -150 kg/hr

#### VALUE ADDITION POST PROCESSING (Tur Dal)

Increase in Sales Price: 50%

### MILLET



Millet processing Mill, Flour Mill



#### CROPS

Foxtail, Finger, Pearl Millets and all other millets

#### PROCESSES

a) Destoner, b) Millet De-husker, c) Grader d) Sorter e) Flour mill or Pulveriser

#### OUTPUT

50-300 kg/hr

#### VALUE ADDITION POST PROCESSING (Foxtail Millet)

Increase in Sales Price: 75%

### CEREALS



Mini Rice Huller, Flour Mill



#### CROPS

Rice, Wheat, Corn

#### PROCESSES

a) Grinding and Pulverising b) De-husking

#### OUTPUT

Grinding - 15 - 20 Kg/hr  
Hulling - 50-60 Kg/hr

#### VALUE ADDITION POST PROCESSING (Paddy)

Increase in Sales Price: 58%

### SPICES



Chilli and Turmeric Grinders



#### CROPS

Chilli, Turmeric

#### PROCESSES

a) Grinding

#### OUTPUT

15- 20 Kg/ h

#### VALUE ADDITION POST PROCESSING (Turmeric)

Increase in Sales Price: 84%

### FRUITS



Tamrind Processor



#### CROPS

Tamarind

#### PROCESSES

a) De-Hulling b) De-Seeding

#### OUTPUT

40 kg/hr

#### VALUE ADDITION POST PROCESSING

Increase in Sales Price: 91%

## 22. DAL(PULSE) MILL

Energy System	SOLAR MODULE (Wp)	2500
	BATTERY (Ah)	1200
	INVERTER	5 kVA
Motor	CAPACITY (W)	2 HP



A Solar powered Dal Mill

## 23. MILLET MILL

Millet Destoning, Grader with Aspirator, and Dehusker/Polisher

Energy System	SOLAR MODULE (Wp)	1800
	BATTERY (Ah)	12960
	INVERTER	4 kW 5 kVA 96V
Motor	TYPE	AC Induction Phase 1
	CAPACITY (W)	1.5 HP
	RPM	1440
	BACKUP HOURS	3



A Solar powered Millet Mill

## 24. FLOUR MILL

Energy System	SOLAR MODULE (Wp)	2400
	BATTERY (Ah)	14400
	INVERTER	4 kW 5 kVA 96V

Motor	TYPE	AC Induction Phase 1
	CAPACITY (W)	2 HP
	RPM	1440
	BACKUP HOURS	3

## 25. TAMARIND DE-SEEDER AND HULLER

Energy System	SOLAR MODULE (Wp)	2000
	BATTERY (Ah)	12960
	INVERTER	4 kW 5 kVA 96V

Motor	TYPE	AC Induction Phase 1
	CAPACITY (W)	1 HP + 0.5 HP
	RPM	1425
	BACKUP HOURS	3

## 26. CHILLI GRINDING, 27. TURMERIC GRINDING

**Chilli:** Chilli grinding has similar issues of drudgery, crop wastage due to not processing on time, high energy expenses incurred to process and loss in income due to selling unprocessed produce. With this solution, there is a considerable increase in the entrepreneur's income and also having an energy backup would have a significant positive impact on people's livelihood. The machine takes lesser time to grind chilli i.e. it takes 4 minutes and 30 seconds to make 1kg chilli into a fine powder and thereby almost doubling the production in the given time. Installing a chilli grinding machine in remote village areas will reduce people's traveling time and cost.

**Turmeric:** Markets are flooded with inefficient grinding machines forcing farmers to bear costs and losses. A market research and mapping was done to identify the most efficient pulverising machine, for the appropriate capacity. Following the research, the chilli grinding machine was retrofitted with new blades and a motor that made it suitable for turmeric processing. Current solutions offered in the market are in ranges from 3 HP and above, which are more suitable for commercial operations. But seen from an operational and business perspective of small and marginal farmers, it will be an over investment and under utilization of an asset. Smaller decentralized machinery are proven to be appropriate solutions for small scale and marginal farmers.



Solar Powered Chilli and Turmeric Grinders

Energy System	SOLAR MODULE (Wp)	2400
	BATTERY (Ah)	14400
	INVERTER	4 kW 5 kVA 96V
Motor	TYPE	AC Induction Phase 1
	CAPACITY (W)	2 HP
	RPM	1440
	BACKUP HOURS	3

## 28. RICE HULLER & POLISHER

After identifying existing rice mill technologies within India, it was realized that the production capacity was too large and so was the energy requirement. A mini rice huller was designed from scratch to cater to marginal and small farmers in remote areas. The huller would be small enough to be used by a single farmer or used as a rental/community owned model to serve a small community of farmers. This gives scope for production of unpolished rice at domestic level as low cost, cottage scaled value addition business for farmers.

**Output Efficiency** - The rice huller improves the output efficiency to 95% from 80-85% of the locally available machine. Most of the products were in the power range of 3 - 20 HP and above - ie minimum 150 kg of rice hulled per hr. To make this feasible, the machine could now cater to at least 1 village consisting of 300 farmers to fill the existing gap for 30-60 farmers.

**Reduction in Operational Costs** - A separator was integrated to the huller to fully separate (100%) unpolished rice and husk. This reduced the labour employed to remove the husk, making the business increasing profitable. Also grading of the rice is usually not possible but this solution allowed for customization by combining the rice hulling technology with a semi polisher and a separator.

**Reduction in Overheads and Incidental Costs** - The portability of the machine helped reduce the market incidental costs, incurred by farmers as transportation cost, in addition to the loss of wages. Also the DC Solar machine now reduced the energy costs incurred by modern/ traditional mills that includes electrical charges that are passed on to the users.

Percentage increase in rice hulled when compared to manual hulling

**+35%**

**14 hrs**  
Time taken to de-husk 100 kg of rice (manually)

**1.5 hrs**  
Time taken to de-husk 100 kg of rice (DC Huller)

Energy System	SOLAR MODULE (Wp)	750
	BATTERY (Ah)	4320
	CHARGE CONTROLLER	30A 24V

Motor	TYPE	PMDC
	CAPACITY (W)	0.25 HP
	RPM	1500
	BACKUP HOURS	4

**A rice polisher is a machine for buffing (or "polishing") kernels of rice to change their appearance, taste, and texture.**

Polishing is the process of removal of bran layer in brown rice. After harvesting and drying, the paddy is subjected to the primary milling operation which includes de-husking as well as the removal of bran layers (polishing) before it is consumed. The rice obtained after this process is called raw rice.

Three varieties of polishers prototyped. These prototypes were solar powered as well.

SEMI POLISHER	POLISHER FOR WHITE RICE	POLISHER FOR BROWN RICE
Removes only one layer of bran	Removes 100% of bran	Removes 100% of bran and polishes into white rice
0.5 Hp Motor	1 Hp Motor	1.5 Hp Motor
Can polish 70 kg/hr	Can polish 45 - 70 kg/hr	Can polish 70 - 100 kg/hr



## 29. RICE MILL

Milling is a crucial step in the post-production of rice. The basic objective of a rice milling system is to remove the husk and the bran layers, and produce an edible, white rice kernel that is sufficiently milled and free of impurities.

Depending on the requirements of the customer, the rice should have a minimum number of broken kernels.

An ideal milling process this will result in the following fractions: 20% husk, 8-12% bran depending on the milling degree and 68-72% milled rice or white rice depending on the variety. Total milled rice contains whole grains or head rice, and broken. The by-products in rice milling are rice hull, rice germ and bran layers, and fine broken.

Multistage milling - can be done in the village or local consumption or commercially for marketing rice; rice undergoes a number of different processing steps, such as:

- Pre-cleaning
- Dehusking or dehulling
- Paddy separation
- Whitening or polishing
- Grading and separation of white rice
- Mixing
- Mist polishing
- Weighing of rice



### RICE MILL

<b>Energy System</b>	SOLAR MODULE (Wp)	7500
	BATTERY (Ah)	36000
	INVERTER	8kW 10kVA 240V
<b>Motor</b>	TYPE	AC induction Phase 1
	CAPACITY (W)	5 HP
	BACKUP HOURS	3.5

## 30. COLD STORAGE

Cold Storage is a kind of a room, the temperature of which is kept very low with the help of machines and precision instruments. The present production level of fruits and vegetables is more than 100 million MT and keeping in view the growth rate of population and demand, the production of perishable commodities is increasing every year. Commercially apples, potatoes, oranges are stored on large scale in the cold storages. Other important costly raw materials like dry fruits, chemicals, essences and processed foods like fruit juice/pulp, concentrate dairy products, frozen meat, fish and eggs are

### SOLUTION

A solar micro cold storage was designed as a solution to store fresh fruits, vegetable, flowers, processed food and other perishable commodities. A small scale solar powered cold room enables both pre-cooling and storage of perishable - thereby helping preserve their freshness and maximising their shelf life.

The system is a solar standalone operation and consists of solar + DG/Grid hybrid operation. The smart control system helps maintain the temperature, humidity and air-quality parameters precisely as per the product requirement. It consists of a battery-less compressor operation (small battery for auxiliary loads and control system) and a thermal backup due to the PCM plates (24-30 hours). It is a completely portable unit and has very minimal maintenance.

being stored in cold storages to regulate marketing channels of these products.

Cold storages are essential for extending the shelf life, period of marketing, avoiding glut, reducing transport bottlenecks during peak period of production and maintenance of quality of produce. The development of cold storage industry has therefore an important role to play in reducing the wastages of the perishable commodities and thus providing remunerative prices to the growers.

### Cold Storage

PRODUCT DIMENSION	20 ft x 8ft x 8ft
STORAGE SPACE	21 m <sup>3</sup>
TEMPERATURE RANGE	4-10 degreec Celcius
BACKUP	PCM Plates
BACKUP DURATION	24-30 hours
SOLAR MODULE CAPACITY	4 kWp
AUXILLARY BATTERY	100 Ah 24V

### CASE STUDY

## Markama Agri Producer Company Ltd

Markama Agri Producer Company Ltd., a Farmer Producer Organisation (FPO) set up in 2016 with an objective to provide an organised market to the farmers of Bissamcuttack, Rayagada, Odisha, now has 369 marginal farmers associated to them. They are involved in agro-business (agro based input - fertilizers and seasonal vegetables) with the support of Harsha Trust. Solar micro cold storage is a small scale solar powered cold room meant to store fresh fruits, vegetable, flowers, processed food and other perishable commodities. The unit enables both pre-cooling and storage of perishables to preserve their freshness and maximize shelf life. With the Cold Storage intervention, the FPO engaged in vegetable cultivation can now store the extra leftover vegetables after sales. Since the installation, the FPO is efficiently storing chili, cucumber, bitter guard and beans.

Lack of decentralized cold storage solution has been one of the major problems faced by farmers which has often resulted in a huge loss to farmers as it deprived them the opportunity to sell their produce as per the market



demand and the power to negotiate the price. In general the wastage was 0.5- 4% in food grains and 4-18% in different horticultural crops, the latter evidently being high value and more perishable. Though there are micro cold storage solutions available in the market their huge power requirement, lower efficiency and requirement for alternate backup power due to unreliable grid power in rural areas results in huge operational expenses making it economically not viable.

A reliable decentralized cold storage solution thus has been of great value in the post harvest management, enabling the farmers to reduce wastage of produce and significantly reducing the loss of income due to fluctuations of market demand.

## CASE STUDY

# Shivamma & Shivamurthy

Agri Processing Entrepreneurs  
in a remote forested location

Nestled in the remote wilderness of MM Hills, Thulsikere has always been disconnected from the main grid, and is known for Bedegampana Tribes, one of the tribal communities scattered across the hilly ranges of southern Karnataka. Although the nearby stone quarry is where majority of the 300 odd families in the villages work, small scale agriculture continues to exist- Ragi being one of the primary crops. Having associated with the region for a while with different implementations, to facilitate the operations, Shivamma and Shivamurthy, a couple from the village, as the operators and caretakers of the machine were selected by the NGO and the locals.

Catering to around 800 households in four nearby villages (Thulsikere, Indiganatha, Nagmale and Mandare), the machines are the first of their kind to be installed in the 8 km radius. So, the right location coupled with the enthusiastic couple



who are taking care of the machines, the implementation has showed success. The number of Ragi and Jowar growers who are coming to get their product De-Stoned and Milled into flour is steadily increasing. It used to take one woman labour an hour to de-stone 15kgs of Ragi, whereas the 2.5 HP De-Stoner does 200kgs/hr. The 2 HP flour mill is also capable of milling 30kgs/hour. Since it is the only machine in the vicinity, the price of INR 7-10 for 5kgs presently charged can be increased in coming days.

The success of the implementation is a proof that the remoteness of the tribal community cannot be a barrier for the right technological and financial intervention.

## CASE STUDY

# Patrappa Mahadevappa

Flour Milling Entrepreneur

Kariammanagar is a small rural establishment in Savdatti Taluk, Karnataka. Main grid hasn't reached the community yet, and even for basic services such as flour milling, people have to travel at least 10 km. Considering the situation, and experience of working with the nearby communities for other livelihood solutions, the solar powered flour mill was conceptualized with the entrepreneur model.

Patrappa Mahadevappa is an agriculturist with a small piece of land, and was interested in taking up the initiative of establishing a flour mill as he had been finding it hard to get his product milled at the right prices all these years, and knew there existed a demand for it. With a little space near the entrance of his house transforming into the mill, Patrappa was partnered up with the foundation to be the entrepreneur for the flour mill.

With a powerful 2HP motor powered by a good number of 3.5 KW solar module, and a 3 hour backup from 150Ahx8 batteries, the entrepreneur has had a good beginning to his enterprise. As the cashflow started to come in a good rate, the



financing of INR 380,000 is being done in one of the partner banks in a nearby town. Currently, serving around 25 customers a day, Patrappa makes around INR 300-400 a day, and it is expected to increase as the news of a solar power mill running without any electricity is slowly spreading across the villages.

The mill is kept busy through flouring jowar, wheat and semolina among other raw materials during the day, and the customers spend a good few minutes with Patrappa in his place as they don't have to travel 10km just get their product floured, but have the luxury of the facility in their vicinity. And for Patrappa, each new customer is a step closer towards achieving the goal of becoming an energy entrepreneur.

## CASE STUDY

# Sagar Majhi

Rice Hulling Entrepreneur

Sagar Majhi is a small farmer who also owns a petty shop in the remote village of Sirimaska, in the district of Kalahandi, Orissa. Rice being the main crop of the region, a good number of marginal farmers like Sagar own small rice field, and have a need to access the rice mills to hull the paddy into rice. Thanks to the earlier experiences with the communities in Kalahandi, the right entrepreneur was found in Sagar Majhi, and the implementation was done.

A 0.5HP capacity huller was set up with a 1 KW solar module, and the systems were deployed at Sagar's place. The implementation is in its initial assessment period, and the rise in income to be seen around INR 1000 per month during the first phase. The news about the machine is being spread across the village community, and although currently the farmers come to get the paddy de-husked are from Sirimaska, Sagar believes, soon the farmers from nearby villages will also come to get the service. The



initial assessment provided some valuable insights such as the farmers wanted the rice to be more polished than it is now, and also, since India is home to hundreds of types of rice varieties, the machines have to have subtle modifications in their settings to mill rice from different regions.

## CASE STUDY

# Sittilingi Organic Farmers Association

Solar Powered Dal Mill, Flour Mill,  
De-Stoner, Grinder, Weighing and  
Packing Machine

The Sittilingi Valley is located amidst the Kalvarayan and Sitheri hill ranges in the district of Dharmapuri, Tamil Nadu. Home to mostly the Malavasi tribal community, the communities in the valley have been involved in rain-fed subsistence farming for a very long time. In recent years, understanding the benefits of practicing the organic way of agriculture, they established Sittilingi Organic Farmer's Association to promote not just organic farming but also to encourage the farmers to deliver value added products from the millets, dals and other major products they grow. Considering the remoteness and the irregularity in the main grid power, the FPO needed a reliable set of machines to process their cultivated products.

Understanding the need in detail, a holistic technological solution was conceptualized



where their agricultural processing is supported by solar powered flour mill, dal mill, grader/de-stoner, dough mixer, weighing & packing machine.

As the solution involved multiple machines, an innovative technological design was made where a solar module of 4.5 kWp was installed to support 6 machines with capacities ranging from 0.5 - 2 HP with the machines up to 4 HP which can be run in combination. Giving a backup of up to 5 hours, today, the whole processing mechanism has become very efficient. The FPO is paying an EMI of INR 4000 which is the expense they had for the cost incurred to procuring diesel. Before the solution the farmers used to travel 60 kms to fetch diesel for the generators, and often taking up to an entire day, halting production

This way, Sittilingi Organic Farmers Association will be able to own the asset of the solar system in a couple of years. This is a great intervention example on how FPOs in remote locations could be greatly benefitted in every step of the value chain through clean energy access.



# Animal Husbandry

# ANIMAL HUSBANDRY

India is the largest producer of milk where more than 70 million rural households are engaged in milk production. The majority of these farmers are small and marginal. The domestic poultry industry is the fastest growing segment with a compound growth rate of 18%.

According to the latest report by IMARC Group, the dairy market in India reached a value of INR 7,916

billion in 2017 and accounts for 18.5% of total world's production.

With continual efforts from the cooperative and private sector, along with prudent policy intervention by the government, India has been transformed from having scarce production of dairy and poultry to being among the largest producing nations in the world.

## LABOUR INTENSIVE

Dairy and poultry are usually done as a secondary businesses but due to the effort and time required for the process it becomes very difficult for them to manage it individually and hence may hire labour. Labour is mostly difficult to find and if available their charge is significantly high, leading to higher costs.

## TIME CONSUMING

Milking is a process which when done manually needs attention and has to be engaged in at a specific period of time. Milking cows and poultry when done individually, becomes a very time consuming and inefficient process.

## UNRELIABLE POWER

In rural areas, poor quality of power supply and voltage fluctuations compromises the automation process such as milking machines in dairy sector and incubation process in the poultry sector. This results in loss of productivity and income.



A Solar Powered Egg Incubator in use at a poultry farm in Madhya Pradesh

## 31. Egg Incubator

Poultry makes a substantial contribution to household food security along with supplementing incomes worldwide (Jensen, H.A. and Dolberg, F. (2001). India is the fifth largest egg producer and eighteenth largest producer of broiler (Mehta R., 2002). At present much of the transformation has been made from backyard poultry to commercial poultry farming.

However, a significant rural population continues to practise backyard poultry as a supplementary source of income. This economic activity is also collectively taken up by the community often breeding indigenous varieties which fetch higher prices.

In rural areas where poultry is predominantly taken up as a livelihood, the villages are electrified but the quality of power remains poor. The voltage fluctuates frequently and power outages are common.

The incubation process is very sensitive as the temperature has to be maintained for 21 days during the whole incubation period. Any change in temperature, even for a short period destroys the 21 day cycle.

- Unreliable and poor quality of power supply in rural areas compromise the efficiency of incubation system leading to loss of eggs, and income.
- Certain indigenous breeds like the Indian Breed of Black Chickens, do not sit long enough on its eggs for hatching- pointing to a need for an incubator.

## DAIRY



### MILKING

System of harvesting milk quickly and gently

 Energy Intervention  
Milking Machine



### COLLECTION

Harvested milk collected at collection centres

 Energy Intervention  
Weighing and Testing



### VALUE ADD

Shaking up the milk/cream to make butter

 Energy Intervention  
Butter Churners

## POULTRY



### LIGHTING

Keeps the chicks warm

 Energy Intervention  
Lights



### BROODING

Nurturing chicks for 2-3 weeks before selling

 Energy Intervention  
Brooders



### INCUBATION

Hatching of eggs

 Energy Intervention  
Egg Incubators

## TECHNICAL SOLUTIONS

Depending on the power quality and availability, as well as the capacity of the incubators, different technical solutions were identified. For completely off-grid scenarios, DC powered 100-egg incubator with power consumption of 165W was found to be viable. In other scenarios, where power is available but unreliable, an inverter-based hybrid system with power consumptions of 250W for both 100-egg incubator.

Income increase per batch of eggs incubated

5x

## EGG INCUBATOR (500 EGGS)

SOLAR MODULE (Wp)	2000
BATTERY (Ah)	17280
INVERTER	2 kW 2.5 kVA 48 V
CAPACITY (W)	280 W
BACKUP HOURS	16

A Solar Powered Milking Machine in use at a dairy farm in Karnataka



## 32. Milking Machine

### LABOUR INTENSIVE PROCESS

In the manual milking process, extra labour is hired increasing cost and reducing substantial savings. The farmer's time is solely occupied for farm management, leaving very less time for engaging in other production processes.

### LOW PRODUCTIVITY

A cow can not be milked more than twice a day manually, thereby decreasing the quantity of milk produced and thus earning very less income.

Difference in time taking to milk a cow manually and mechanically **60%**

### DRUDGERY

There is increased drudgery involved in manual milking process when it's done in a large scale as the entire process needs to be monitored individually.

### TECHNICAL SOLUTIONS

Many of the milking machines available in the market are designed with oversized motors ranging from 0.5 HP to 2 HP. Due to this, efficiency cost of any backup source was found to be very expensive.

An existing AC Milking Machine was modified to a DC version, reducing 50% of the cost, and thus making the solution affordable to small and medium farmers.

**1. Single cluster:** Suitable for farmers having a herd of less than 15 milking animals.

**2. Double Cluster:** The motorized double cluster milking machine is suitable for farmers having herd of 15 to 30 milking animals.

The machines are mounted on a stainless steel trolley having polymer wheels. The trolley can be dragged easily within the cow shed.

### MILKING MACHINE

		Single Cluster with 5W LED light (For 5 Cows)	Single Cluster with 10W LED light (For 10 Cows)	Double Cluster with 10W LED light (For 15 Cows)	Single Cluster with 30W LED light (For 20 Cows)
Energy System	SOLAR MODULE (Wp)	75	120	150	300
	BATTERY (Ah)	960	1440	1920	3600
	CHARGE CONTROLLER	20A 12V	20A 12V	20A 24V	20A 24V
Motor	TYPE	PMDC	PMDC	PMDC	PMDC
	CAPACITY	120 W	120 W	180 W	180 W
	BACKUP HOURS	1	2	1.5	2

## 33. Milk Testing & 34. Milk Weighing

India's dairy industry has grown considerably ever since the White Revolution, making it the world's largest milk producer accounting for 17% of world's total milk production. It is estimated that around 20% of milk procurement is through cooperatives, about 15 million milk producers in India are members of about 150,000 village dairy cooperatives. As milk is a highly perishable item, any weakness in the upstream supply chain may result in milk spoilage before reaching the processing plants.

- There is a lack of efficient milk procurement system and a need to upgrade the critical infrastructure such as installation of electronic milk testing equipment, weighing equipment etc.
- Since a large number of milk procurement centres are located in the interior rural parts of the country, they also face erratic power supply absence, causing delay in procuring the milk resulting at times in quality of milk getting deteriorated and thus resulting in income loss.

### TECHNICAL SOLUTIONS

The intervention has helped ensure reliable power through the solar based solution - so that equipment can be now run with minimal down time mainly during the peak procurement times.

- Savings through power bills due to reduced dependence on grid power - thus resulting in substantial savings in operational costs - and boosting the income of the members.
- Helps the cooperatives in ensuring accuracy in measuring quantity and fat content of milk and in making fair payments to the farmers. Indirectly helping in reducing the quality variations among the sellers.
- In the process, also reducing the carbon footprint substantially with the shift from using fossil fuels to generate power.

Energy System	SOLAR MODULE (Wp)	100
	BATTERY (Ah)	1320
	CHARGE CONTROLLER	15A 12V
	CAPACITY	85 W
	BACKUP HOURS	3



## CASE STUDY

# Karnataka Cooperative Milk Producers' Federation Limited (KMF)

Karnataka Cooperative Milk Producers' Federation Limited (KMF) is the Apex Body for the dairy co-operative movement in Karnataka. It is the second largest dairy co-operative amongst all dairy cooperatives in the country. KMF has 14 Milk Unions covering all the districts of the State, which procures milk from Primary Dairy Cooperative Societies (DCS) and distributes it to the consumers in various 100-egg incubator markets in Karnataka. Through their 14521 functioning dairy cooperatives, having a membership of 24.97 lakhs procuring annually 75.87 lakh litres, the breadth and scale of operations is gigantic in nature.

KMF has taken lead in empowering women through a federally funded programme called Support to Training and Employment Programme (STEP), as one of the measures to ensure wellbeing of women in the traditional informal sector. KMF seizing the initiative today has 2199 STEP units functioning led by women. As part of the larger initiatives towards upgrading and strengthening milk procurement infrastructure, specially STEP units were targeted. Given these centres being run by women, they are widely dispersed and majority of them are located in rural areas. Smooth functioning of these centres became a challenge in absence of basic equipments like portable Milk testing equipment, weighing scales - compounding to an absence of reliable power undermining efficient functioning.

KMF was keen to address the above stated issues, and in the process approached SELCO Solar Light Pvt Ltd for a solution. Following the procurement procedures, competitive bidding and after due evaluation, the project was awarded to SELCO Solar Light Pvt Ltd for execution. The key highlights of the project are:

- 522 units led by women were energized by solar power - thus resulting in savings of INR 5-7 thousand per system, cumulatively saving INR 31 crores.
- Lowering the operational costs of the centres, thus resulting in higher savings and boosting income for members, in terms of more dividend earnings for members.
- Helped the cooperatives in ensuring accuracy in measuring quantity and fat content of milk and in making fair payments to the farmers.
- Indirectly helping in reducing the quality variations among the sellers.



## CASE STUDY

# Ranapur

Egg Incubator for Women's Collective

Ranapur is a Block in Jhabua district in Madhya Pradesh, India. The land in Ranapur is shallow hilly terrain (Dungarwala Jameen) and dry. Practicing rain fed, single cropping cycle, 80% of the population migrates to nearby cities and states for daily wage jobs. Apart from agriculture, any alternate source of income in the area was nearly absent.

Ranapur block is one of the original places of 'Kadakhnath' Chickens - an Indian breed of black chicken whose meat is popular for its high protein content; also fetching a price 3-4 times higher than a broiler chicken. Every family keeps a small poultry in their backyard. Due to the meat's alleged medicinal properties, the meat is also in high demand. The chicken sells per piece (instead of weight) in the local market. One Kadakhnath chicken depending on its size will sell at Rs. 700 - 1000. Women raising 5-10 chicks as a family backyard poultry have a reasonable income by selling kadakhnath chickens.



An intervention with multiple women SHGs (Self Help Groups) and JLGs (Joint liability group) and develop an income generating business out of egg incubation. A 100 egg incubator was installed, shared by 10 members of the SHG. Women as a group would operate and maintain the incubator. The project was designed such that they would buy kadakhnath eggs, hatch them and sell their chicks in the market. The local monitoring and hand-holding was provided by the NGO.

## CASE STUDY

# Vittal Jagtap

Dairy Farmer

Mr. Vittal Jagtap from Gadegaon village of Solapur district, Maharashtra is one of the more entrepreneurial shopkeepers of the village. He owns a saloon at the village market which is his primary business and source of income. Mr. Jagtap also does dairy farming for a secondary income and owns 6 cows, which on an average give 12-15 liters of milk every day. Due to his primary business, he was unable to give time to the milking process.

After investing in the milking machine, Mr. Jagtap is able to invest more time in his saloon shop while earning more money compared to manually milking the cows. He can save upto 2 hours a day which would otherwise be engaged in milking and allied activities. If Mr. Jagtap engaged a hired labourer in the task he would have to shell out approximately 300 INR per day for the service provided. Now his dairy farm is primarily handled by his wife and milking has become much easier for her as she can handle the milking process and the cows by herself. With the addition of the



milking machine technology now, Mr. Jagtap plans to invest on additional cows and thereby increase his total earnings. The machine has also reduced their physical drudgery and as milking machine is considered to be safe and hygienic compared to hand milking it would also avoid any health issues associated with the hand milking method.



# Food Processing

# FOOD PROCESSING

The Indian food processing industry accounts for 32% of the country's total food market, one of the largest industries in India and is ranked fifth in terms of production, consumption, export and expected growth.\*

**This industry provides a linkage between the two pillars of our economy - manufacturing and agriculture - and hence is undergoing constant transformations. It**

**also has a high concentration of the unorganised sector, representing almost 75% across all product categories.**

Thus, there exists inefficiencies in the existing production system, which explains the disability of small rural entrepreneurs to invest in technology upgradation and product diversification.

## LOW PRODUCTIVITY, HIGH DRUDGERY

Most of the vendors in rural and urban areas are engaged in long hours of manual work, leading to high drudgery and even higher demand for labour for lesser productivity and poor efficiency.

## LACK OF ACCESS

There are various mechanised options available in the market but they remain inaccessible to majority of the small entrepreneurs. They further get deprived due to lack of access to the various market linkages that restrict them from venturing into different geographies, thus affecting their income.

## UNRELIABLE POWER

Production is affected due to lack of grid connectivity, which may be available but may not be functioning for long hours. Many resort to using diesel generators, which result in high recurring operational costs. There is a need for decentralized clean energy based solutions and thereby improve their access to it in terms of both technology and finance.



## 35. Roti Rolling



'Roti' is a flat round bread cooked fresh on a griddle and usually is an important part of most Indian meals.

**The roti making entrepreneurs engage in making different types of bread as part of their business strategy, availability of raw materials and market demand. They earn their maximum income from jowar roti and bajra roti. These rotis are mostly sold at marriages, community functions, hotels, dhabas, khanawalis, catering and retail shops.**

A common home based livelihood, women usually utilize their existing kitchens as the production units- making different kinds of rotis and selling them in local restaurants, canteens; or in some cases packing and selling them in nearby cities. The entire workflow, from kneading the dough, rolling the rotis, to cooking the rotis and then storing them, is done within the same workspace. But their business is often limited by their physical capacity- entrepreneur's often complain of body pain and not being able to meet the market.

Among them, the soft rotis are used for an everyday consumption whereas kadak rotis are packaged for travelling purposes with a shelf life of a month.

**Additionally, restaurants and canteens spend enormous time and labour in making large numbers of rotis- hampering productivity.**

**Chapatis are only made on the basis of orders as they have a shorter shelf life of 3 days. Similarly, Shangi Holige (Sweet Peanut Bread) can be eaten within 3 days. For an additional income to their business, a few entrepreneurs may also engage in making papad for selling it at local hotels.**

The solar powered DC roti rolling machine increases the output multifold in such scenarios, and increases business opportunities, leading to increase in income.

The various kind of rotis, both in the form of freshly prepared and dried variety are consumed in great quantities not just in the households of various regions

	<b>ROTI ROLLING</b> Flattening and Rolling of Indian Flatbread		<b>DAIRY &amp; FLOUR</b> Pani Puri and Dough Mixing, Wet Grinder, Butter Churner
	<b>SNACKS</b> Pop Corn, Banana Chips, Corn Grilling		<b>OIL EXTRACTOR</b> Cold Press Oil Extration Machine
	<b>SWEAT MEATS</b> Pedha/Khova Making		<b>JUICE</b> Sugarcane and Mosambi Juice Machines



**ROTI (WHEAT / JOWAR / BAJRA)**

3 DAY SHELF LIFE

AVAILABLE ACROSS INDIA



**PAPAD**

GREATER THAN 6 MONTHS SHELF LIFE

AVAILABLE ACROSS INDIA



**KADAK ROTIS**

1-2 MONTHS SHELF LIFE

AVAILABLE IN THE SOUTHERN PARTS OF INDIA



**SWEET PEANUT BREAD (HOLIGE)**

3 DAYS SHELF LIFE

AVAILABLE IN THE SOUTHERN PARTS OF INDIA

## POWER CUTS

Most of the regions where roti rolling is prevalent are prone to power-cuts. Thus, even if the entrepreneurs make the shift to a mechanised roti rolling machine, the entrepreneurs face frequent power cuts & energy issues, during peak production hours; which directly impact the growth potential of their business.

## LABORIOUS PROCESS

Small bundles of dough are rolled into a ball shape size and then rolled out often using a rolling pin. This process takes a long time and requires a lot of continual endurance when done manually to keep flattening the pre-prepared balls making it a highly laborious task. Post intervention, the entrepreneurs are able to increase their productivity by 10 times- moving from 50-100 rotis per day, to 500-1000 rotis a day (depending on the time available to the entrepreneur and the market linkage present) with less effort and labour needed in the process.



Avg. manual production per day

50-100 Rotis

## TECHNICAL SOLUTION

		Single Cluster with 5W LED light (For 5 Cows)	Single Cluster with 10W LED light (For 10 Cows)	Double Cluster with 10W LED light (For 15 Cows)
<b>Energy System</b>	<b>SOLAR MODULE (Wp)</b>	80	150	300
	<b>BATTERY (Ah)</b>	1440	1920	2400
	<b>CHARGE CONTROLLER</b>	10A 24V - Hybrid	10A 24V - Hybrid	10A 24V - Hybrid
<b>Motor</b>	<b>TYPE</b>	PMDC	PMDC	PMDC
	<b>CAPACITY</b>	150 W	150 W	150 W

■ PMDC motor drives the roti rolling machine and is powered by an optimally designed solar power system and comes in two different configurations with respective roti output capacities. The RPM of the rolling plate has been designed as per the needs of the user by using a simple small flywheel. This slowed the rotation and reduced the chance of the motor failing. The roller mechanism was also redesigned for more hygienic and better quality roti rolling.

■ The rolling pin and spring pressure adjuster allowed for even spread of the dough in concordance with the spin direction of the plate where the two halves of the rolling pin spin in opposite directions- ensuring quality control.

## OWNERSHIP MODELS



### HOME BASED ENTREPRENEURS (Individual ownership)

#### CONSUMER

Smaller shops, temples, rural and urban hotels

#### AVG. PROFIT PER MONTH

INR 12,000-15,000 (INR 4 per roti)

#### LABOUR

Family members support in preparation, market linkage and delivery

#### FINANCIAL MODEL

Selling 200 rotis a day at an average, and with existing financial products- 20% of the profit per month, would pay back the loan in 2 years



### ENTERPRISE MODEL (Employing multiple members with clear task division)

#### CONSUMER

Smaller shops, canteen, temple, weddings, restaurants

#### INCOME (AVG)

INR 30,000 (INR 4 per roti)

#### LABOUR

The Self Help Group (SHG) and shared ownership model for the enterprise results in profit being shared between its different members equally. The tasks in the enterprise are divided, and no extra labour costs are incurred.

#### FINANCIAL MODEL

Selling 400 rotis a day at an average, and with existing financial products- 10% of the profit per month, would pay back the loan in 2 years



### CANTEEN, RESTAURANTS

#### CONSUMER

Students, families, neighbours, local community

#### INCOME (AVG)

INR 40,000 - 50,000 (INR 10 per roti)

#### LABOUR

Women and young boys from the local community are employed to handle various tasks related to meal preparation, cooking and cleaning.

#### FINANCIAL MODEL

Selling 400 rotis a day at an average, and with existing financial products- 15% of the profit per month, would pay back the loan in 1 years

## MARKET LINKAGE MODELS

### MARKET LINKAGE MODELS



Selling rotis at nearby hotels, dhabas, marriages functions, khanavalis and retail shops



Using local transportation services like buses for delivering rotis to different markets and towns / cities



Word of mouth generates business at a smaller level while at a larger scale, ads in newspapers, banners and distribution of business cards helps get bigger orders.



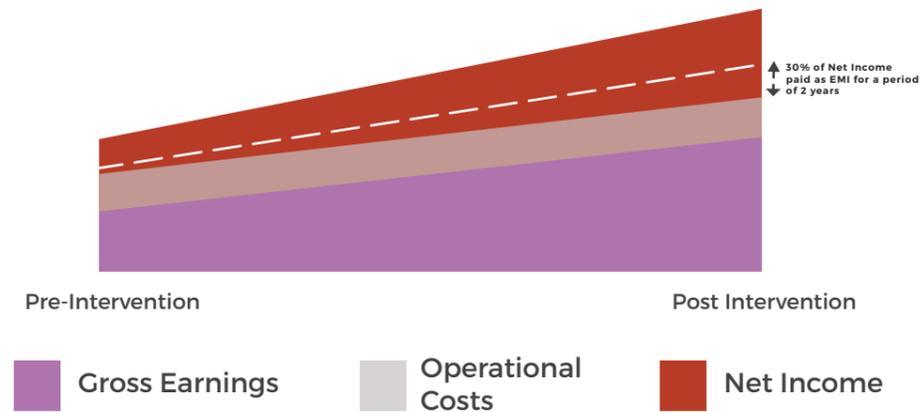
The use of social media like whatsapp and facebook are also being ventured into to spread the word about the same.

## FINANCIAL SOLUTION

Financial products have been developed with different financial institutions by studying the cashflow of roti rolling entrepreneurs and the role of sustainable energy and the intervention in the same. For this solution, it was found imperative that the solution is designed to significantly improve net profit first, and the loan product designed in a manner that a part of the profit increase is channelled to an EMI (refer to graph). Keeping in mind the continuous raw material investment in the business, some financial institutions also designed a weekly collection mechanism to ensure financial discipline.

EMI AMOUNT (As per cash flow)	INR 2353
LOAN TENURE	24 Months
INTEREST RATE (REDUCING)	12 %
DOWN PAYMENT	20% of Total Cost

**Note:** This specific financial product has been availed by over 70% of the total roti rolling entrepreneurs worked with; and is viable for even a small home based entrepreneur purchasing one roti rolling machine.



## CASE STUDY

### Anusuya

Roti Rolling Entrepreneur



Anusuya and her husband migrated to Khoppala town for better education for their three children. Her husband worked as a security guard. Being burdened with expenses, Anusuya wanted to contribute to the household income, but was looking for livelihood options that she could do from home. Hearing about the roti rolling entrepreneurship option, there was an initial apprehension as starting a business was a new concept to the family.

A planned structure of the functioning and the financials were introduced- estimating cost of procurement of raw materials, market price and income thereof. Starting small with just 50 rotis, and through the support of a loan from a private sector bank; Anusuya slowly increased production to 100, 150 and 700-800 rotis per day - earning a net income which is 3 to 4 times what her husband earned through his job as a security guard.

Anusuya expanded further when newspaper articles started publishing stories on her success. Today, she and her husband take orders for 5,000-10,000 rotis.

They have hired labour so each woman makes 100 rotis per day, so if a group of 3-4 women do it together- thus, creating employment in their community. Being in a small town, Anusuya has not let the market limitations affect her business. She has a tie up with the bus drivers who commute to nearby cities on an everyday basis, and deliver the rotis made by her growing enterprise. Packing bundles of 200-250 rotis, the drivers charge a small amount to deliver and it works as additional income for them. Their story is an example of improving not just their living but also of their community as a whole.

## IMPACTS

### REDUCTION IN DRUDGERY AND INCREASED PRODUCTIVITY

The solar roti rolling machines have enabled entrepreneurs, partnerships and self help groups to increase their productivity from 50-200 rotis a day to 500-1000 rotis a day. It takes about 5-15 seconds for each roti to be made, depending on the entrepreneurs experience.

### IMPROVEMENT IN INCOME

In most cases roti rolling entrepreneurs or self help groups have mentioned a seasonal spike in income which has tripled or quadrupled their income levels. At least 30% of the entrepreneurs have been able to diversify their business through the machine. Post installation of the intervention, these entrepreneurs were on an average, able to increase their daily production 2X (from 200 to 400 rotis), resulting in additional income in hand.

### EMPLOYMENT CREATION AND MARKET INNOVATION

The increased market demand have made women entrepreneurs to spread awareness among other women in their communities and also employ them as additional labour.



## CASE STUDY

### BASAMMA HUCHUNNUR

Roti Rolling Entrepreneur at a Khanavali (Eatery)



Most of the labour in Ilkal, a medium-sized town in Bagalkot district, in Karnataka, have primarily engaged in the granite business since the past 10 years. They used to travel 5 kms or more for just having their lunch. Basamma and her husband spotted a market demand for food and hence decided to open a Khanavali 10 years back for these labourers. The process of preparing rotis manually turned out to be very tiresome with even lesser productivity.

In the recent years, due to increasing migration rate, labour had become many a times, unavailable. Initially, they used to produce 250-300 rotis but it had come down to hardly 150-200 rotis. To make things worse, health issues and ageing affected their business as well. Solar powered roti rolling machine intervention promised to help

increase their productivity, thereby not just satisfying the demand but also expanding to other market spaces. With one extra labour alone, they were able to make 300-350 rotis a day and produce further more if demand increased. Now every month they are able to earn an income of INR 24,000 from the roti sales alone. A loan of INR 50,000 was made available from a local financial institute at the interest rate of 16.75% for a 1 year loan term. A small percentage (approximately 20%) of their total income was collected weekly. In such a market space, energy access and technology did not just increase their income but also helped reduce their strain and health issues.



## Snacks

- 36. Flour mixing
- 37. Pani puri

According to FAO, due to its low cost and convenience, 2.5 billion people consume street food, among which a popular one is pani puri. Like other informal sector enterprises, street food enterprises are characterized by the small scale of the operation, use of traditional food processing technologies, and low capital costs that allow ease of entry into the sector.

### LONG PROCESS TIME

Entrepreneurs are not able to cater to their potential market. Their productivity is hampered due to the laborious tasks involved.

**11 hours** = **3000 - 10,000**  
5/6 labourers      puris per day

### TECHNICAL SOLUTION

As many end users want to boost their productivity to appeal to a larger market as well as increase their efficiency, the solution has been to supply solar powered flour mixing machines which is used to make pani puri (usually larger capacity 1 HP) and bakery products (smaller capacity of 0.5 HP). There is now a productivity increase due to automation, better distribution of work in the households and increased efficiency due to the all-round decentralized and clean energy based power supply.

Avg. increase in production amounts and income **100%**

### FLOUR KNEADER AND PURI CUTTER

Energy System	SOLAR MODULE (Wp)	2400
	BATTERY (Ah)	14400
	SPCU	4 kW 5 kVA 96V
Motor	TYPE	AC Induction 1 phase
	CAPACITY	1 HP + 1 HP
	RPM	1400

"Pani puri" (unleavened Indian bread that is fried, is crisp and which is filled with tamarind, chilli, potato, onion and chickpeas) is very popular among all age groups and is sold in every nook and corner of the country.

### POWER CUT

Most of the vendors belong to areas that face irregular power cuts which often lead to disruption in their work or leads to further lack in confidence to move to a mechanised process. This also leads to excessive wastage of ingredients, low productivity and low incomes.



## 38. Sweet Meat Making

India is the largest milk producing nation in the world. Milk is perishable in nature, thus it cannot be stored for a very long period. In order to preserve it, more than half of milk produced in India is converted into a variety of traditional value-added milk products which play a significant role in the Indian economy.

### LABOR INTENSIVE WORK

Khowa makers would usually work with 50 ltrs of milk per day, manufacturing 20 kg of khowa, which is then sold to nearby sweet shops once a week. The whole process takes a minimum of 3 hrs if done manually, and requires constant stirring attention using a ladle which is a drudgery packed task.

**50 ltrs milk** + **3 hours** = **20 kg khowa**

### TECHNICAL SOLUTION

Utilization of a single hour of a mechanized khowa making machine can lead to an average of 35 kgs, (15kg's more than manual production) which equates to an additional 45kg's across 3 hours.

**260 ltrs milk** + **3 hours** = **105 kg khowa**

Avg. Increase in productivity **>400%**

Khowa is a heat desiccated indigenous milk product. Due to its large scale consumption, close to 600,000 tonnes of khowa is being produced annually, which is equivalent to 7% of India's total milk production.

### POWER CUTS

If using a machine, frequent power cuts affect the users income for the day and lead to wastage of time. There are also high chances of spoilage in case of power outages leading to economic loss.

### SWEET MEAT (KHOWA) MAKING

Energy System	SOLAR MODULE (Wp)	1200
	BATTERY (Ah)	7200
	SPCU	3 kW 4 kVA 48 V
Motor	TYPE	AC Induction 1 phase
	CAPACITY	1 HP
	RPM	1400



## 39. Popcorn Making

Packaged popcorn is a very popular snack and is instant and convenient to prepare. It is prepared by heating the corn kernels in a kettle, pot, or stove-top by adding vegetable oil or butter. The popcorn machine needs two-power sources, gas for heating purposes and power supply for the automatic rotation function.

**There are two types of popcorn vendors- indoor who sell the packaged popcorn in market and the other**

**are street vendors who travel within their villages and neighbourhoods selling fresh popcorn.**

The ones who process it indoors, they could either have an electric machine which has an electric heater or a gas connection. The street vendors have LPG gas for cooking and motor for operations which runs with a battery that they charge 2 times in a week and carry along with them.

### LACK OF MOVEMENT AND EXPANSION IN BUSINESS

The push cart restricted the users movement to travel to other villages and towns so they used to cook at home and make packaged popcorn for selling at different markets. There was market demand that the user could envision but not enough resources to supply.

**The need for mobility was very crucial for expanding the business - and a gap that needed decentralized & portable ways of generating clean & affordable energy.**

### TECHNICAL SOLUTION

A pick up vehicle housing the popcorn machinery was solarised to cut down the operating costs and easy charging of the battery for the motor as well as lighting purposes. Entrepreneurs are also now in the position to cover various markets, while selling fresh popcorn as opposed to packaged as was previously done. A distance of about 150 kms could be now covered within 4 days, which was mostly in the urban market space.

Addition of lighting solution ensured that the vendors were able to further maximise their profits by working late in the evenings- a time where the markets are busier.

Percentage increase in productivity due to energy access solution

**+100%**



### POPCORN MACHINE WITH A 60W LED LIGHT & MOBILE CHARGER

Energy System	SOLAR MODULE (Wp)	300
	BATTERY (Ah)	1800
	CHARGE CONTROLLER	10A 12V Hybrid charger with 5A Grid charger
Motor	TYPE	DC
	CAPACITY	20W
	BACKUP HOURS	6

## 40. Oil Mill

India is one of the largest producers of oilseeds in the world and has a wide range of oilseeds crops grown in different agro-climatic zones. **India's share in the world oilseed production is about 8%. The estimated demand for vegetable oil is over 18mt (million metric tonnes) which is predominantly met by imports.**

### MARKET AWARENESS AND LINKAGES

Oil used most commonly is hot pressed, as it is cheap and easily available. The hot press oil applies external temperature and requires pre-conditioning of the input material. Due to the chemicals used in the oil extraction process, high quantity of oil is extracted which kills the required micro-nutrients. Even though the oil extracted from hot press and chemical extraction is not good for health, it is still consumed as it is cost effective and the manufacturer gets benefitted as they can extract more oil from these methods.

Earlier, traditional oil extraction method was used for extracting oil like bullock-driven local indigenous machines ('Ghani or Kolhu'). In order to improve technology, motored powered Ghani was introduced but over a period of time, Ghani became obsolete as their efficiency was found to be less as compared to hot press and chemically extracted oil mill.

### LACK OF SMALL MACHINES

For small farmers who have the ability to engage in the oil extracting process, are unable to do so due to the unavailability and lack of awareness of the small machines. This holds them back from venturing into oil extraction business even when they may have the resources and raw materials for it.

Avg Power consumption of hot press oil machine

**15 HP**

### TECHNICAL SOLUTION

Implementation location of cold press oil mill sites are located close to oil seed growing areas, close to farms. The efficiency of this machine is far greater than hot press oil. At the current motor capacity, the machine has an output of 5-70 litres of oil a day.

Power consumption of cold press oil machine

**2 HP**

### OIL EXTRACTOR

Energy System	SOLAR MODULE (Wp)	2400
	BATTERY (Ah)	14400
	INVERTER	4 kW 5 kVA 96V
Motor	TYPE	AC Induction 1 phase
	CAPACITY	2 HP
	RPM	1440
	BACKUP HOURS	3

## 41. Sugarcane Juicer

**Many of the sugarcane juice machines are installed roadside in a cart structure (2.6 X 4.08 feet) and is powered by electricity.** AC motors generally used in sugarcane juice machine is of 1.5 HP (single phase) and is controlled by a rotatory switch which provides functions like forward and reverse rotation of motor.

The machine has 4 drum structures, out of which 2 drums are used for soft crushing and 2 for hard crush. The machine is capable of crushing only one sugarcane at a time.

## USE OF DIESEL ENGINE

The sugarcane juicer is run by either a diesel engine or a diesel generator. This proves to be very costly for the vendor. Also in some cases, it is noticed that the smell of diesel and lubrication oil is retained in the juice prepared by the machine. This makes the entrepreneur further lose customers.

Amount spent on diesel per day (INR)

1500 - 2000

## TECHNICAL SOLUTION

A solar portable sugarcane juice maker which is mobile and hence allows the entrepreneur to experiment with other market spaces. The solar powered machine is more cost effective than the diesel powered variant which would incur costs everyday. The machine has added features of hygiene as well.

Power consumption of the new machine

1 HP

## LACK OF PORTABILITY OF THE ELECTRIC MACHINE

Electrically operated sugarcane juice machines are not portable. Additionally, since the nature of the entrepreneurs is mobile, it also required a decentralized and portable energy solution.

Power consumption of machines currently in use

2 HP

## SUGARCANE JUICER

Energy System	SOLAR MODULE (Wp)	500
	BATTERY (Ah)	3600
	CHARGE CONTROLLER	30A 24V
Motor	TYPE	PMDC
	CAPACITY	0.5 HP
	BACKUP HOURS	3

## TECHNICAL SOLUTION

- A solar based motorized system designed to extract juice from the fruit. The system can be retrofitted with existing hand operated Mosambi juicer machine and the solution can be provided to new entrepreneurs as well.
- The solar juicer consists of light and mobile charging solutions so that the vendors could increase their sales by selling in the night time for the additional income.

In an urban scenario, the entrepreneur can pay back for the system by setting aside the cost sales from 6 glasses of juice every day for a period of approximately a year with interest rate of 12%

## SWEET LIME JUICER

Energy System	SOLAR MODULE (Wp)	400
	BATTERY (Ah)	120
Motor	TYPE	PMDC
	CAPACITY	0.25 HP

## 43. Puffed Rice

### HIGH LABOUR INTENSIVE OPERATION

The processing of puffed rice from paddy traditionally takes about 6 days. Some of the tasks, particularly manual roasting of paddy and immersing it in water, mixing the ingredients with milled rice and stirring the rice in roaster pan for uniform heating are highly labour intensive operations.

Puffed rice is a type of puffed grain made from rice, commonly used in breakfast or snack foods in Karnataka and some other regions in India. It is prepared by roasting conditioned rice grains in a hot sand bed.

### LACK OF EFFICIENT MECHANISATION

Complete mechanization of the process has not yet been undertaken which leads to many problems. Many of the rice puffing units are of the traditional type and are inefficient. Also, modern rice puffing machines have higher capacity and hence produce higher energy bills. Power outages also leads to loss of production and efficiency.

## TECHNICAL SOLUTION

- Oversized 1 HP motor was replaced with an efficient 0.25 HP DC motor along with a speed controller that has been solar powered with the backup of 3 hours.
- Diesel generators used by the entrepreneurs were now fully replaced by the solar solution. Also the motor with its increased efficiency gives the users the same output but at a lesser electricity cost.

INR 36,000 on diesel / year  
50% increase in productivity

Also, modern rice puffing machines have higher capacity and hence produce.

Energy System	SOLAR MODULE (Wp)	500	Puffed Rice - Single Spin	1200
	BATTERY (Ah)	3600	Puffed Rice - Multiple spin with 4 spindle with 80W Fan and 120W Table Fan & 9W led light	8640
	INVERTER			3 kW 48W
Motor	TYPE	PMDC		AC Induction 1 phase
	CAPACITY	0.5 HP		600 W
	BACKUP HOURS	3		3

## 42. Sweet Lime Juicer

### LACK OF ACCESS TO GRID CONNECTION

There are a number of motorized juicers available in the market which run on alternating current, but these solutions are accessible to only those kind of vendors who have a grid connection. But there are also many roadside juice vendors who don't have grid connections and are unable to meet their energy needs in their daily life. Such juice vendors are either permanent or mobile.

### INCREASED DRUDGERY AND LOW PRODUCTIVITY

The juice vendors who sell juice over a push cart near the roadside, currently use the manual Mosambi juicer, which has a lot of drudgery and very less productivity. They are able to only make a minimum of 40-50 glasses and a maximum of 80 - 100 glasses of Mosambi juice per day by manual machine methods.

## 44. Corn Grill DC Fan

Street vending as a profession has been in existence in India since time immemorial. However, their number has increased manifold in the recent years. With growing cities, increasing urban population, and reduced employment opportunities, the number of people taking to street vending have also increased. Urban vending is not only a source of employment but provides 'affordable' services to the majority of the urban population.

According to the National Policy for Urban Street Vendors, women constitute a large number of street vendors in all the cities of India. And many of these Street Vendors survive on a hand-to-mouth existence and not working even for a single day - means no food for them and their family for that entire day. Also, poor living and working conditions, poor health, increased expenses on health care often leaves them in debt for long periods of their life. Increasing the income levels and productivity is a vital measure for the survival of urban street food vendors.



- Corn grilling is a seasonal livelihood for street vendors and involves drudgery as it requires the vendors to fan the coal faster when flooded with many customers. It involves repetitive motions causing sustained body aches and other health issues.
- The customers generally lose interest and do not wait long when they do not get the corn immediately - which is again a loss of income for the vendors itself.

### TECHNICAL SOLUTION

A portable solar solution has been designed which consists of an adjustable efficient DC fan and an adjustable 3W light fixture to function at night time with a light-weight lithium ion battery which can be used for a duration of 4 hrs per day. The solution provided for the entrepreneurs is a design that is installed on an open cart structure which can be mounted easily. Everything on the cart i.e. the panel, battery, light and fan can be easily removed and carried while moving from one place to another. The DC fan now helps reduce the drudgery of fanning by hand and can fan more than one corn in less time.

#### CORN GRILL DC FAN with 3W LED Light

<b>Energy System</b>	<b>SOLAR MODULE (Wp)</b>	<b>20</b>
	<b>BATTERY (Ah)</b>	<b>14Ah Li Ion Battery</b>
	<b>CHARGE CONTROLLER</b>	<b>Inbuilt 5A CCR</b>

#### IMPACT FROM THE PILOT

	Pre intervention	Post Intervention	Percentage Increase/Decrease (%)
<b>TIME SAVED IN GRILLING THE 3 TO 4 CORNS SIMULTANEOUSLY (MINUTES)</b>	10	5	<b>50%</b>
<b>CORNS COBS SOLD PER DAY (NOS)</b>	50	60	<b>20%</b>
<b>INCOME EARNED PER CORN COB SOLD (INR)</b>	20	25	<b>25%</b>
<b>NET INCOME PER DAY</b>	1000	1500	<b>50%</b>



## 45. Banana Chips Making Machine

Banana chips are dried fried slices of bananas. They can be covered with sugar or honey and have a sweet taste, or they can be fried in oil and spices and have a salty or spicy taste. Fried banana chips are usually produced from under-ripe banana slices deep-fried in sunflower oil or coconut oil. Both ripe and unripe plantains are used for this type of chip preparation.

#### Manual process

The entrepreneurs engage in a manual process of slicing and deep-frying the chips which becomes an extremely drudgery prone and time consuming process with very less output produced. Most of them slice the banana chips manually and after engaging in this process for 3 hrs, are able to make only 30 kg of banana chips.

#### No time for expanding business

Entrepreneurs who want to increase the production or expand the market size are unable to do so as cutting chips manually limits their overall production. It becomes an extremely time consuming process as well - which limits them from engaging in any other activities like marketing his business.

#### Erratic power supply

Most of the areas have irregular power supply and frequently face power cut problems. This means providing a mechanised solution will do very less to improve their production due to the lack of uninterrupted power supply.

#### BANANA CHIPS MAKING MACHINE

<b>Energy System</b>	<b>SOLAR MODULE (Wp)</b>	<b>1200</b>
	<b>BATTERY (Ah)</b>	<b>7200</b>
	<b>INVERTER</b>	<b>2 kW 2.5 kVA 48 V</b>
<b>Motor</b>	<b>TYPE</b>	<b>AC Induction 1 phase</b>
	<b>CAPACITY</b>	<b>1 HP</b>
	<b>RPM</b>	<b>1440</b>
	<b>BACKUP HOURS</b>	<b>3</b>

### TECHNICAL SOLUTION

A 1 HP slicing machine powered by solar has been designed in specificity to a mid-size entrepreneur. With this machine, the entrepreneur would be able to now slice around 100 to 150 kg of bananas per hour which if done manually can only slice 30 kg/day and therefore earn more income with increased productivity. Also due to the mechanised motion of slicing the chips, there is a consistency that is maintained in its thickness which helps improve the quality of chips and its taste.

#### IMPACT FROM THE PILOT

	Pre intervention	Post Intervention	Percentage Increase/Decrease (%)
<b>WORKING HOURS</b>	3-4 hours	1 - 1.5 hours	<b>66%</b>
<b>OUTPUT</b>	30 kg	150 kg	<b>400%</b>
<b>INCOME BY SELLING BANANA CHIPS</b>	10,000	30,000	<b>200%</b>



## 46. Butter Churner

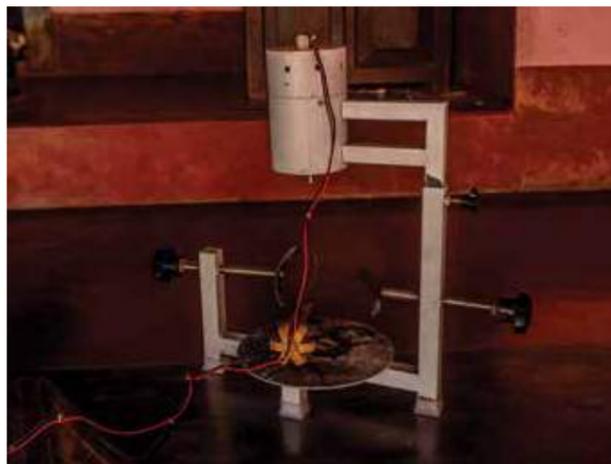
India is the largest milk producing country in the world. Operation Flood programme has seen India producing 140 million tonnes of milk which resulted in the development and up-gradation of rural life. Butter is one of the most important value-added dairy products. India is the largest producer of butter with annual production of 5035 million tones. Out of the total production of milk in India, 1% is converted into butter.

Even though a lot of potential exists, the traditional dairy product preparation is labour intensive and the quality of finished products are highly variable in terms of physical, chemical, microbiological and sensory properties, so there is an urgent need to produce uniform and high-quality products.

A butter churner is a device used to convert cream into butter. This is done through a mechanical process, frequently via a pole inserted through the lid of the churn, or via a crank used to turn a rotating device inside the churn.

### TECHNICAL SOLUTION

An efficient solar powered agitator was developed which is aimed to be versatile, user friendly, ergonomic and aspirational especially for rural unelectrified households. As a larger context, this device can also be a means of livelihood generation. For this solution, an old DC fan motor was used to churn the butter and this innovation was born out of a need to have a low cost locally manufacturable solar powered kitchen appliance that would be useful in remote regions of the country where grid supply is erratic or none.



- In many parts of rural India, dairy farming is practiced on a large scale and there is high consumption of buttermilk. Especially in central parts of Karnataka, either they churn the curd manually or rely on electric butter churners. As the people here face a lot of power issues, even in the presence of an electric machine, they end up manually churning the milk - taking 60-75 mins to churn around 20 ltrs of curd.
- Most rural households churn their own butter since it is fresh and cheaper than consuming store-bought butter. The health benefits from this practice are definitely superior to that of processed dairy products. Regardless, the process is time-consuming and often involves drudgery or fatigue - requiring a hand motion of 60 mins.
- It is also a laborious job as it needs the time of one person for the entire processing cycle - leaving no time for any other activity.



## 47. Wet Grinder

There is a high demand for food preparation appliances to substitute traditional cooking aids. Cooking at home is a common practice in India and food preparation differs widely across the regions. But with advances in technology, old-style cooking aids can be replaced with modern ones which make the job much easier and more convenient.

Wet grinder is a mechanised solution adopted in food preparation, used especially in Indian cuisine for grinding food grains to produce a paste or batter. They usually are used to grind grains and lentils and is used extensively in South Indian cuisine for preparation of popular dishes such as dosa, idly, vada etc. It consists of granite stones which rotate inside a metal drum with the help of an electric motor and the food grains get crushed between the stone and drum.

### Drudgery due to manual grinding

Those types of food preparation involving grinding, both at household and eatery levels take a considerable physical effort, which is compounded by the fact that there is usually a shortage of labour for these tasks. Also, because of the time invested in manual processing, the entrepreneur lost a large amount of their business.

### Low Output

When the motion is manual, the speed is much less than a mechanised solution which leads to a lower output being produced.

### TECHNICAL SOLUTION

A solar powered wet grinder was designed to boost production and reduce drudgery. Using this solution a single grinding unit can cater to the needs of multiple eateries, saving all stakeholders time and resources.

### IMPACT FROM THE PILOT

	Traditional stone grinder	Solar powered stone grinder	
TIME SAVED TO GRIND	45 - 60 minutes	1 - 1.5 hours	<b>77.77% reduction in time</b>
QUANTITY	5- 7 Kg per eatery per day`	15 - 18 kg per hour	<b>30 kg * INR 10 INR 300 per day earning INR 300 * 25 Days = INR 7500 per month</b>



# Blacksmithy

# BLACKSMITHY

As an ancient profession, the blacksmith has its roots dating back to thousands of years, producing a wide range of equipments and tools used in agriculture, construction, household and hardware products.

Despite the advances in modern mechanization, many blacksmiths still use outmoded methods to deliver their work, while some have graduated towards mini fabrication units. Access to energy is often the gap in making that transition from smithing to fabricating.

Depending on the scope of work, the scale of blacksmith operations vary across the value chain. Some have only basic tools, dealing with smaller household level or farming hand tools and engage in basic cutting and grinding. These

blacksmiths usually have a temporary setup and are also nomadic in nature, moving from market to market or farm to farm. Others have larger smithing workshops, catering to larger farmer needs, and even the needs of the construction industry.

After carefully examining their fundamental processes, it was identified that access to sustainable energy could play a critical role in transforming three specific aspects of their work, and thus the profession. Different typologies of blacksmiths were identified- bring out the role and feasibility of energy access models for each.

There are above 7.5 million blacksmiths currently practicing in India.

## A BLACKSMITH'S PROCESS

HAND/MECHANISED FORGING TOOLS

MANUAL/MECHANISED BLOWER



A FURNACE & FUEL SOURCE

### CUTTING

Cutting of metal strips



Angle Grinder

### HEATING

Heating of iron for easier shaping



Fan Blower

### FORGING

To shape metal by hammering



Power Hammer

### FINISHING

Heating of iron for easier shaping



Angle Grinder

## TYPES OF BLACKSMITHS



+

Solar Powered Angle Grinders

+

Solar Powered Power Hammers

### Solar Powered Portable or Fixed Blowers

#### 1. NOMADIC

##### PRODUCTS MANUFACTURED

Household tools, small hardware products, small agri tools

##### USER GROUP

Nomadic - traveling constantly on predefined routes, making metal products and selling them in villages on the way and returning to their home village once in a year.

##### MONTHLY INCOME

INR 10,000-15,000

##### LABOUR REQUIREMENTS

Family members engage in the task with occasional assistance from customers

##### TOOLS USED

Manual blowers, hand cranked wheels, manual angle grinders and hammers

#### 2. SMALL SCALE

##### PRODUCTS MANUFACTURED

Household tools, small hardware products, small agri tools, cultural products

##### USER GROUP

Small workspace, usually adjacent to the home or near a market place, livelihood seasonal- dependent primarily on agri season

##### LABOUR REQUIREMENTS

Hire 1-2 labourers depending on the workload; expenditure INR 150 - 250 day for hand cranked blower

##### MONTHLY INCOME

INR 10,000-15,000

##### TOOLS USED

Manual blowers, hand cranked wheels, manual angle grinders and hammers

#### 3. MID - SCALE

##### PRODUCTS MANUFACTURED

Agri tools or machinery, gates, railings, hardware products, automotive garages

##### USER GROUP

Small workshop - usually near a market place; primarily dependent on the agri season

##### LABOUR REQUIREMENTS

Hire 2-3 labourers depending on the workload; expenditure INR 250 - 400 per day for hand cranked blower + hammering

##### MONTHLY INCOME

INR 15,000-25,000

##### TOOLS USED

Basic blacksmithy tools, power hammers, angle grinders

#### 4. LARGE SCALE

##### PRODUCTS MANUFACTURED

Agri tools or machinery, gates, railings automotive components, customised products, lifestyle products

##### USER GROUP

Fabrication workshops - usually near the marketplace - caters to wide variety of customers

##### LABOUR REQUIREMENTS

Highly skilled tradesperson employed; expenditure INR 400 - 500 per day for hand cranked blower + hammering

##### MONTHLY INCOME

INR 25,000-60,000

##### TOOLS USED

Power hammers, heavy duty bending jig, quick change conversion dies, lathe machines, oxy - acetylene and arc welding.



## 48. Blacksmith Fan Blower

The Blacksmiths hire labour to work the hand cranked fan blowers or bellows to keep the fire burning during forging of metal. Due to the high costs, and unavailability of labour, blacksmiths involve members of their family in the task- often taken up by children or women in the household.

### HIGH COST OF LABOUR

Approximately  
**INR 2000**  
Per Week

Exposure to harmful fumes and long hours of work make blacksmithy a hazardous occupation. Currently, blacksmiths use large wheels, hand-cranked blowers that are utilised to maintain and regulate temperatures of the fire. The methods of igniting and keeping the furnace running, add to the drudgery

### EXTREME DRUDGERY

Injuries to  
**Hand, Wrist, Eyes, Legs, Fingers, Face**

### TECHNICAL SOLUTION

SELCO Foundation designed a high efficient, high quality, powerful blower solution for the blacksmiths.

The standard capacity motors (0.25 HP/ 0.5 HP) are oversized and run at high-speed. This makes it difficult to operate, especially for blacksmiths working with small workpieces. Thus, heat is only partially used, and most of it goes to a waste. Optimization and scaling down of the blower, resulted in development of a range of efficient

and affordable solutions for smaller blacksmiths. The innovation also kept in mind the need for ergonomic design with suitable air flow control. The addition of a speed controller provides good airflow control to suit the size of the workpiece.

Blowers in the market  
**200W**

New DC Blowers  
**15W - 60W**

	15W Blacksmith Blower	60W HD Blacksmith Blower	60W HD Blacksmith Blower	
<b>Energy System</b>	SOLAR MODULE (Wp)	40	200	250
	BATTERY (Ah)	240	960	1200
	CHARGE CONTROLLER	10A 12V	10A 24V	10A 24V
<b>Fan</b>	TYPE	PMDC	PMDC	PMDC
	CAPACITY	15 W	60 W	60 W
	RPM	2970	2800	2800 W
	BACKUP HOURS	8	6	8

### COMPARISON OF BLOWERS

	Small Scale & Nomadic		Medium Scale	Large Scale
WATTAGE	15 W	30 W	50 W	60 W
CFM*	8	24	80	168
TIME TAKEN FOR HEATING AN TOOL	15	12	6	4

CFM stands for cubic feet per minute (it is also referred to as airflow). Put simply, CFM is how much air a fan moves. The measurement is taken when the fan is on its highest speed and uses both the volume of air and the rate at which it moves.

Here is an example of how higher airflow being generated by the blower helps in reaching higher heating temperatures - thus saving time.

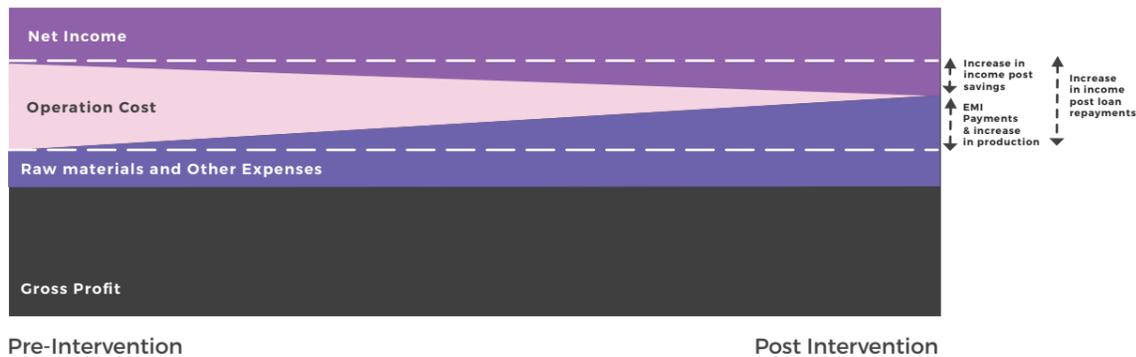


## FINANCIAL SOLUTION

The solution integrates financial access that is customized to the existing cash flow. The loan is designed such that the labour charges became the EMI payment along with additional earnings.

As the payback period for the solution is really short (2-4 months) considering saving in labour cost, it is an affordable solution for blacksmiths.

PRE INTERVENTION OPERATIONAL COST (For 20 Days/month)	INR 6000-8000
EMI AMOUNT (As per cash flow)	INR 500-700
LOAN TENURE	2 Years
INTEREST RATE (REDUCING)	12 %
DOWN PAYMENT	20% of Total Cost



### INCREASED PRODUCTIVITY

With the additional provision of lighting, the workshop operational hours gets extended by 2-3 hours per day thereby improving their productivity during peak season.

Percentage increase in productivity of the blacksmith **+20 - 30%**

## IMPACTS

### IMPROVED HEALTH & WELLBEING

All the blacksmiths where interventions were carried out, reported a reduction in impact of injuries related to physiological and upper limb musculoskeletal disorders (MSD). This has improved the health and wellbeing of not only blacksmiths, but of children and women engaged in the livelihood.

### INCOME INCREASE

Without the additional requirement of a typically difficult to find and expensive labourer, the expense component for the blacksmith has come down drastically.

Percentage decrease in operational expenses of the blacksmith **-45%**

# 49. Power Hammer, 50. Angle Grinder

## EXTREME DRUDGERY, DANGER AND HIGH LABOUR COSTS

Shaping heated metal is a very force intensive process and is commonly achieved by manual hammering, which requires an extra person (commonly labourers or the son of the household) depending upon the task at hand to hammer the piece in sequence. This can be very exhaustive and extremely dangerous, considering the lack of safety measures and force/proximity values, and high labour costs.



POWER HAMMER - TECHNICAL SOLUTION

- A solar hybrid system was designed to be a retrofittable system, as the diesel motor was not completely replaced and could be activated again when reconnected with the belt drive.
- The user is required to loosen the bearings of the belt drive for the diesel motor to be replaced with the DC motor. The DC motor takes the role as the predominant motor, whilst the diesel takes a secondary stance. The two motors can be now used alternatively depending on the energy source.

Energy System	DC Power Hammer
SOLAR MODULE (Wp)	2000
BATTERY (Ah)	1600
Motor CAPACITY	2 HP

## UNRELIABLE POWER AND USE OF DIRTY FUELS

Some metal workers and blacksmiths will also invest in an AC powered power hammers and angle grinders, however these often have very high power consumptions and operate on diesel. They also become inoperable during power outages.



ANGLE GRINDER - TECHNICAL SOLUTION

Sharpening the tools require some amount of physical effort- this is specifically true for blacksmiths who deal with larger machinery tools or components for the construction industry where angle grinding is a significant part of the work. The existing methods are manual or pedal powered and battery operated hand held angle grinders. Being primarily in rural areas, the battery operated hand held angle grinder was provided a back-up. A micro-inverter for converting AC to DC.

Energy System	Angle Grinder
SOLAR MODULE (Wp)	75
BATTERY (Ah)	960
Motor CAPACITY	54W

## CASE STUDY

# Venkatachari

Blacksmith Entrepreneur

Venkatachari is a physically challenged blacksmith living in Devalaapura village, Mandya district. Blacksmithy is his family business and primary source of livelihood. He used to have a hand-cranked manual blower which had to be rotated by the customer himself. Two years ago, a solar powered blower was installed at his site. The total cost of the blower was financed by SKDRDP, a microfinance institution with margin money support received from SELCO Foundation. He initially would receive orders of 5-6 farm tools per day but post installation, he has been getting orders of 20-30 tools per day. During the peak season in the months of January, July and September he is able to get an order of 30 - 40 tools per day. He has successfully cleared the entire loan with the increased savings generated with the machine. He charges INR 20 per sickle and receives 10-15 tools from farmers on a regular basis as he is able to finish his work faster with the help of the solar powered blower.



## CASE STUDY

# Leelavathi

Blacksmith Entrepreneur

Leelavathi, is a single mother supporting her 3 daughters. Housed in a rented premises, along with her brothers, Leelavathi makes a living by making general and specialized tools (e.g. for rubber tapping), earning approximately INR 400/- per day.

Leelavathi approached a leading banking correspondent in the state of Karnataka for financing the equipment, as a short term loan for 18 months with weekly payments of INR 250 (approximately equal to the amount spent on labour per day in case of a power outage). The biggest impact, as cited by her, has been the reduction in drudgery and the physical exertion required because of the motorised blower.



## CASE STUDY

# Ashok Pawar

Blacksmith Entrepreneur

Ashok Pawar, from Dharwad, initially had an AC blower and a power hammer. A demo of the HD Blower was provided to the entrepreneur as a value-add to his process chain. After a month of deliberation, he was interested in buying the blower as he faced frequent power cuts causing disruptions in his work leading him to manually complete the entire process by hand. The main challenge was having to hire an extra labourer when he was working with the manual machine. For all the work that he was engaged in, he needed a bigger machine which was time and heat consuming with a low airflow speed. The older AC blower's motor also generated a lot of noise and when used manually, leads to health deterioration as well.

The solar powered blower was financed by SKDRDP, a local MFI. The whole unit can now be run by one person allowing him to save on major labour costs. His the poor impact on his health has reduced as well.



## CASE STUDY

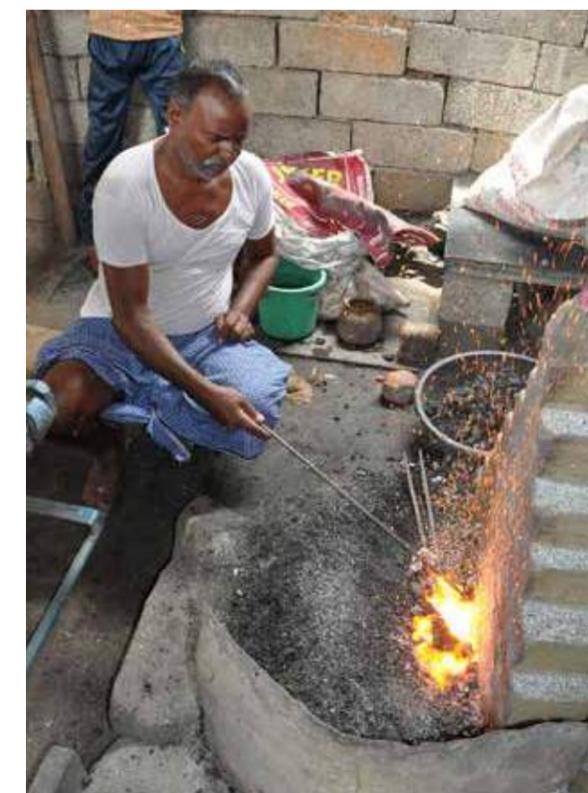
# Nagarajappa

Blacksmith Entrepreneur

Nagarajappa from HD Pura, Chitradurga district is a traditional blacksmith who has been engaged in the craft for decades. A solar powered blacksmith blower was installed in his work space over a year ago which has had positive impacts on his health with respect to drudgery and on his income and productivity.

He had invested in a mechanical power hammer which was previously diesel powered. The engine would guzzle a lot of diesel and would produce a lot of noise and smoke which would engulf his shed. One to two liters of diesel would run for three to four hours while incurring an expense of INR 2625 per month.

A retrofit solar powered DC motor was installed on the existing power hammer completely eliminating the diesel cost, smoke and noise pollution. He also has the flexibility to make a new product for which he charges INR 60 per tool. Post the intervention, his income excluding diesel cost has come to INR 6850 per month and he hopes to innovate on more products and designs.





# Carpentry

# CARPENTRY

Carpentry is a labour-intensive process that has many successive steps, made easier with the use of specific equipment and machines. Carpenters use these machines to reduce the drudgery involved in the process and also lead time for each product, thus increasing customer satisfaction as a result of quality end products and in-time deliverables. A typical operation involves the use of a planer, grinder and polishing machine.

Carpentry is one of the oldest crafts in India. A good carpenter can always find a gainful employment even in village with poor purchasing power of the people. Carpentry involves the usage of power driven equipments- but due to off-grid situation or unreliable power in the rural areas, carpenters often face difficulty in completing the order in time. The off-grid situation makes the carpentry work drudgery intensive.

## COMMON CARPENTRY TOOLS



**51. SIDE PLANER**

Smoothing as well as removing rough edges



**52. POWER DRILL**

Making holes and driving screws



**53. WOOD LATHE MACHINE**

Shaping of wood material



**SMALL SCALE CARPENTER**

**PRODUCTS MANUFACTURED**

Chairs, tables, beds, sofa sets, doors, windows etc.

**MARKETS**

Local villagers



**SKILLED CARPENTER FOR DECORATIVE PIECES**

**PRODUCTS MANUFACTURED**

Artist costumes, beads, gift items etc.

**MARKETS**

Artist costumes, beads, gift items etc.

Solar Powered Angle Grinder, Side Planer and Power Drill

Wood Lathe Machine

## TECHNICAL SOLUTION & IMPACT

### PLANER, SIDE/ANGLE GRINDER, DRILL MACHINE & CIRCULAR SAW

Energy System	SOLAR MODULE (Wp)	1000
	BATTERY (Ah)	8640
	SPCU	1.6 kW 2 kVA 24 V

Motor	TYPE	AC
	CAPACITY	370 + 1000 + 300 + 520



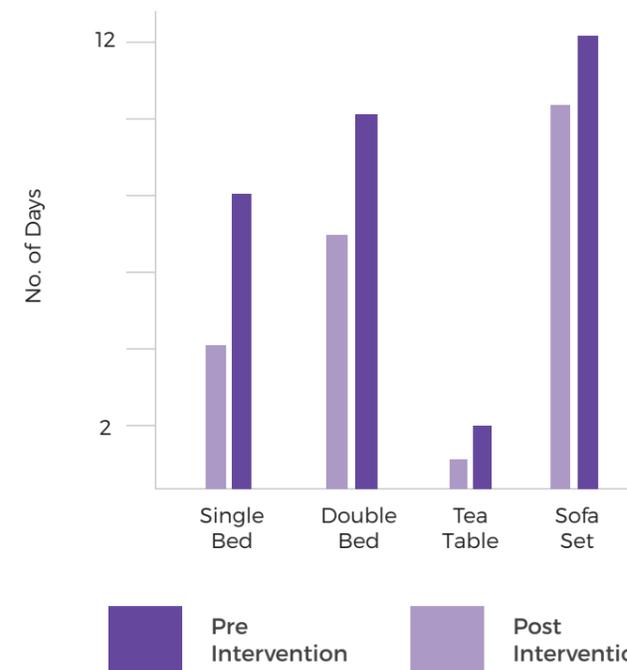
### PRODUCT QUALITY IMPROVED

In case of finer carvings, in some cases, neatness in the work can be achieved by even the lesser skilled carpenters- adding value and increasing the scope for design. .



### PRODUCTION EFFICIENCY INCREASED

The carpenters and artistic craft makers reported a decrease in time taken to craft various products. This has helped them in meeting the orders on time, resulting in satisfaction in the customer, as well as confidence in the carpenter to take up larger orders.





# Pottery

# POTTERY

Pottery is one of the oldest traditional livelihoods in India, and thrives as both an art form and a means to create functional items. The craft has been practiced and passed on over generations with the form constantly evolving.

In the last decade, the industry has been introduced to technological interventions aimed towards reducing drudgery. However lack of access to information, lack of markets, absence of reliable source of energy and easy financing holds back the community to completely switch to modernisation.

The need of efficient technological interventions supported by sustainable energy, in the whole process chain of the pottery making were studied. Based on this, four processes were identified and subsequent solutions have been developed and deployed.

The type of market (size and kind of products made and number of units produced) determines the viability and feasibility of the extent of technical intervention in the production value chain (detailed below). With demand, the potters progress from using manual wheel to electric pottery wheel to a combination of motorized pug mill and pottery wheel.



## 54. Pottery Wheel

### LOW PRODUCTIVITY AND PHYSICAL DRUDGERY

The productivity of the pots or any other products associated to the wheel is very low as it takes a lot of time to make any product in a manual wheel and the work comes to a stand still in case of power cuts while using an electric wheel.

Time taken to knead one batch of clay (Stomping of legs)

5

HOURS

### UNSAFE TECHNOLOGIES

The commonly available technologies are often not ergonomically designed- keeping in mind the work flow of the potter. For example, electric models for pottery wheel available in the market were found to be unsafe during testing. The mechanics of the wheel are exposed in a manner that when the potters throw on the wet clay and water on the wheel, there can be accidents because of electric shocks.

### LABOUR DEPENDENT

It's very difficult for a potter to do all other jobs like mixing the clay, kneading the clay, throwing and finally burning them in a kiln, so there is skilled labour requirement. However, in most cases, there is shortage of skilled labour.

No. of people to make one pot manually

2

### TECHNICAL SOLUTION

In the traditional pottery methods, the pottery wheel is continuously rotated manually. Either the potter switches between the activities of making the pot and rotating, or family members are involved in rotating of the wheel. This takes considerable amount of time and physical effort. The traditional pottery wheel is also extremely heavy. If the wheel loses balance while rotating, there are high chances of injuries.

The pottery wheel implemented was retrofitted with an efficient PMDC motor, designed for better balance and integrated with customized speed controller for easy operation.

25 - 50%

Percentage decrease in time taken to mould and scrape one pottery article

### POTTERY WHEEL & BLUNGER

Energy System	SOLAR MODULE (Wp)	300
	BATTERY (Ah)	2400
	CHARGE CONTROLLER	15A, 24V CCR with 5 A Grid charger
Motor	TYPE	PMDC
	CAPACITY	0.25 HP + 0.25 HP
	RPM	1500
	BACKUP HOURS	4

### 55. BLUNGER & PUGMILL

Mixing clay is an important activity in pottery. Mostly done manually, potters spend around 4 days in mixing the clay. Specifically for potters with large orders, this take significant amount of their time. A blunger is a machine commonly used in the pottery industry for making 'slip' (a mixture of clay and water). A blunger usually consists of a round or octagonal tank with a mixer. Clay is added to the water-filled blunger and then mixed into a slurry.

#### DC BLUNGER

POWER CONSUMPTION	180 W
OPERATING VOLTAGE	24V



#### MIXING & KNEADING

Mixing of different clay types



Pug Mill

#### POUNDING

Smoothering of clay mixture



Blunger

#### MOULDING & SCRAPING

To shape the clay into articles



Pottery Wheel

#### FIRING

Heating and drying of finished articles



Efficient Kiln



## 56. EFFICIENT KILN

Currently kneading is done by stomping on the clay. Manually, in this manner, it takes around 5 hrs to knead one batch of clay. **Through a pugmill, the potter is able to knead a 10 kg batch of clay within 2 hrs, while able to tend to his other work at the same time.**

Percentage of time saved by the pugmill

**60%**

Firing clay pots is one of the most important stages in pottery. But traditionally used kilns are inefficient, leading to heat losses and uneven baking of the pottery. Procuring firewood has also become challenging in some cases. The current kilns lead to almost 20% wastage of the firewood used. An efficient updraught kiln was built, which consumes 40% less fuel and energy as compared to traditional kilns.

Percentage of fuel saved by the efficient kiln

**40%**



## CASE STUDY

# Raghu Kulal

Potter

Raghu Kulal is a traditional potter hailing from the village Aloor where the primary occupation used to be pottery for most households in the community. Most potters have given up on the craft due to drudgery, erratic power supply causing a hindrance in their work, not enough market linkages and support. Mr Kullal has orders coming in through the year but was unable to meet them as he couldn't use his electric wheel during power cuts. He was on an average earning INR 15000 before the intervention per month. Post the installation of the solar powered DC wheel, he has started earning INR 45000 per month and is able to meet his orders.

Due to the larger orders, technical interventions were also brought in to mechanize the other pottery making processes- a pugmill, blunger and an efficient kiln were installed. By enrolling himself in a skill building program with a local organization (Namma Bhoomi), Mr Kulal was also able to diversify his product range to include terracotta jewelry, decorative pots, cookware etc. He has since registered a proprietor enterprises- "Guruvandana Pottery Products" and has employed a designer for terracotta jewellery making. He has also opened a small exhibition space to showcase and market his product.

## CASE STUDY

# Ningappa

Potter

Holehosur, a small village in the Bailhongal taluk houses 12 traditional potter families, who have had the skill passed on to them over generations. Over the past few years, excepting one or two families, all the families have switched to AC electric wheels. These cheaply available wheels are manufactured in Belgaum (a nearby district) and have flooded the market. Due to these wheels, the potters are susceptible to frequent electric shocks and have loss in working hours due to 2-3 hours of power cuts every day. The diameter of the AC wheel is also small allowing the potters to stack 25 kgs of clay at a time reducing the productivity. The potters could make a total of 180 flower pots earning INR 3060 a day on working days.

One of the families from the community took up the solar powered DC pottery wheel a year ago and



are now able to make 300 flower pots a day earning INR 5100. Due to the diameter of this wheel being larger, they can now stack up to 40 kgs of clay and the chances of electric shocks are now zero as well. The family is keen on taking up the pug mill, blunger and the efficient kiln too and will be assisted with market linkages as their productivity will shoot up considerably.



# Cottage Industries

# COTTAGE INDUSTRIES

Cottage industries are small scale manufacturing industries that are operated out of the homes or decentralized work spaces of producers. They often supply a fixed set of niche products or services and operate on a smaller output scale in comparison to larger businesses with larger capital capacity. Before the rise of industrialization, most products were produced using cottage industries, and in parts of the world such as Asia, South America and India, cottage industries are still a dominant force. Some examples are rope makers, cotton wick makers, and paper plate makers.

**Those who are employed or own cottage industries often rely on the particular craft or skill that they may have inherited as their sole source of labour. As a result, they suffer with the challenges such as competition from big industries in the form of factory production that relies on cheap and low labour production with the use of machines, non-traditional but more efficient fabrication techniques and economies of scales leading to reduced costs.**



## ROPE MANUFACTURING

Rope spun from coir, plastic, grass etc.



Coir yarn spinning machine, rope spinning machine



# 57. Coir Ratt and 58. Rope Spinning

Rope making is a very versatile livelihood, with many practitioners being able to make rope out of any material that can be defibred with a high tensile strength. One of the most common materials used is coir which is the native name of the fibre extracted from coconut husk, however among this other materi-

als that are used include, sabai grass, plastic bags and plastic/nylon products. **Rope makers can be categorised by the material they are using or the length of rope they produce, the latter of which often dictates the device they use to create.**

## HIGH AMOUNT OF LABOUR AND LOW PRODUCTIVITY

Excess labourers are required to carry out monotonous and drudgery prone tasks which can be automatised.

No. of people required to make one batch of rope manually

3-5

## HIGH DRUDGERY AND CHANCES OF INJURY

Certain lengths of rope and materials used can be very demanding for the labourer who is responsible for turning the spindles. Users often experience shoulder pains after work, which in the long run could lead to health issues and disability.

No. of times the wheel set has to be turned to produce one batch of rope

360 revolutions

## UNRELIABLE POWER

Coir industry hotspots suffer from power outages on a regular basis which leads to productivity loss.

## TECHNICAL SOLUTION

A range of rope making machines have been innovated which can be used for thin to thick ropes of differing materials. These devices would help to reduce the drudgery incurred as well as the labour required for the particular role of turning the wheel, by motorising the wheel.

The devices took into consideration keeping traditional habits and anthropometrics of the manual method. The space in between the hooks on the devices will be similar to that of that found on the manual. Apart from serving the practical purpose of being ideal for catching the thread when hooking and unhooking, it means the learning curve for the users is lower and allows them to apply their pre-existing methods and habits, at no extra cost.



## STONE SCULPTING

Grinding and Polishing Tools



Stone polisher



## COTTON WICK MANUFACTURING

Wicks for traditional candles



Cotton wick making machine



## PAPER PLATE MAKING

Powering the plate making value chain



Paper plate pressing machine

### Coir Ratt Spinning with 5W LED Light

### Rope Spinning 4 Spindle

#### Energy System

SOLAR MODULE (Wp)

75

BATTERY (Ah)

720

CHARGE CONTROLLER

10A 12V

#### Motor

CAPACITY

30W (10 x 3)

RPM

4000 x 3

BACKUP HOURS

8

600

4800

50A 24V

0.5 HP

1500

4



## IMPACTS

### REDUCED DRUDGERY

Automation of the machine reduces risk of injury that would occur if the end user was required to turn the wheel.

### REDUCED OPERATIONAL COSTS

The reduction of labour required to make rope reduces overall costs incurred which increases profitability.

### REDUCED CAPITAL COSTS

The cost of operating the machine has also dropped when compared to many AC powered rope making machines which are often oversized for production.

## CASE STUDY

# Jagadish Naik

Coir Yarn Rope Maker

This case study highlights the process involved in financing the solar powered coir yarn making machine through an MFI and its impact on the entrepreneurs livelihood activity. Jagadish Naik, living in Pochikatte Thandya village, Tumkur district, is a farmer who along with agriculture, is also involved in coir yarn making as an addition to his livelihood. For over 6 years, he was practicing this livelihood activity through the manual machine.

To run the machine, he usually needed one separate labourer who was involved in just rotating the wheel and while the wheel was in motion, it used to generate a lot of noise. Due to these reasons, a solar powered coir yarn making machine was suggested. After seeing the product and technology the entrepreneur got interested and found that the technology is extremely useful for him as the system does not generate any noise and no labor is required to rotate the wheel allowing him to save labour charges as well. The solution has helped him to increase his savings. He bought the system through the help of SKDRDP finance, a local microfinance institution. Other villagers have shown interest after seeing the successful implementation of the machine. This shows how solar powering to a coir yarn making machine has helped the entrepreneur improve his livelihood and efficiency of his processes.



## 59. Cotton Wick Making

### LOW PRODUCTIVITY AS A RESULT OF MANUAL OPERATION

Creating cotton wicks at an individual rate by hand often takes a long duration and individual workers differ in efficiency due to their learning curve and level of experience.

No. of cotton wicks produced manually per hour

8-10

One of the prominent activities in the Indian cottage industry is the labour intensive cotton wick making segment. Cotton wicks for small candles are mostly made by women using their hand manually.

The cotton wick making machine produces wicks of uniform shapes and sizes. This machine is easy to operate, portable and requires very less maintenance. The cotton wick machine is solar powered to allow continuous operation of the machine even during power outages.

No. of cotton wicks produced mechanically per hour

20-25



## 60. Stone Polishing

### TECHNICAL SOLUTION

This solution involves repurposing the existing angle grinders used by blacksmiths. The design involves solar powering of a selected angle grinder with stone specific polishing pads and blades. The angle grinders are lithium ion battery-run for versatility and are solar charged. This allows the end users to complete their work at a much faster pace and achieve a better finish which could be marketed at a higher price.

## 61. Paper Plates

Paper plates have a huge demand in the market and are available in different shape, diameter and design. Production of paper plates require - paper which is laminated with thin plastic or aluminium foil, a cutter to cut laminated paper into the desired shape, and a compressor for pressing paper in the die. The third process requires heat as well as energy for compressing.

### ERRATIC POWER SUPPLY

Power cuts and high energy consumption of machinery used means hindrance for the entrepreneur in achieving his/her maximum potential.

In many historic locations of India, decorations with ornate carvings or sculptures of deities, animals and humans etc. This art form called stone sculpting or stone carving still continues on, however, a number of issues means that it is slowly fading out of practise.

### LACK OF UPDATED TECHNOLOGIES

Stone polishers continue to use outdated technologies and manual methods which can be inefficient and cause low productivity.

### SCOPE FOR QUALITY IMPROVEMENTS

Often the stone quality finish is not on par with what could be accomplished with stone polishing tools because of which local craftsmen cannot command higher price points.

### STONE POLISHER

Energy System	SOLAR MODULE (Wp)	75
	BATTERY (Ah)	960
	SPCU	500 VA 12V
	CHARGE CONTROLLER	24A 12V
Motor	CAPACITY	54W 18V
	INBUILT BATTERY	3 Ah/ 5Ah Li ion (2)
	RPM	8500
	BACKUP HOURS	1

### TECHNICAL SOLUTION

Paper plate making machines solarised to provide additional 3 hours of backup. Additional saving on labour achieved when compared to the usage of the manual pressing machine. The machine can produce 1960 plates every hour.



# Services & Retail

# SERVICES & RETAIL

Lack of energy access not only limits the opportunities of small businesses in creating new revenue streams but also impedes the existing business to run smoothly.

Additionally, for the people in rural and peri-urban areas, the unavailability of electricity results in the absence of basic facilities such as printing and

photocopying, and often makes them travel long distances in search of the services.

Presented in this section are interventions that have complemented small retail businesses and helped establish new livelihood solutions and streams.



## DIGITAL SERVICES

Printing, scanning and photocopying facilities in under/un-electrified rural, urban, peri-urban areas.



Photocopier, Laptop, Printer, Scanner and Cameras



## COLD STORAGE

Cold storage facilities for petty stores, small restaurants to store drinks, dairy products, ice creams and other perishable products



Refrigerators

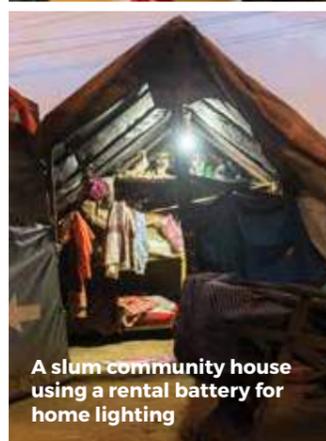


## MECHANICAL

Air refilling facilities replacing inefficient machines or as an additional service at the repair shops



Air Compressor



A slum community house using a rental battery for home lighting



## INTEGRATED ENERGY CENTERS

Integrated Energy Centers offer multiple services for the local community.



Mobile Charging, Light Charging, Water Purifier, and Health Checkup Equipment



Refrigerator used in a rural Indian Cafe

# 62. Refrigerators

## LACK OF ACCESS TO COLD STORAGE FACILITIES

For the local dairy farmers to sell their home-made dairy products (milk, butter, curd etc.) makes them travel longer distances.

## UNFULFILLED DEMAND FOR COLD PRODUCTS

Hotter and prolonged summers have necessitated a great demand for locally produced cold drinks and milk products in rural areas.

## TYOLOGIES OF SOLUTIONS



Mobile Solutions

These 'Fridges on the Move' have provided a great platform for entrepreneurs who own mobile food stalls. Entrepreneurs use it mounted on trucks and other vehicles and travel to places with high footfall.



Petty Shops

Rural and semi-urban micro entrepreneurs in the hot, arid regions have expanded their product range to locally produced cold drinks and milk products in their petty shops. Apart from drinks, it has been used to keep flowers fresh by the vendors next to a temple.



Cafes

The availability of freezer allows the entrepreneurs to add new products such as ice cream, fish and also preparation of ice cubes helped them attracting more customers. Other products include home-based milk items, dosa batter, sprouts etc.

Medium DC Refrigerator

Large DC Refrigerator

AC Refrigerator/Freezer

## TECHNICAL SOLUTIONS

Based on the requirements and constraints, different capacity fridges are implemented ranging from 100 Ltr to 240 Ltr. Using R135 as the refrigerant and with efficient DC compressors, these fridges work at a relatively low wattage, and by replacing high energy consuming refrigerators, on a day with an average temperature of 25 deg, they consume power as low as 0.1KWh per day.

**Design of the system needs to keep in mind the optimal temperature and the kind of stored goods. Efficient DC refrigerators can potentially result in reduction in energy consumption by 90%**

		Devidayal (100 L)	Devidayal (268 L)	Phocos (240 L) Light Usage	Phocos (240 L) Heavy Usage
<b>Energy System</b>	<b>SOLAR MODULE (Wp)</b>	200	750	300	500
	<b>BATTERY (Ah)</b>	2400	4800	1920	3600
	<b>CHARGE CONTROLLER</b>	20A 12V	40A 24V	Inbuilt Charge Controller	Inbuilt Charge Controller
<b>Motor</b>	<b>CAPACITY</b>	65W	155W	65W	65W
	<b>BACKUP HOURS</b>	24	24	24	24



## 63. Digital Services Printers & Photocopiers, Photo Studio

Digital Service provider for remote tribal communities in Odisha

### EXISTING DEMAND AND UNAVAILABILITY

Access to digital services is integral for financial institutes, government offices, identity documentations, schools and colleges, business transactions, record keeping etc. Without these basic digital services in rural, tribal and peri-urban areas, end users lose significant time and money to access or reach these services.

### INEFFICIENT DELIVERY OF SCHEMES

With government records and schemes getting dependent on digital records, energy divide leads to a digital divide. Inaccessibility to digital services in rural, tribal and peri urban areas is an obstacle delivering government social and financial inclusion schemes.

### LOW PRODUCTIVITY AND INCOME

Even if the facility exists, several times the extremely erratic power with varied voltage fluctuations has led to disruption in the entrepreneurs business (leading to breaking down of expensive equipment, inconsistent service provision and loss in income).

## FINANCIAL SOLUTIONS & IMPACT

Different financial solutions are implemented in tandem with cash flows. In the average case, a 60 month loan period has been found to be suitable at a rate of 12 % p.a

Increase in profit post intervention (INR)

**5000**  
Per Month

The following factors have played a big role in the success of the solar refrigerator implementations.

- Geographical Location**  
Small retail stores and hotels in hotter and drier regions have catered to higher demands.
- Supply Chain**  
Availability of fridge appliances via local vendors along with adequate after sales service.
- Finance**  
Availability of cash flow based financial products via local financial institutions increases the uptake and affordability vs upfront cash payments.
- Market Innovation**  
Creating better seating atmosphere in the small hotels, promoting local soft drinks, adding other types of products to be cooled.

**1280**

Per day  
Total no. of dairy units sold in one highlighted case

**INR 1030**

Per day  
Resultant turnover increment



## TYOLOGIES OF SOLUTIONS



Petty Shops/Home Based

#### USER GROUP

Petty shop owners, home based woman entrepreneurs

#### MARKET SOURCE

Emerged as an additional source of income when coupled with general groceries or stationary items.



Digital Centres

#### USER GROUP

Small entrepreneurs with separate infrastructure near office/academic establishments

#### MARKET SOURCE

Photocopying and printing as the main source of income. Additional services provided like internet downloads, computer training, photography.



Institutional

#### USER GROUP

Institutions, and establishments to meet internal documentation work

#### MARKET SOURCE

Shared service for in-house purposes. Generally paid for by internal mobilisation of funds via committees.

## TECHNICAL SOLUTIONS

The digital solution centre gives a comprehensive set of solutions from single photocopier machine to multiple systems to provide several digital services, all powered by solar energy. Depending on whether the service is housed in a petty shop, as an additional source of income or a full-fledged service, different combinations of technical solutions are provided.

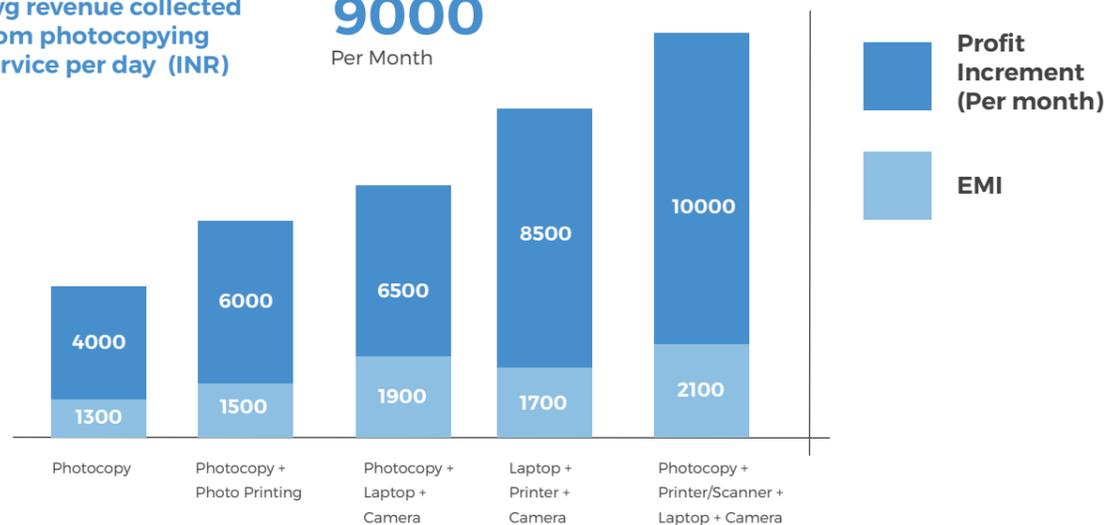
3 different technical solutions are designed depending on the scale of the digital service centre. This is packaged with computer and software training.

## FINANCIAL SOLUTION

Considering the exact requirement and cash flow that's generated through the digital services, different elements of financial linkage are designed. The direct correlation between the number of digital services and the increase in average profit dictates the EMI, and since most of the centres are situated close to the localities of school and offices, it is observed that the presence of different services compensates for the dip in the revenue generated through certain services during the holiday seasons, hence allowing the entrepreneurs to maintain the EMIs.

Avg revenue collected from photocopying service per day (INR)

9000  
Per Month



### PRINTING, PHOTOCOPYING WITH 5W LIGHT

SOLAR MODULE (Wp)	40
BATTERY (Ah)	360
CHARGE CONTROLLER	10A 12V
CAPACITY	15W

EMI AMOUNT (As per cash flow)	INR 1900
LOAN TENURE	4 Years
INTEREST RATE	10.3 %
MARGIN MONEY	20% of Total Cost

**Note** - The financial product above is an example for a specific service combo (Photocopy + Laptop + Camera). Refer to graph below:



## IMPACTS

### NEW SOURCE OF INCOME

Solar Digital Solution Centres owned by women entrepreneurs at households have helped them in adding to their earning potential and to some extent social standing within the society.

Percentage of users with the solution as a new income source **20-25%**

### LIVELIHOOD OPTION FOR PEOPLE WITH DISABILITIES (PWD)

As it has been seen in several cases, an unintended positive impact of the asset was that it was well accessible to differently abled individuals, so many have been provided with new livelihood options.

Percentage of PWDs with such systems **5%**

### ACCESS TO SERVICES

Presence and access to digital services have facilitated the remote communities to transcend the barriers that limited the access to and flow of information. Long durations spent in order to access the services have been reduced due to the centres, and have helped the rural and semi-urban daily wage dependent workers to save their half day to full day wages.

Amount of money at an average saved on travel per person accessing the service (INR) **200-300**

## 64. Air Compressors



A rural garage providing air filling services and tyre puncture repair

### INCREASE IN NUMBER OF VEHICLES

An increasing vast road network in the rural and semi urban areas necessitate opportunities for more servicing centers due to the suboptimal road conditions.

### DIESEL BASED AIR COMPRESSORS

Run by diesel power or inconsistent main grid, the current air compressors aren't easy to work with in the smaller service shops, and the powercuts result in everyday losses.

## TECHNICAL SOLUTION & IMPACT

	20L Air Compressor	90L Air Compressor
SOLAR MODULE (Wp)	300	500
BATTERY (Ah)	3120	5280
SPCU	1.5 kVA 24V	2.5 kVA 48V
TYPE	AC	AC
CAPACITY	0.5 HP	1 HP
BACKUP HOURS	1	1

- The expenses on electricity and diesel have become nil, so in the tenure period of 2-3 years depending on the financial circumstances, the air compressor will run without any cost. **The EMI is designed in such a way that it matches or less than the amount they spent pre-intervention.**

- It has been observed that the number of vehicles attended to has increased due to the reliability of solar air compressor as the prevalent powercuts in the rural regions haven't affected the work.

- Since the machine is less bulkier, many entrepreneurs could have the setup in smaller work platforms, especially in densely packed urban scenarios.

- The lighting and the power back up associated with the system have helped the entrepreneurs to extend their work hours post sunset, and other repair services are done under a better lighting conditions.

Increase in profit due to savings on diesel

**+40%**

An entrepreneur providing rental batteries to members of his labour housing colony



## 65. Integrated Energy Centres

### NEED FOR RENTAL SERVICES

- The temporary nature of slum/nomadic communities makes them incapable of accessing stable energy sources in their makeshift households.
- Financial institutions find it very hard to create financial linkages for each member of the community due to the lack of documents and ephemeral nature of their stay pattern.
- Considering the remoteness of certain tribal communities, providing individual systems becomes unfeasible, and servicing becomes a daunting challenge, hence systems aren't sustainable.
- With the community mindset that's been moulded by years of hardship, the awareness and priority towards energy access is very low.

	Energy Centres - Mobile Charging Station with 20 mobiles	Energy Centres - Mobile Charging Station with 30 mobiles
SOLAR MODULE (Wp)	120	200
BATTERY (Ah)	1440	1800
CHARGE CONTROLLER	15A 12V	20A 12V
TYPE	DC	DC
CAPACITY	100W	150W
BACKUP HOURS	3	3

## TYOLOGIES OF SOLUTIONS



Solar lights from the community members are charged in the IEC during the day, and the lamps are taken back in the evening. A nominal fee is charged (INR 10/day) to charge the battery.



Along with batteries for powering lights, mobile charging facilities are also provided at such centres, which saves both travel expenses and opportunity costs incurred.



Water purification systems run using capacitative de-ionisation technology. On the chosen days, the IEC is used as a community health clinic, and the doctors have a clean space to consult, store medicines and conduct awareness programs.

### URBAN SLUM

#### USER GROUP

Average family size of 5-10, around 100-200 households  
Land rented/given out by people; legality issues  
Uncertainty regarding their stay, so individual systems are not always possible. Unsafe environment especially in the nights, as the locations are next to dump yards, empty patch of lands.

#### SOLUTION

Entrepreneur Model: Individuals with already existing infrastructure in the vicinity is chosen as the entrepreneurs to run the IECs. Each user in the community gives in a refundable deposit to the entrepreneur that allows them to avail of the rental services at the centre. User monthly/daily rental for each battery pack with a light and a mobile charger.

### NOMADIC

#### USER GROUP

Nomadic communities skilled in a particular craft, moving from place to place, making/selling their crafts  
Lack of lighting and other energy sources hindering their work. Multiple livelihood solutions needed, as they need to move around with their created craftwork.

#### SOLUTION

Community owned: Due to the smaller size of communities, and very low level of income, they come together to pay a deposit to create an IEC. Shared responsibility, where no one person is to be paid, and is managed by the community itself. Provision to return the system when they move out  
Unique solutions such as light for carts are provided to support their activities.

### LABOURERS

#### USER GROUP

Slum communities formed by migrant labour families seeking for livelihood in construction, cleaning, carpentry, gardening and other areas in the urban localities. Mix of different geographical backgrounds but united through their skills, so families of smaller sizes  
Stay for relatively longer durations as availability of jobs in those fields are prevalent in the cities.

#### SOLUTION

Operator: An individual who's a part of the community is chosen as the operator, the IEC system is built around his/her existing small establishment  
The solar charge battery system is rented out to a community through the operator who provide similar services as entrepreneurs in exchange for a monthly wage. Their already existing relationship with the community helps in liaising.

### REMOTE RURAL

#### USER GROUP

Grid access isn't possible due to the remoteness of the region, and the communities are still in the process of integrating with the mainstream society. The remoteness results in the absence of basic facilities in the vicinity, so viable for different livelihood options.

#### SOLUTION

Operator / Entrepreneur model: Carefully chosen local individual helps IECs as entry point interventions as a way to build trust with the community through a co-designed central service Customizing to the tribal and village settlement need, different livelihoods from mobile charging to photocopy centre. The inaccessibility to the main grid makes the IEC as the main hub of different services.

## IMPACTS

### FINANCIAL IMPACT

Paying around INR. 450 (INR. 250 for Kerosene + INR. 200 for charging mobile phones) per month before the IEC intervention, the communities pay INR 200 - 300 post intervention towards a cleaner form of energy for their light as well as with the mobile charging port.

### IMPACT ON HEALTH AND SAFETY

One of the biggest problems that communities faced was a threat from snakes, rodents and scorpions- biting young children and infants in the dark. Access to light in the night, ensures a general feeling of safety against insects or animals as well as intruders, making them feel less vulnerable.

### ACCESS TO SERVICES AND GENERAL WELLBEING

The community has constantly expressed how wonderful it is to see light for the first time in their homes and especially for the artisan communities, they felt more productive and active even after sunset. Other solutions such as drinking water facilities, health & education centers at IECs have helped communities to access services and information that were beyond their reach before. IECs have also helped in bringing a general sense of belongingness as centers become a hub. Often, remote rural communities spend a large percentage of their wages in commuting to farther distances to access basic services, sometime spending around Rs. 300 just to get a Rs. 10 photocopy done. Services at IECs have made it more accessible.

## CASE STUDY

# Digital in Odisha

Entrepreneurs in Sunger, Badchatrang & Dumarpadar

The Kalahandi region in Orissa has several villages with no basic energy access. Apart from residences finding it difficult to manage daily chores, there is also a huge lack of infrastructure for basic activities such as printing, documentation, and other digital solutions that are critical to access information and facilities from the governmental organizations, banks etc. Even with the basic photocopying, printing, facilities that one of our entrepreneurs in Sunger village had, he had to spend around INR 1000 per month on travelling to purchase kerosene to run the generator. The other two entrepreneurs however, were struggling with finding sustainable income through daily wage labour work.

After a detailed need assessment, locations were chosen where the solar digital solution model would work best in i.e. locations that are easy to access and that are strategically placed close to panchayat buildings, schools, government offices, shops etc. Once the financial models were worked out for all the three through the loans from two major banks and marginal money support, along with the infrastructure support for the two of the new entrepreneurs, the systems were installed in the villages of Sunger, Badchatrang, and Dumarpadar of Kalahandi. To expedite the learning, they were sent to an existing Solar Digital Solutions entrepreneur to learn how to operate the printers, camera and solar equipment. Each of these centres cover a geographic area of 15- 20 KM. Being the only centres with these facilities, they have been operative all 7 days a week with increasing footfall of customers. Earlier, the community members used to spend Rs. 100 - 200 just for a couple of pictures



or a photocopy due to the inaccessibility to a nearby reliable service.

The first entrepreneur with an existing small shop has seen an increase of 100% in his income (earning around INR 15000 a month post intervention), and the other two entrepreneurs who were daily wage labours pre-intervention have been earning around INR 10,000 with a significant improvement from their earlier INR 1500 earnings. The EMI of around INR 1,500 to INR 2,000 has been decided considering their change in income. So, with the strategically implemented solar digital service centres, the entrepreneurs are not only happy about their earnings, but also express their sense of fulfilment as they are providing basic necessary services needed for the community.

## CASE STUDY

# Eeranna

Solar Refrigerator and IEC Entrepreneur

Indiganatha is located at the foothills of MM Hills, and has no access to grid electricity due to its presence deep inside the forest. All the hamlets at the MM Hills had no choice but to opt for decentralized energy. Indiganatha is also an important junction between Karnataka and Tamil Nadu, the neighbouring state, and also is the last village on this path towards a more interior and popular religious destination, so acts as a nodal point of access to communication networks, food and water. Eeranna, an entrepreneur who runs a shop at Indiganatha knew the market potential for cold fruit juice and drinks as the absence of it there was quite clear.

Mobile phones being prevalent in the area, a reliable charging point also had a great demand. So, considering the requirements, an Integrated Energy Center (IEC) was conceptualized in collaboration with Eeranna.

Financed by an MFI in which he was a member, Eeranna obtained a 2.5 year loan for INR 80,000 along with a margin money support. The



implementation, specifically the refrigerator delivered with a great success, resulted in him making over INR 60,000 in the first 6 months itself where he had also earned a good bit from charging INR 10 for mobile charging for his customers. After paying over half of the loan amount in the first year itself, he was able to finish the payment much before the tenure. The investment made in the IEC along with a solar powered TV and a mixer to make fruit juices resulted in the rise in footfall over the months and today, Eeranna has plans to invest in other solar appliances such as a wet grinder to assist his wife's preparation of Dosa/Idly batter.

Although the earnings ebb and rise depending on the season, overall, the implementation of IEC resulted in making a great impact on Eeranna's family.

## CASE STUDY

# Shridevi Melavanki

Handicapped computer trainer and entrepreneur

'Shri Guru Madivaleshwara Computer Tarabeti Kendra', the basic computer training and photocopy centre is housed in an old Panchayat building that was built in 'Gram Rozgar Plan' in Neginahal village. Shridevi Melavanki, runs the centre, and it has kept her busy since its inception around 6 months ago. But the situation was quite different pre-intervention. Shridevi, who along with her brother Praveen, are unfortunate to have been the victims of polio during their childhood when both of them lost their walking abilities. They had been searching for jobs for a very long time, but were never successful apart from a couple of part-time stints. Considering the basic computer training experience Shridevi had acquired in the past, a solar powered computer set up with a printer and a photocopying machine were conceptualized, and established with the support of Gram Panchayat, and other members of the village community.

Today, Praveen drops Shridevi to the computer center in the morning in his modified two-wheeler, and on a weekday, she would already have a few customers waiting with some documents to be photocopied. "There will be



around 150-200 pages to photocopy every day, and now I earn around INR 300 a day. We have constant power-cuts here, so when people cannot get their copies done in nearby shops, they come to my shop, so the number of people coming here is increasing even more", says Shridevi as she is serving a customer who had come with a few bank documents. Today, she is not only busy with printing and photocopying, but also using her experience in computers to conduct basic computer courses to a few village students. "In last few months since we started, I have trained 4 students, and currently there are 3 girls who come here to learn how to operate computer for basic applications", she charges around INR .900 for a three month course, and it's made their financial conditions even better. Today almost everyone in the village of Neginhal knows about Shridevi and Praveen. Their constant efforts after the intervention have not only helped them beat the odds in creating a decent livelihood for their family, but also have made them a source of inspiration for people with similar circumstances.



## CASE STUDY

# Thipperudrappa

Mobile Canteen Entrepreneur

Thipperudrappa is an entrepreneur who has converted his van into a mobile canteen that serves in the vicinities of National Highway 4 in the little town of Hiriyur, Karnataka. His experience with solar energy goes back to 8 years as he has reaped the benefits of it though solar lighting both in his house as well as the canteen. Having been served near the toll plaza on the highway for years, he knew he has a market access that's very unique and constant, as almost all the hours of the day there will be a long queue of vehicles waiting to cross the toll gate, and plenty of long distance truck drivers using the milieu as a resting place. With an almost year long prevalent heat in this region, and the sheer number of trucks that take a pit stop over there, there was an obvious demand for cold products. But being mobile, it wasn't easy to have a refrigerator for the entrepreneur.

A solar powered DC fridge with a 100 Ltr capacity was conceptualized, and implemented in his food van. The familiarity of the place and people around, coupled with the real demand - from the initial days itself, he started making around INR 400-500 per day. Starting his day as early as 4:00 AM, he is able to serve for more than 14 hours a day, and charging around extra INR 2 per product as the 'cooling charges', he is able to earn extra margin on the products as well. The total cost of INR 93,000 financed by the bank is being returned with an EMI of INR 3000 per month and within 3 years from the installation, the loan will be repaid. He earns approximately INR 15,000 per month from the products kept in the fridge through his efforts combined with neat marketing strategies.



## Conclusion

Through the ecosystem based approach-efficient technology, tailored financial models, ownership models, conducive policies, training programs and market linkages can be institutionalized.

**By 2020, SELCO Foundation would have developed over 100 effective sustainable energy driven energy efficient livelihood interventions,** and built the ecosystem for many of those to be scaled up and replicated across for poor populations in various geographies. Interventions need to be innovated at the individual level, community level, stakeholder level and at the state level to challenge the status quo, create enabling conditions that can create opportunities for the poorest and truly transform societies.

This document, captures the work done by SELCO Foundation to create a database of processes that can unlock innovations in technology, finance, market linkage and skill building. These processes when scaled via sharing of learnings, and approaches can result in a catalytic effect. Through the 65 specific livelihood interventions detailed out in the previous pages, the document makes an effort to bring about the viability of decentralized renewable energy for various productive applications, and introduces processes around technology, finance, market linkage and skill building- which can be taken up by respective players to unlock the livelihood ecosystems in their own geographies.

**The ecosystem based approach for livelihood interventions, transforms the technology and product centric approach into one that makes the user and the sustained impact at its core-providing for new avenues for partnerships, collaboration and cross learning.**