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LEISA INDIA

Renewable Energy in Agriculture

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Solar energy is moving farmers towards self-sufficiency and stable incomes.
(Photo: Sanjana B M)

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Dear Readers

As consciousness and awareness on use of green energy has been rising, we also do come across a lot of initiatives on the ground, either at individual level or community level. To share the ground level initiatives, we decided to present this issue focussing on "Renewable Energy".

The link between water-energy-agriculture is very strong. The problems with erratic electricity supply and subsidised or free power is very well known. While on one hand, crops do not get timely irrigation owing to erratic power supply, there is a concern of indiscriminate use of water owing to free power supply. Ofcourse, there are a plethora of environmental concerns, associated with conventional energy use.

Of all the renewable sources of energy in agriculture, solar energy use seem to be on the rising. Simple innovations and initiatives on the ground include solar pumps, solar drying unit etc., which make the routine farming tasks much easier. Also are included some initiatives on using biomass energy, on a limited scale. Biogas cook stoves though do not impact farming directly, they make lives more livable, especially for women. Other initiatives include solar photovoltaics, solar heaters, solar powered hydroponics systems etc. Solar photovoltaics in crop production is yet another concept, catching up extensively as the land for crop production need not be compromised.

Along with ground experiences, for wider awareness, we have also included a couple of articles which were interesting, but published elsewhere. Hope you will enjoy reading this issue and support our initiative on sharing knowledge on agroecology through this magazine. We have also introduced simpler payment methods for you to donate online. Please continue your exemplary support in future too.

The Editors

LEISA is about Low-External-Input and Sustainable Agriculture. It is about the technical and social options open to farmers who seek to improve productivity and income in an ecologically sound way. LEISA is about the optimal use of local resources and natural processes and, if necessary, the safe and efficient use of external inputs. It is about the empowerment of male and female farmers and the communities who seek to build their future on the bases of their own knowledge, skills, values, culture and institutions. LEISA is also about participatory methodologies to strengthen the capacity of farmers and other actors, to improve agriculture and adapt it to changing needs and conditions. LEISA seeks to combine indigenous and scientific knowledge and to influence policy formulation to create a conducive environment for its further development. LEISA is a concept, an approach and a political message.

MISEREOR founded in 1958 is the German Catholic Bishops' Organisation for Development Cooperation. For over 50 years MISEREOR has been committed to fighting poverty in Africa, Asia and Latin America. MISEREOR's support is available to any human being in need – regardless of their religion, ethnicity or gender. MISEREOR believes in supporting initiatives driven and owned by the poor and the disadvantaged. It prefers to work in partnership with its local partners. Together with the beneficiaries, the partners involved help shape local development processes and implement the projects. This is how MISEREOR, together with its partners, responds to constantly changing challenges. (www.misereor.de; www.misereor.org)

AME Foundation promotes sustainable livelihoods through combining indigenous knowledge and innovative technologies for Low-External-Input natural resource management. Towards this objective, AME Foundation works with small and marginal farmers in the Deccan Plateau region by generating farming alternatives, enriching the knowledge base, training, linking development agencies and sharing experience.

AMEF is working closely with interested groups of farmers in clusters of villages, to enable them to generate and adopt alternative farming practices. These locations with enhanced visibility are utilised as learning situations for practitioners and promoters of eco-farming systems, which includes NGOs and NGO networks. **www.amefound.org**

6 Renewable energy for self sufficiency

Levine Lawrence

Decentralized renewable energy (DRE) in India is not only moving farmers towards self-sufficiency but also providing solutions that can solve major environmental issues from the ground level. Included in this article are a few inspiring cases of affordable and sustainable energy options in rural areas.

10 Solar milk cooling in Bangladesh

Off-grid clean energy solutions for rural milk collection centres

REEEP

PRAN, one of Bangladesh' largest food processing companies, has in recent years set up a network of dairy hubs and village milk collection centres to help them source milk from small farmers and to provide those farmers with a steady source of income.

27 Empowering Rural India

The RE way

India has considerable experience and is home to several innovations and successful examples of providing energy access to the remotest areas of the country. Around 28 inspiring success stories from different parts of the country which are the living examples of the zeal to bring about a change, a determination to surpass the barriers, and an urge to adopt and promote renewable energy technologies to suit local requirements, have been compiled into a compendium titled 'Empowering rural India the RE way: inspiring success stories'. In this issue, we present two such inspiring stories of use of renewable energy in the farming sector.

32 Solar energy models for sustainable farming

Arunkumar Shivaray

Sufficient and timely availability of water is essential to irrigate crops during critical stages of crop growth. This shall ensure improved farm productivity and incomes. However, a critical prerequisite is a reliable energy-based system which enables timely extraction and distribution of water supply. Solar models have shown the way.

CONTENTS

Vol. 24 no. 4, December 2022

4 **Editorial**

6 **Renewable energy for self sufficiency**
Levine Lawrence

10 **Solar milk cooling in Bangladesh**
Off-grid clean energy solutions for rural milk collection centres
REEEP

13 **Scale up micro solar pumps to make farms 'diesel free' by 2024**
Shaikh Wase Khalid

16 **In the news**

19 **Making urban dairies more sustainable**
Pranav Kumar and Maninder Singh

21 **Economic empowerment of rural women**
Through small enterprises
Madhuri Revanwar

25 **New Books**

26 **Sources**

27 **Empowering Rural India**
The RE way

32 **Solar energy models for sustainable farming**
Arunkumar Shivaray

Renewable Energy in Agriculture

Ecological agriculture and Renewable Energy are based on the same fundamental principles – Living in communion with Nature recognising eco relationships; judicious use, reuse and recycling of resources while reducing harmful pollution; bringing down costs while improving access to healthy food, nutrition and incomes. If we put farmer at the centre, he/she is already facing umpteen challenges – unpredictable weather, rising farming costs, debt burdens and equally unreliable markets. Renewable energy sources can be a solution to deal with several problems - not only for farming communities but for humanity as a whole.

Energy is crucial to sustainable development and poverty reduction, and the lack of electricity is a major constraint to economic growth and increased welfare. Farmer's challenge in dealing with a reliable energy source required for farm operations, is often underestimated. Renewable energy sources can make an important contribution for farming household in terms of providing timely irrigation, small scale post harvest processes like threshing, crop drying, hulling or large-scale agro-processing activities. In the agriculture sector, direct demand for electricity is likely to continue to be driven by irrigation. The agricultural sector is the second largest consumer of diesel in India. Among 30 million conventional agricultural pumps in India, ten million run on diesel. Therefore, harnessing solar energy for irrigation is crucial to enable 'diesel free' farms (Wase Khalid, p.13).

India has considerable experience and is home to several innovations. In this issue, we present some of the inspiring experiences of individuals, entrepreneurs, non-governmental agencies, and development practitioners in providing access to clean energy to the poor in rural areas, especially farmers. The cases presented in this issue primarily cover experiences related to providing access to two sources of renewable energy—solar and bio-energy – to meet the energy needs in farming and off farming activities.

Innovations on the ground

Community Solar Irrigation Model (CSIM) was developed by Kalike Trust in Yadgir district in Karnataka. Apart from helping install solar pumps, the organisation focused on holistic development by promoting multi crop layering and improved soil and water conservation practices. Instead of limiting it to individual level, the programme aimed at fostering community ownership and benefit. Lead farmers (who installed the solar pump) provided water to fellow farmers for at least two crops in a year on a paid service basis to meet loan repayments. This has resulted in increased cropping area and better incomes (Arunkumar Shivray, p.32).

GERES developed an Improved Green House (IGH) for Ladakh farmers to protect crops from freezing. Farmers were incurring losses as crops died owing to freezing cold temperatures. With Ladakh having clear sunny days for almost 300 days in a year, GERES developed an IGH (improved greenhouse) to maximize the capture of solar energy during the day, minimize the heat loss at night, and thus prevent plants from dying due to freezing. A wide variety of vegetables are grown in the greenhouses, with people consuming more frequently fresh vegetables and sharing with 9 more families (p.27).

S4S, has worked with more than 1000 women in setting up solar dehydration unit. The procured vegetables are then given out to women agri entrepreneurs who convert fresh vegetables into dehydrated products. The dehydrated vegetables are graded, sorted and

marketed to wide range of customers. These initiatives, besides minimising harmful emissions, has improved livelihoods and has also created enterpreneurs (Levine Lawrence, p.6).

In Bangladesh, PRAN, one of Bangladesh' largest food processing companies has offered Off-grid clean energy solutions for rural milk collection centres. Through solar photovoltaics installations and solar water heaters at four centres, provides 95% of the electricity for these centres, besides cutting downtime to zero. The initiative improved income reliability for the dairy farmers producing milk for PRAN (REEEP, p.10).

A livestock farmer in Karnataka is producing sufficient fodder for his livestock by using a solar powered hydroponics system. Besides being based on a soil-less farming technique, requiring minimal amount of water, the unit makes it highly suitable for off-grid areas (Arunkumar Shivray, p.32).

Biomass is yet another source of energy that is being tried out to meet the growing energy needs. A project by BERI (Biomass Energy for Rural India) in Tumkur, Karnataka, focuses on bioenergy technologies to reduce GHG (greenhouse gas) emissions and promoting sustainable approaches to meet rural energy needs (p.27). The bioelectricity produced makes use of the biomass coming from tree plantations raised to support the biomass requirements of the power plants.

Cowdung is yet another resource which can be used for biogas generation. Urban diaries generate a lot of cowdung which when left unutilised could lead to enormous problems to the drainages and to the people living around. For example, in Jammu, the cowdung was utilised for biogas generation. Besides biogas, other products like non-synthetic paints and briquettes could also be prepared (Kumar and Singh, p.19).

Many benefits, some concerns

The inspiring cases in this issue while indicating innovative solutions also bring out certain lessons and some concerns.

With the kind of energy demands in India, solar powered systems would be a good and suitable alternative for helping farmers as a reliable energy source. Invariably, these technologies create tremendous savings in terms of reduced carbon footprint. For instance, by use of photovoltaics, the GHG emissions from the centres have been reduced to close to zero and PRAN saves an estimated USD 17,000 per year in electricity and diesel costs (REEEP, p.10). Greenhouses in Ladakh save about 460 tonnes of carbon emissions per year (p.27). On the other hand, while biomass could be a source of energy, there are several concerns about the use of biomass for biofuels, particularly at scale. Un-regulated production of biofuels threatens food security and damage to the environment and land may be diverted to non-food production purposes.

Renewable energy adoption invariably leads to gainful employment to locals and offer better livelihoods – as is the case with greenhouses, cooking stoves, and plethora of new village level committees and shared ownership. However, to have its impact on the environment and livelihoods, there is a need to upscale the renewable energy models. To upscale any innovation, the convergence and collaboration with diverse stakeholders is the key. A couple of experiences illustrate how diverse agencies like the community organisations, NGOs, Government, panchayat institutions, private entrepreneurs etc., together have achieved remarkable success on the ground. Networks like Clean Energy Access Network (CLEAN) is one shining example.

There is a need to be conscious about more inclusive development, while trying to promote renewable energy on a wider scale. For instance, thrust to promote micro solar pumps is necessary which are suitable for small holder farming majority enable 'diesel free' farms (Wase Khalid, p.13). Besides heavily subsidized high capacity pumps, both national and state schemes should include micro solar pumps in existing schemes and recommend pump sizes to farmers in line with their needs. Only then the dream of making agricultural sector diesel-free by 2024, as announced by the Ministry of Power, Government of India, could become a reality.

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Renewable energy for self sufficiency

Levine Lawrence

Decentralized renewable energy (DRE) in India is not only moving farmers towards self-sufficiency but also providing solutions that can solve major environmental issues from the ground level. Included in this article are a few inspiring cases of affordable and sustainable energy options in rural areas.

When we talk about Indian agriculture, a bleak picture comes to our mind – unpredictable weather, rising fertilizer costs, stagnant market prices, non-payment of dues, piling debt burden and eventually farmer suicides. While the great Indian farmer who provides all our essential foods constantly suffer from nature's vagaries someone else in the farm supply chain rakes in profits. Why cant we break the vicious cycle of high debt and low earnings and paint a greener future scenario for our farmers?

Fortunately, clean technology is lending a helping hand to break this vicious cycle and ensuring our farmers are self-reliant in their villages. Decentralized renewable energy (DRE) in India is not only moving farmers towards self-sufficiency but also providing solutions that can solve major environmental issues from the ground level.

The DRE concept makes energy affordable for beneficiaries and ensures sustainability for the years to come. Here are some case studies of a few innovative DRE companies that are enabling rural communities with appropriate clean technologies. These companies are members of a nationwide network named Clean Energy Access Network (CLEAN) to popularise and implement DRE.

Ginger is being dried using the Solar Induction Dryer

Preserve food at farmgate

It is a well known fact the 20-30% of food produced perishes at the farmgate before it reaches the end-user. Despite various government schemes focused on food wastage, things have not improved due to serious lack of infrastructure and investment. Decentralised renewable energy can offer solutions for food preservation and refrigeration during post-harvest, storage, transport and distribution.

S4S Technologies aims to convert farm losses to Food-Ingredients through farm-gate sourcing and processing

– *all done by Women Entrepreneurs*. S4S trains landless women and farmers, transforming them into Micro-Entrepreneurs by providing the right combination of - technology, finance, and the market. By mitigating food wastage and post harvest losses, S4S Technologies have already benefitted more than 1000 farmers across 6 countries with their sustainable technology driven by solar power minimising harmful emissions as well as improving livelihoods and creating enterpreneurs.

S4S reached out to 29 rural women in Vadala–Vadali in Jalgaon district of Maharashtra, with their flagship product – a solar conduction dryer. Solar Conduction Dryer (SCD) is a solar-powered food dehydrator that reduces moisture content in agro-produce preserving produces up to 1 year without using any chemicals and preservatives. SCD is the first solar dryer that uses all the modes of heat transfer together (conduction, convection and radiation) giving one of the best drying efficiency of 22%.

The women were trained on safety and hygiene, time management, food safety protocol and other standard operating procedures for onion and ginger dehydration. After getting educated about the food dehydration process, these women realised that there are immense opportunities in becoming micro-entrepreneurs. Taking a leap of faith, all thirty women joined forces with S4S. The case of Dhurpadaa Shevare is described in Box 1.

Box 1: Case of Dhurpadaa Shevare

Forty-five-year-old Dhurpadaa Shevare always craved for a fulfilling life. Born into a poor family in the remote village of Vadala–Vadali in Jalgaon district of Maharashtra meant that she'd have to brave challenges right from her childhood. The last time Dhurpadaa ever went to her school was when she was in Class 2. She was unable to pay for her schooling which compelled her parents to take her out of school. A few years later, Dhurpadaa became a bride. An early marriage led to an early motherhood and she bore four children, two sons and two daughters. In their best days, she and her husband toiled hard in the farms to provide for their children. Combined, they could only make a meager INR 3,000 per month if they had a good season (4 months in a year). Their children grew up fast. Soon they were married and moved out to start their own families. At a relatively young age of 45, Dhurpadaa was already a grandmother to a 17-year old boy. All these developments exhausted her physically and mentally. Just as her dream of a stable life was starting to drift away, she crossed paths with Science for Society (S4S). Gradually, as Dhurpadaa got a hang of things, she started drying a daily input of 45-90 kg of fresh raw material. This, in turn, led to an output of 10-12 kg dried ginger flakes per day. The training helped her to produce good quality output with improved potency for consumption. Most of all, it was financially rewarding. With her newly acquired skills, Dhurpadaa was now able to make INR 5,000 per month, something that had seemed beyond her reach her whole life. This opportunity gave Dhurpadaa and her husband renewed zeal to live an independent life together.

Biomass for clean cooking

Rural women struggle to get proper access to clean cooking fuel even today, despite decades of work done by voluntary NGOs and governmental agencies. Since biomass fuel resources are abundantly available across the country, there are a few cleantech startups and renewable energy enterprises that are working towards bringing self-sufficiency to remote rural regions through DRE.

A Bengaluru-based cleantech company named TIDE (Technology Informatics Design Endeavour) mainly implements projects related to biomass products and clean technologies in Karnataka, Tamil Nadu and Assam by collaborating with partner organizations to ensure wider dissemination among marginalized tribal communities in forest fringe areas. TIDE leverages appropriate clean technology for conserving the environment as well as creating livelihoods, and addressing societal issues. WWF India (World Wide Fund), through its Western Ghats Nilgiris Landscape division, partnered with TIDE to promote the

Improved cook stoves from TIDE have made kitchens smoke-free

Sarala improved cook-stove in remote villages inside Sathyamangalam Tiger Reserve (STR) in Erode district, Tamil Nadu. This partnership helped convert dark and smoky kitchens among households in forest fringes into clean and smoke-free ones by training locals in stove construction. The unique aspect here is that the households contribute to the construction process, by which local employment is also created through the stove construction training.

R Sekar, a former census enumerator, is one such beneficiary of this program. He got himself certified as an improved cook-stove installer by Skill Council for Green Jobs and has constructed more than 120 stoves in the Nilgiris region. In 2019, he witnessed a sea change in his fortunes after getting trained by TIDE in Sarala improved stove construction. The 36-year-old father is now proud of his newly acquired skill and says, *"I have been able to make monthly savings of INR 2,000, which I have invested in gold for my daughter's higher education"*. He has led the organization of clean cook stove building projects during the agricultural off-season when casual laborers don't find work on farms.

Sekar also trained many other stove builders, helping them improve their income, effectively. Today, there are 15 such certified stove-builders in Erode district, trained by TIDE in improved low-cost cook-stove construction. After getting trained, these skilled stove builders have constructed Sarala stoves in many small hamlets located on the Tamilnadu-Karnataka border. A stove builder can make about INR 300-500 per day, if they build 3-5 stoves a day. The end beneficiary of these improved cook-stoves is also happy that their kitchens are finally smoke-free and are no longer spending their time foraging for firewood in the forest.

R J A Steffan Ajay, Senior Program Officer in WWF-India, WGNL says, "This skill training partnership between TIDE and WWF-India has effectively reduced the consumption of forest firewood in STR region. More than 1000-plus Sarala stoves have been built during the last three years in this sparsely-populated forest belt. The pilot project of 1,000 stoves has prevented more than 1,440 tons of forest firewood from being consumed annually in the kitchens of the STR belt. Further, there is a large potential to scale up this activity as we have mapped out about 9,000 potential beneficiaries of the Sarala stove for the future". Going forward, TIDE would be training few more selected stove builders like Sekar in the STR region on the construction of institutional cook-stoves for dhabhas and hotels. This would not only increase their income but also create a business plan for DRE solutions such as commercial cook-stoves that have the potential to mitigate at least 2.5 metric tons of carbon dioxide per unit installation.

Future augurs well for both the community and wildlife of the STR belt as TIDE ensures there is a sustainable DRE solution for cooking that can conserve the forest area and improve the lives of tribal communities.

Box 2: Briquette making process

All kinds of agro-waste material is first shredded into tiny pieces. This mixture is then blended together with little water and cow dung to create a slurry. Once the slurry is ready, it is poured into the cylindrical cavity of the BLP machine and the lever is pressed to start the compression process. Then the compressed slurry is removed and dried in the sun and the briquette is ready.

Agro-waste to wealth

A vast majority of Indian farmers do not value the waste generated by their agricultural produce. Farmers tend to burn the crop residues of paddy, sugarcane and wheat after harvest, since removing the crop stubble and using it as fodder requires labor resources and time. This kind of burning not only wastes a valuable resource but also causes air pollution.

There are some innovative solutions to manage this kind of crop stubble burning. Various agricultural machines like Happy Seeder, Rotavator, Paddy Straw Chopper, manual briquetting machines have been developed so that farmers can manage crops and crop residue with ease. State governments provide subsidies on such crop machines so that farmers can afford these machines. The use of farming residues as biofuels for transportation or manufacturing can significantly reduce carbon emissions as well.

S K Engineers, Vapi-based company established in 2011 by a group of technocrats, has innovated a manual briquetting machine that can convert any agro-waste and prove to be a boon for rural India. During his company's work with NM Sadguru Foundation, Darshil Panchal, Managing Partner of S K Engineers, worked closely

Briquetting machine, is turning agri waste into briquettes, used as cooking fuel

among rural communities and observed the lack of a reliable source of cooking fuel. In search for a solution to this problem, Darshil came across boilers that used briquettes instead of coal.

Agricultural waste being generated in abundant quantities was procured from the rural communities by briquetting plant owners. They in turn make briquettes out of it and supply it to boiler plants. Understanding this, Darshil ideated on manufacturing a manual version of a briquetting machine to manage agricultural waste. Working closely with various NGOs and voluntary organizations, he came up with an appropriate solution for the effective management of various types of waste such as agro waste, fodder, kitchen waste, paper/plastic/cardboard waste, etc. Generally, plastic waste, multi-layered plastic packaging, paper waste, cardboard, farm waste etc., do not have much value since they are too bulky to transport easily. Understanding this problem, Darshil Panchal innovated a new type of manual baler machine that helps to effectively manage waste and transport them in an organized way.

This Manual Baler Machine can be easily transported since it has the provision of wheels. It is easy to operate and highly economical as there is no maintenance required for it. These machines are unique since they need no electricity and very less manual power and are easily installable and operable. With the Briquetting machine, the agri waste is turned into briquettes. These briquettes can be directly used at home as an alternative fuel for cooking or can also sold in the market at a price of INR7-10 per kg to earn extra income.

Already numerous NGOs and rural development organizations have bought these machines and are utilizing them for waste management and income generation.

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Solar milk cooling in Bangladesh

Off-grid clean energy solutions for rural milk collection centres

REEEP

PRAN, one of Bangladesh' largest food processing companies, has in recent years set up a network of dairy hubs and village milk collection centres to help them source milk from small farmers and to provide those farmers with a steady source of income.

An MCC in Goihatta, equipped with a solar installation and a solar water heater

Photo: Enerplus

Credit: Enerplus

Design for a fully containerised milk collection centre, including solar installation, solar water heaters and ice batteries

Almost all economic activities in rural areas in Bangladesh are affected by power cuts, and it has been estimated that they result in a loss of annual national industrial output of USD 1 billion. The Government of Bangladesh recognises the lack of reliable power as a major barrier to GDP growth, and intends to improve the power sector by encouraging the formation of public-private partnerships for the execution of power projects. This project demonstrates how businesses can get involved, and interest from other sectors has been high.

Enerplus, a small international engineering consultancy company specialized in delivering clean energy solutions, partnered with PRAN, one of Bangladesh's largest private food processing companies, to introduce renewable energy and energy efficiency measures in the early stages of PRAN's dairy production chain in remote areas of Bangladesh. The project focused on supporting the network of Dairy Hubs and village-level Milk Collection Centres (MCCs) which has allowed PRAN to replace milk powder imports with fresh milk sourced from small farmers in rural areas, and increase its daily production from 70,000 to 200,000 litres. As of 2018, this network has brought over 30,000 farmers into the formal dairy market and provided them with a steady source of income.

Dairy Hubs and MCCs use energy to cool milk and to heat water for cleaning. The centres are connected to the central grid, but power cuts necessitate the regular use of back-up diesel generators. These diesel generators produce noise and local pollution as well as considerable greenhouse gas (GHG) emissions, and are costly to run. PRAN's generators - like most units installed in remote areas – regularly face supply problems and when they run out of diesel, the milk in the collection centre goes to waste. In 2013-14, the region of Pabna, where most of PRAN's Dairy Hub network is located, experienced power failure more than eight hours every day on an average, mostly during peak hours when the cooling systems were needed. Diesel is not always available at all pump stations of the region and on occasions, has to be bought as far as 50 kilometres away.

PRAN and Enerplus plan to install clean energy technologies in all 103 currently operational Dairy Hubs and MCCs in PRAN's network, and include it in the design of a further 97 hubs and centres to be built. The pilot project supported by REEEP demonstrated the feasibility of this plan by installing solar photovoltaics installations and solar water heaters at four MCCs. Solar PV now provides 95% of the electricity for these centres, with the remaining 5% coming from the grid. As a result, the GHG emissions from the centres have been reduced to close to zero and PRAN saves an estimated USD 17,000 per year in electricity and diesel costs. The payback time for the installed systems is estimated to be around 8 years. The pilot installations were custom designed to match each collection centre's specific needs. Based on lessons learned, Enerplus has designed a standard solution which integrates the entire MCC and all its equipment into two shipping containers. This solution will be used for the full project, reducing payback time to just under 6 years. Enerplus also trained a PRAN team including two engineers to carry out energy audits of chilling systems and maintain and repair solar PV systems.

Since MCCs can only accept milk when their chillers are running and the highly reliable solar PV installations have cut downtime down to zero, the project has increased income reliability for the dairy farmers producing milk for PRAN. Furthermore, the use of solar PV to power Dairy Hubs and MCCs will allow PRAN to expand its milk collection network to areas that are still unconnected to the central electrical grid. This would

provide a reliable income to farmers in the remotest parts of Bangladesh. In addition, since the 15 kW -peak capacity of the Solar PV installation is only required for a short time each day to start the cooling equipment before the morning milk arrives, surplus electricity can be sold to neighbours through a mini-grid-like installation, and play an important role in expanding energy access. PRAN is currently testing one of its systems in a fully off-grid configuration.

Another significant achievement of this project is the planned joint investment by PRAN and Enerplus in a Special Purpose Vehicle (SPV), a subsidiary company which will undertake the roll-out of renewable energy solutions not only to the entire PRAN Dairy Hub and MCC network but also to other dairies in Bangladesh. In addition, the SPV will support PRAN in developing energy efficiency and renewable energy measures for other stages of its production chain, and will offer similar services to other businesses in the industry.

The SPV will formalise the long-term collaboration between the two partners, guaranteeing the continuation of the project beyond the pilot phase. In addition to its immediate climate change mitigation impact, this project has demonstrated that a collaboration between a small international consultancy and a large local business can lead to significant sustainability gains in the operations of that large business, as well as those of the wider sector. It has also demonstrated a successful mechanism for a small injection of public money to leverage significant private sector buy-in.

What have we learned?

- ENERPLUS kick-started the cooperation with PRAN by offering free advice on 'low-hanging fruit' energy efficiency interventions in PRAN production facilities – these led to 5% energy savings and convinced PRAN of the feasibility of the Dairy Hub project.
- The project had to find a balance between standardising technology options to utilise economies of scale and customizing solutions for each MCC. Though the pilot installed custom installations at each of the 4 MCCs, Enerplus has since developed a standard solution based on the pilot installations that can be deployed in the rest of the network.
- Under current regulations, it is difficult for a small company like Enerplus to transfer profits out of Bangladesh. This has caused delays in the founding of the SPV. PRAN and Enerplus have agreed on an interim solution to start the project before the SPV is fully finalised, though a permanent solution is yet to be found.
- On one hand, sourcing the technology for the installations was made more difficult by PRAN's strict procurement rules. On the one hand, foreign technology suppliers were unwilling to enter into long term service and maintenance contracts for assets deployed in Bangladesh. As a solution, the technology suppliers provided maintenance training to PRAN staff.

The delays the project ran into, some due to the volatile political situation in the country, some due to initial hiccups in the cooperation with PRAN and others due to unforeseen regulatory issues, could only be absorbed by Enerplus because of the grant provided by REEEP. However, the learnings generated can help de-risk similar collaborations between international consultancies and large businesses in the future, without the need for grant funding.

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This is an edited version of the original document, REEEP, ***Solar Milk Cooling in Bangladesh.*** *If you would like to learn more about this project, please contact info@reeep.org. or Mr. Hakim Zahar, Enerplus, at hakim.zahar@videotron.ca.*

Scale up micro solar pumps to make farms 'diesel free' by 2024

Shaikh Wase Khalid

Almost two-thirds of the marginal farmers who own agricultural pumps still rely on diesel/kerosene pumps.

Earlier this year, the Ministry of Power, Government of India, announced its ambitions to make the agricultural sector diesel-free by 2024, by switching to renewable energy (RE). The announcement is in line with India's commitment to achieving net zero by 2070. Additionally, it will also reduce India's import expenditure on crude oil, which nearly doubled in the fiscal year 2021-22 and stood at USD 119 billion.

After transportation, the agricultural sector is the second largest consumer of diesel in India. Among 30 million conventional agricultural pumps in India, ten million run on diesel. Therefore, harnessing solar energy for irrigation is crucial to enable 'diesel free' farms.

So far, the deployment of solar pumps have been limited, with only 380,000 units in operation. Moreover, most of the existing deployments are of higher capacity (2 horsepower (hp) and above). Interestingly, higher capacity pumps can effectively meet the irrigation needs of only 32 per cent of farmers who own land over one hectare. Whereas micro solar pumps, which are typically less than 1 hp in size, can meet the irrigation needs of 68 per cent of farmers who are marginal farmers and own land less than one hectare. But current schemes have not focused on micro solar pumps thus far.

A report by the Council on Energy, Environment and Water (CEEW) estimates that micro solar pumps offer a market opportunity of INR 48,000 crore to meet irrigation demand. An additional opportunity of INR 10,000 crore exists for animal husbandry application, where these pumps can help improve access to water for livestock.

Adoption of micro solar pumps by marginal farmers can have multiple benefits

Photo: CEEW

More than 9 million micro solar pumps could be deployed across India, impacting the lives of at least those many marginal farmers. However, realising this impact would require a focused effort along five key areas.

First, include micro solar pumps in schemes to generate interest. The exclusion of micro solar pumps from subsidy schemes creates an uneven playing field, where it competes against heavily subsidised (60–90 per cent subsidy) high-capacity pumps. As a result, most farmers, including marginal farmers, are tempted to purchase higher capacity pumps even if they do not need them. Hence, both national and state schemes should include micro solar pumps in existing schemes and recommend pump sizes to farmers in line with their needs.

Second, revise the approach to pump performance standards to encourage innovation. Currently, for the micro pumps category, the Ministry of New and Renewable Energy (MNRE) has given performance standards for 250 W, and 500 W pumps only. Instead of fixed size-based performance benchmarks, MNRE should consider performance benchmarks on a per Watt basis, allowing innovators to design pumps of various capacities that can receive government support.

Third, adopt output-based instead of input-based tendering. Prevailing tendering approaches for solar pumps are based on the input (hp) capacity of pumps rather than their output. For example, if a tender for micro solar pumps is limited to 500W pumps, a more efficient pump with lower capacity but with an output equivalent of 500W is not considered. Hence, national and state agencies should adopt a water output–based tendering approach to support more efficient solutions.

Fourth, support demonstrations to boost stakeholder confidence. A key reason for the sparse deployment of micro solar pumps has been a lack of awareness about their potential amongst the end-users, financiers, and state officials. The central ministry should work with State Nodal Agencies, State Rural Livelihood Missions, and other relevant departments to support 1,000 micro pumps in each high-priority district in the country.

Finally, improve access to end-user financing to enable deployment at scale. The PM KUSUM scheme, so far, has aided the adoption of solar pumps in India. However, there are around 100 million marginal holdings and providing solar pumps to all through subsidies is difficult. A majority of these pumps cost anywhere between INR 30,000 – 60,000. Access to finance is critical to enable the adoption of these pumps. By working with anchor organisations like National Bank for Agriculture and Rural Development (NABARD), MNRE should extend risk guarantees to financial institutions to unlock financing for micro solar pumps.

Further, institutions like NABARD can help build the capacity of the regional banks around the potential of micro solar pumps, thereby improving their confidence in the technology.

Call for articles

Millet farming systems

Vol. 25 no. 1 March 2023

Millets have been an integral part of Indian diets. Millet crops are climate resilient, capable of growing in dryland conditions with low water requirement. They are the source of food security for the small and marginal farmers residing in fragile conditions. Also, they are highly nutritious.

There is a growing interest in the revival of millet cultivation owing to its several benefits. Owing to the growing demand by the urban consumers, there have been several efforts to popularize it through higher production, processing, value addition, packaging and branding. Cuisines from millets have become a new trend. With the aim to create awareness and increase production & consumption of millets, United Nations, has declared 2023 the International Year Millets.

In the March 2023 issue of LEISA India, we would like to look at all these changing trends towards bringing back millets into our food systems. We would like to know how farmers growing different types of millets experience benefits to their livelihoods as well as well being. Are farmers food secure by shifting to millet farming? How are millets entering into food distribution systems as nutritious alternatives? What are the types of value addition initiatives being promoted? How are the millet markets, both domestic and international, evolving? What is the role of women in the entire production-value chain and what are the challenges being faced? How is the research and policy, creating enabling environment for promotion of millets?

Kindly send your articles to the Editors at leisaindia@yahoo.co.in before 31st January 2023.

Photo: CEEW

Access to finance is critical to enable the adoption of micro solar pumps.

To conclude, the adoption of micro solar pumps by marginal farmers can have multiple benefits: reducing irrigation costs, reducing harmful local and global emissions, enhancing cropping cycles, increasing farmers' net incomes and hence enhancing the resilience of the most vulnerable farmers.

However, challenges such as the absence of subsidies, inflexible performance standards and inefficient tendering processes hinder the large-scale adoption of micro solar pumps. Hence, a coordinated effort to support access to finance, targeted policy, awareness generation and technological innovation is required to enable the deployment of micro solar pumps at scale. This could help India achieve its ambitions of diesel free farms by 2024 and also contribute to the efforts around net zero by 2070.

Notes

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Note: This article was originally published in https://www.ceew.in/blogs/how-can-india-scale-solar-pump-irrigation-and-make-agriculture-sector-diesel-free-by-2024

Centre plans to add 16 Centres of Excellence in agriculture under Indo-Israel collaboration

India and Israel will collaborate to establish 16 centres of excellence (CoE) in agriculture under the ongoing Indo-Israel Agricultural Project. On completion, the total number of CoEs operating in India will increase to 45, and cover 21 states, an Israel Embassy official said.

The focus area for each centre will depend upon the local requirement and will be finalised by respective state governments. Israel's contribution to the project comes in the form of technical assistance, resource persons and training programmes offered in India and Israel. In a media interaction during a visit to the CoE for Vegetables in Gharaunda, Karnal, Haryana, Sudhir Kumar Yadav, Deputy Director (Horticulture), Haryana said the CoE Gharaunda has been established to demonstrate the protected cultivation technology of high-value vegetables.

According to the Ministry of External Affairs (MEA), 29 CoEs' are fully active in twelve states (Bihar, Gujarat, Haryana, Karnataka, Maharashtra, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, Mizoram, Andhra Pradesh and West Bengal). One of the recently set up CoEs for vegetables in Chandauli (Uttar Pradesh) plans seedling production of tomato, pepper, brinjal, chilli, cucumber, tomato, pepper, brinjal, chilli and exotic vegetables in the hi-tech climate-controlled greenhouse. This centre will demonstrate farming with fertigation and chemigation systems. Demonstrations of the installation of seepage, sprinkler irrigation and other plastic culture applications are also planned.

India and Israel signed a comprehensive work plan for cooperation in agriculture on May 10, 2006. The bilateral projects are implemented through MASHAV (Center for International Cooperation of Israel's Ministry of Foreign Affairs) and CINADCO (Centre for International Agricultural Development Cooperation of Israel's Ministry of Agriculture and Rural Development).

Agricultural cooperation between the two sides is formalized through three-year action plans. The two sides are currently implementing the fifth phase of the joint action plan (2021-23), MEA notes.

Source: https://www.fortuneindia.com/macro/centre-plans-to-add-16-centres-of-excellence-in-agriculture-under-indo-israel-collaboration/110557

Pilot study facilitating simultaneous solar power generation, crop cultivation underway in Telangana Agri varsity

Availability of land is becoming an issue in view of growing urbanisation and construction activity.

A unique pilot study on 'Agri Photovoltaic System,' which is simultaneous use of land for solar energy generation and agricultural crop production has been taken up at the Prof Jayashankar Telangana State Agricultural University (PJTSAU) here.

Availability of land is becoming an issue in view of growing urbanisation and construction activity, and the 'Agri Photovoltaic System' would ensure both solar power generation and also cultivation of crops, said Dr Avil Kumar Kodari, Director of Water Technology Centre at PJTSAU.

Agricultural land would be lost with the installation of conventional solar energy plants which shade the ground making cultivation of crops difficult. Coupled with this, the ever-increasing construction activity is resulting in reduced availability of land, he noted. The solution lies in the 'Agri Photovoltaic System' in which crops can be cultivated underneath the solar panels.

The system would yield two benefits – solar power generation and also crop cultivation. Crops like carrot, cabbage, cauliflower and broccoli have been selected

for the study. There is a possibility of crop failures in rain-fed cultivation due to frequent droughts and the solar energy generation would be an assured income to the farmers with the expansion of 'agri photovoltaic system' (under such drought conditions).

Observing that there could be a reduction in electricity generation from the solar panel if its temperature increases, he said cultivation of crops underneath the solar panel can have a cooling effect on the panel due to evapotranspiration (water lost from soil and plants). Because of evaporation and transpiration, the solar panels will get a cooling effect thereby improving the efficiency of solar panels, Kumar told PTI. In some cases, crop yield increases due to the shade of the solar panels, mitigating some of the stress on plants caused by high temperatures and ultraviolet rays (UV) damage. Water requirement would be less in the photovoltaic system as evapotranspiration will be reduced due to the shade to the crops.He also said "shade tolerant" crops (requiring less light) have to be grown underneath the panels.

Vegetable crops require less light compared to crops like maize, rice, cotton which need more light to get the yield. The pilot study, undertaken in association with a Bengaluru-based solar startup, would take a couple of years for completion before the technology reaches the farmers. It began a couple of days ago at the university.

Source: https://www.thehindu.com/sci-tech/science/pilot-study-facilitating-simultaneous-solar-power-generation-crop-cultivation-underway/article66160095.ece

New Holland Agriculture unveils 'world's first' LNG tractor

With its 270hp power, T7 Methane Power LNG tractor delivers the same power and torque as a diesel tractor while delivering autonomy without the need for any extra tanks

London: New Holland Agriculture, a global agricultural machinery brand of CNH Industrial unveiled the next step in its Clean Energy journey with the 'world's first' T7 Methane Power LNG (Liquefied Natural Gas) pre-production prototype tractor, the company said today.

New Holland Agriculture has long championed alternative fuels as the future of farming, establishing its Clean Energy Leader Strategy in 2006. Since then, the brand has accumulated vast experience and expertise in

this area, developing concepts, prototypes and ultimately the first ever commercialised natural gas tractor: the New Holland T6 Methane Power, CNH Industrial said.

T7 LNG tractor: the blend of autonomy, power, comfort and opportunity.

A farm's carbon footprint is a major factor in determining its sustainability. And farmers still need powerful tractors that can run around the clock. Natural gas, and especially biomethane, are presently the ideal solutions to guarantee higher horsepower machine performance, while also lowering emissions and reducing operating costs.

According to the company, the T7 Methane Power LNG tractor will more than double the autonomy compared to a CNG design whilst boosting overall farm sustainability. In comparison to the T6 Methane Power CNG, this is a fourfold increase in fuel capacity. LNG is also a key facilitator for the expansion of CNH Industrial's broader future natural gas portfolio, particularly towards larger and heavier agricultural equipment, as well as construction equipment.

The T7 Methane Power LNG pre-production prototype tractor offers unparalleled performance for an alternative fuel tractor. With its 270hp power, it delivers the same power and torque as a diesel tractor while delivering autonomy without the need for any extra tanks. It is also more sustainable, being better than carbon neutral when powered by Liquefied Biomethane sourced from livestock manure and slurry.

Source: https://agriculturepost.com/farm-inputs/farm-mechanisation/new-holland-agriculture-unveils-worlds-first-lng-tractor/

India promotes heat-resistant varieties of wheat to tackle adverse impact of heat waves

The Government of India aims to promote the use of heat-resistant varieties amongst farmers through public and private partnership and providing seed directly to the farmers

The wheat varieties DBW187 and DBW222 have been found superior over HD-3086 as far as heat tolerance is concerned. During the crop season 2021-22, the heat-resistant varieties of wheat namely DBW187 and DBW222 have shown tolerance with yield gain of 3.6 per cent and 5.4 per cent, respectively as compared to HD-3086, quoting AICRP on Wheat and Barley progress report, 2020-21 & 2021-22, Union Minister of Agriculture & Farmers Welfare, Narendra Singh Tomar said in a written reply in Rajya Sabha Friday.

The variety PBW 803 developed by the Punjab Agricultural University (PAU), Ludhiana is suitable for irrigated timely sown conditions and resistant to brown rust as well as moderately resistant to stripe rust. This variety is not recommended as heat-tolerant variety, the agriculture minister informed the upper house of the Indian parliament.

The Government aims to promote the use of heat-resistant varieties of wheat amongst the farmers through public and private partnership and providing seed directly to the farmers. To promote the use of these varieties, the ICAR-Indian Institute of Wheat and Barley Research (IIWBR), Karnal has signed 250 memorandums of agreement (MoAs) for DBW 187 and 191 MoAs for DBW 222 with private companies for seed production. The institute has distributed more than 2500 quintal seeds of DBW 187 and 1,250 quintal seeds of DBW 222 during the crop season, 2021-22, Tomar further said.

The ICAR-IIWBR Karnal has initiated a specific research project entitled "Breeding high-yielding wheat genotypes for stress conditions of warmer regions of India" on heat tolerant varieties. Besides, ICAR-IIWBR Karnal is also collaborating with International Maize and Wheat Improvement Centre (CIMMYT), Mexico on the development of climate-resilient wheat varieties, the minister added.

Source: https://agriculturepost.com/agri-research/india-promotes-heat-resistant-varieties-of-wheat-to-tackle-adverse-impact-of-heat-waves/

Making Urban dairies more sustainable

Pranav Kumar and Maninder Singh

Dependence of mankind on the non-renewable sources of energy such as coal, oil and gases is increasing worldwide. It is time to switch over to readily available, economical, and environment-friendly renewable source of energy like cattle dung, which is plentily available.

Jammu, the city of temples in India, is flooded with many small urban dairies. While these farms are very important for the local communities in procuring fresh milk, these dairies are also becoming a cause of concern. The cattle dung is being flushed into the colony's drainage system, overloading the already overloaded drainages in the area. This becomes inevitable owing to the lack of space for storing dung, even temporarily. There is a need to procure this wasted cattle dung and urine from urban dairies on payment basis and recycle them into various products.

Cattle dung can be recycled in many ways. It can be processed for bio-gas and then converted to compressed biogas (CBG) / compressed natural gas (CNG), which dairy/milk processing units may use for running their boiler plants, restaurants, running generators for electricity, lightening of streets and by other such industries on-demand basis. The remaining cattle dung and the huge quantity of slurry obtained from biogas plant can be used for making vermicompost, crematorium logs, eco–friendly lamps, paints, idols/murtis, flower pots, bio-fertilizer, cow dung cake etc. on a large scale basis which can be a commercially viable and sustainable business proposition. Moreover, collected urine can be distilled for making bio-pesticides, repellants, medicines etc.

Recycling cow dung has several benefits - enhances dairy farmers income; employment generation through green jobs; promotion of sustainable agriculture and livestock development, clean and green cities. According to an ILO study, the productive use of dung could support 2 million green and decent jobs in rural and peri-urban areas of India. The study also reports that the value of one kg of cow dung multiplies over ten times if used to its maximum uses.

Following are some of the products that could be developed from treating cattle dung.

Bio-Compressed Natural Gas (Bio-CNG) or Compressed Bio-Gas (CBG) is a clean and renewable energy source obtained from the wasted cow dung. Bio-CNG contains about 92-98 % methane and only 2-8 % carbon dioxide. The calorific value of Bio-CNG is about 52,000 kilojoules (kJ) per kg, which is 167 % higher than that of biogas.

Presently, there are seventeen Bio-CNG plants operational in India, with a combined capacity of 46,178 kg per day. The Bio-CNG plant located in Malur in Kolar District, Karnataka, has a production capacity of 1.6 tonnes of Bio-CNG per 40 tonnes of wet waste

Prakritik/Vedic paint: A steady source of additional income for cattle growers is being explored by the Khadi and Village Industries Commission (KVIC) with the innovative technology of 'Khadi Prakritik' paint made

out of cow dung. Prakrtik / Vedic paint developed from cow dung is also 'healthy product' as it is devoid of plastic or synthetic ingredients and free of heavy metals like lead, mercury, chromium, arsenic and cadmium. This will help in reducing the harmful effects of heavy metals present in commonly used synthetic paints.

Cow dung paint, is a potential income booster for farmers. The eco-friendly, non-toxic, odourless product with anti-fungal and anti-bacterial properties could enable a farmer to earn an additional Rs 30,000 from one cow annually. According to KVIC, with an estimated potential sales of Rs 6,000 crore of these paints in the next few years, farmers could expect to get Rs 1,000 crore by selling raw cow dung, which is now largely wasted.

Around 150-170 kg of dung is required to produce of 500 litres of Prakritik paint. To set up a plant of 500-litre per day capacity, an investment of Rs 20 lakh is required, which will be funded by government scheme for the MSME sector. Each such plant could provide direct employment to 11 people. Hence, Khadi Prakritik Paint has immense potential of creating sustainable development for the benefit of the poorest of the poor.

Vermicomposting

Owing to simple technology, many farmers are engaged in vermicomposting production as it invigorates soil health, soil productivity reduces the cost of cultivation. As a result, there is a gradual increase in demand for vermicompost due to the high level of nutrient contents. Though many progressive farmers in Jammu are preparing and selling vermicompost, there is no large-scale commercial manufacturing of vermicompost for a large landholding farmer who wishes to switch from conventional to organic/natural farming.

Cow dung logs are one more way of recycling cattle dung. As per one UN report, wood obtained by cutting around five crore trees is consumed every year in India to fuel the cremation. However, to date, there seems to be no large scale government plan to effectively substitute the usage of wood with products such as cow-dung logs. In Jammu, no electric crematorium is working, and all the crematoriums are using tree wood only. So, there is an excellent opportunity to replace the woods with cow dung logs.

Facts about cow dung

- As an estimate, a cow provides 3500 kg of cow dung, 2000 liters of cow urine, 4500 cubic feet of biogas, 100 tonnes of organic manure per year. The production of organic manure also increases by 20 to 30% in the crop.
- One kilogram of cow manure can produce 35–40 litres of biogas •when mixed with equal amount of water with hydraulic retention time (HRT) of 55–60 days maintained at an ambient temperature of24–26 °C (Kalia and Singh 2004).
- Cow dung generated from 3–5 cattle/day can run a simple 8–10 cubic metre biogas plant which can produce 1.5–2 cubic metre biogas per day which is sufficient for the family 6–8 persons, can cook a meal for 2 or 3 times or may light two lamps for three hours or run a refrigerator for all day and can also operate a 3-KW motor-generator for one hour (Werner et al. 1989).

Conclusion

Dung and urine-based entrepreneurial venture can be developed into a model training centre where interested entrepreneurs (tourists and devotees coming to Jammu) from all over India can come and learn all the dung and urine-based products manufacturing at a single place. In addition, this training centre may also engage in further research and development in dung and urine-based products.

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Economic empowerment of rural women

Through small enterprises

Madhuri Revanwar

Majority of the rural women are landless. Invariably, they work as farm labourers. Sanskriti Samvardhan Mandal, an NGO has helped women of Sagroli in Maharashtra in empowering them financially by providing the needed credit support in managing their enterprises.

Sagroli, located in Biloli, in Nanded district of Maharashtra, is quite a big village with 2046 households. As per the census 2011, the female population is 3796 of the total 8494. Average land holding is 1.24 Ha. The village depends on rain fed agriculture which keeps them occupied for two agro seasons while leaving them unemployed during other times.

Sanskriti Samvardhan Mandal (SSM) has been working in this area, untiringly in the fields of education, livelihoods, skill development, agriculture and natural resource management. It facilitated the formation of 500 women Self Help Groups (SHG). The Home Science Department of the Krishi Vigyan Kendra (KVK), run by SSM, imparts technical support to the SHGs in Health and Entrepreneurship. The KVK organizes need based training programs at regular intervals in garments, food processing, farm-produce processing and packaging, back-yard poultry, goatery, dairy etc. The duration of such training programs ranges from 1 day to 3 months.

Involving simple repayment mechanisms, SSM has extended interest free financial support to 5-10 village based small entrepreneurs every year, since 2015-16, to scale up their business. SSM helped them through financial support and marketing. This has resulted in 20-40% hike in the income of the entrepreneurs per year. This activity was further strengthened through a project, Embrace, supported by Drishti, Mumbai. The project main objectives are: to encourage rural women to start businesses to support their family; to give financial support to needy rural women/youth to start enterprises; to increase self-employment among rural youth; and to reduce financial burden of rural families.

The initiative

SSM supported 42 village based small-scale entrepreneurs through Savitribai Phule Mahila Vikas Mandal since October 2019. The micro entrepreneurs and aspirant women were supported with micro-finance with 3% interest per year as management cost. Role of the Mahila Mandal was to identify such entrepreneurs and do the necessary processing.

A total of 51 women and youth from village Sagroli and its vicinity applied for loan to the Mahila Mandal. The Mandal appointed a committee of three members

Table 1. Trades and Enterprises

Sr no.	Vocations/Trades	Number of enterprises	
		2019-20	2021
1	Garment	7	1
2	Retail	16	
3	Animal husbandry	10	
4	Craft and furniture	2	
5	Food processing		5
6	Fishery		1
Total		35	7

for selecting beneficiaries. During Oct 2019, the first batch of 15 beneficiaries were identified. Similarly, the second and the third batch with 20 and 7 beneficiaries, respectively, were identified. Thus, the benefits of the project Embrace were extended to 42 beneficiaries.

The beneficiaries, with a legal agreement, were selected on the basis of scope of business, their repayment capacity and overall background. The loan amount was directly deposited to the bank account of the beneficiaries.

All the beneficiaries were divided into different trades (See Table 1). This included garments (tailoring and garment business; retail (Kirana, General Store, Ladies-Emporium, Bangle Store etc.), Animal Husbandry (Goatery, Dairy and Fishery), handicrafts (Burud) & furniture and food processing (Dal mill, masala making unit, flour mill, oil extraction etc.). Around 35 women started their business in 2019-20 and 7 in 2021.

In the year 2019-20, 16 out of 35 belonged to retail entrepreneurship like kirana shop, barber, electrical shop, mobile shop, bangle store, general store etc., whereas ten beneficiaries belonged to animal husbandry sectors like dairy and poultry and others were from either garment sector (7) or crafts and furniture entrepreneurship (2).

In the year 2021, 5 of the 7 beneficiary entrepreneurs belonged to food processing sector. They started Dal-Mills, Flour-Mills, Masala Making Units, Food Packaging and Oil Extraction Unit whereas, one beneficiary started garment shop and another purchased fish nets for her existing fishery business.

Categories of loan amount: All enterprises were categorized under various ranges of loan amount. Under garment trade, most of the (14.28 percent) entrepreneurs were given loan in the range of Rs. 40001 – 70000/-. While only 7.14 percent entrepreneurs got loan in range of Rs. 20001 – 40000/-. Under retail trade, maximum i.e. 21.42 percent entrepreneurs got loan between Rs. 20001 to 40000/- while 9.52 percent were in the range of Rs. 40001 to 70000/- and only 4.76 percent were less than Rs. 20000/-. In animal husbandry trade, 19.04 percent entrepreneurs were benefited by Rs. 40001 to 70000/- and 7.14 percent were by Rs. Rs. 20001 to 40000/- . From food processing sector, 7.14 percent entrepreneurs were benefited by Rs. 40001 to 70000/- while 2.38 percent (1 beneficiary) got loan Rs. 20001 to 40000/- and only 2.38 percent (1 beneficiary) got loan Rs. >70001/-. From craft and furniture trade, of the two entrepreneurs, one entrepreneur (2.38 percent) got Rs. 20001 to 40000/- and another (2.38 percent) got Rs. 40001 to 70000/- as a loan amount.

It was observed that, 21 of the 35 entrepreneurs, got net profit ranging from Rs. 24000 to 180000 per year (average Rs. 47714.29) from their existing enterprises, while others being first time entrepreneurs did not get any income. After availing loan from project EMBRACE, all entrepreneurs started either new enterprise or expanded

Table 2. Percentage of EMBRACE entrepreneurs under various categories of loan amount

Sr no.	Vocations/ Trades	% of EMBRACE entrepreneurs benefited by loan (Rs.) (N = 42)			
		< 20000/-	20001 – 40000/-	40001 – 70000/-	>70000/-
1	Garment	0	7.14 (3)	14.28 (6)	0
2	Retail	4.76 (2)	21.42 (9)	9.52 (4)	0
3	Animal husbandry	0	7.14 (3)	19.04 (8)	0
4	Craft and furniture	0	2.38 (1)	2.38 (1)	0
5	Food processing	0	2.38 (1)	7.14 (3)	2.38 (1)

Mahadevi expanded her business after setting up a new shop, by availing loan.

their existing business and get average profit up to Rs. 88514.29 per year (range Rs. 24000 to 220000). However, average growth in income of all entrepreneurs was calculated to be around Rs. 40800.00.

Inspiring Cases

Mahadevi Sanjay Kotnod is a very active woman living in Sagroli with her husband and two-children. Her husband is working as peon in a school and has a low salary which was quite insufficient to bear their regular expenses. She made up her mind to join hands to support her family. She is very good at tailoring. She started stitching clothes in her locality. She received a good response. Later, she wanted to rent shop near the market for growing her business, but required one lakh rupees for investment. She could manage only 50000/- To make up the rest of the amount, she applied to the Sanskriti Samvardhan Mandal for the loan support through EMBRACE project. Now with tailoring, stitching and all general women toiletry, she is running her business very effectively. The name of her shop is "Gauri Ladies Emporium." Her husband helps her for purchasing shop material from Nanded and Nizamabad. Before setting this shop, she was earning on an average, Rs. 1000 per month. Now she is able to earn Rs. 6000/- profit per month. She has become confident and very happy now. She is investing her profit for purchasing more material. She has purchased a counter for the shop through this profit.

Pragati Textiles is a tailoring unit started in 2015. A group of four women named Mrs. Shanta Harale, Sushama Muttepod, Sunita Kolnure and Mosina Korbo started this unit after getting trained by Krishi Vigyan Kendra on different types of bag making. The women started stitching uniforms, different types of bags, kitchen aprons, saree petticoat, sun coats and drudgery reducing cotton picking apron, soybean harvesting mittens for farm women etc. In addition to these cloth articles, these women wanted to keep some women's daily need items in their shop. But due to lack of space in shop they could not start it. When financial support of Rs. 50000/- was given by DRISHTI under project EMBRACE, these women started their new shop on rental basis in December 2019. They purchased daily need items for women and girls. They purchased more material for making different types of bags. Previously they were earning 150000/- per year, specially by stitching uniforms. Now they are selling material worth Rs. 1000/- on an average, per day. Pragati Textile unit also trained other women. Unfortunately, due to COVID 19 imposed lockdown, they suffered losses.

Further in July 2020, considering the results of soybean hand mittens and cotton-picking coats for

Women of Pragathi Textile Unit benefitted from KVK training and credit assistance received

Training session in progress

villages on stitching cotton coat and mittens. With leadership of Pragati women, all women worked hard and completed the order within one month. The rate of cotton-picking coat was Rs. 270 while soybean hand mittens pair was priced at Rs. 170. Stitching charges for cotton coat was Rs. 80 per piece and Rs. 50 per pair of mittens. In this way, this group of 54 women who stitched these coats and mittens got a total amount of Rs. 250000/- as stitching charges. Pragati textile group got Rs. 150000/-. They are very happy and want to improve their work in future also.

drudgery reduction of farm women, a Project on Climate Resilience in Agriculture, running under State Agriculture Department (In Marathwada and Vidarbha Zone) gave an order for stitching 1563 cotton-picking coats and 1606 pairs of soybean hand mittens to Krishi Vigyan Kendra, Sagroli. KVK trained Pragati textile members and 50 needy women from Sagroli and nearby

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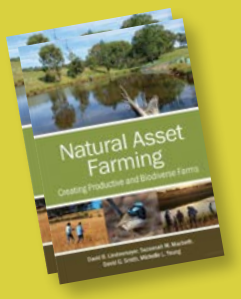
NEW BOOKS

Indian Agriculture towards 2030 Pathways for Enhancing Farmers' Income, Nutritional Security and Sustainable Food and Farm Systems

Pramod Joshi, Ramesh Chand, Shyam Khadka, 2022, Springer Nature Singapore, 311 pages, ISBN 9789811907630

This open access book brings together varying perspectives for transformational change needed in India's agriculture and allied sectors. Stressing the need of thinking for a post-Green Revolution future, the book promotes approaching this change through eight broad areas, indicating the policy shifts needed to meet the challenges for the coming decade (2021-2030). The book comprises of ten contributions. Apart from the overview chapter on transformational change and the concluding chapter on pathways for 2030, there are eight thematic chapters on topics such as transforming Indian agriculture, dietary diversity for nutritive and safe food; climate crisis and risk management; water in agriculture; pests, pandemics, preparedness and biosecurity natural farming; agroecology and biodiverse futures; science, technology and innovation in agriculture; and structural reforms and governance.



Natural Asset Farming: Creating Productive and Biodiverse Farms

David B. Lindenmayer, Suzannah M. Macbeth, David G. Smith, Michelle L. Young, 2022, Csiro publishing, 204 pages, ISBN:9781486314843

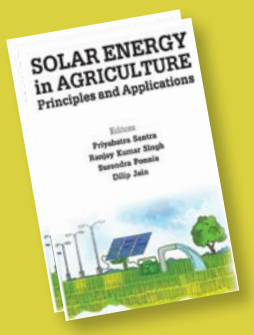
Farm dams, creeklines, vegetation and rocky outcrops are natural assets that are essential for healthy, sustainable farms. Protecting and enhancing these elements of natural capital on farms not only supports biodiversity, but also contributes to farm productivity and to the well-being of farmers and farming communities. Natural Asset Farming. Creating Productive and Biodiverse Farms reveals seven key natural assets and why they are so valuable for biodiversity and productivity on farms. Drawing on two decades of long-term ecological monitoring and knowledge exchange with farmers, Landcare groups and natural resource management experts, this book is a tool for building and enhancing natural assets in agricultural landscapes. In bringing together ecological science and the experience of farmers in the wheat–sheep belt of south-eastern Australia, Natural Asset Farming will help foster ideas, boost resilience and improve the sustainability of agricultural production.

New Generation of Organic Fertilizers

Ertan Yildirim, Metin Turan, 2022, IntechOpen, 174 pages, ISBN: 9781839692123

This book provides a comprehensive overview of organic fertilizers and their importance in sustainable agriculture, biodiversity, and the environment. It presents new approaches, ideas, and trends on how to increase the effectiveness of chemical fertilizers as well as the resistance of plants against biotic and abiotic stress conditions. Chapters address such topics as the benefits of organic fertilizers over their chemical counterparts, vermicomposting, organic farming, insects in organic fertilizer production, and much more.

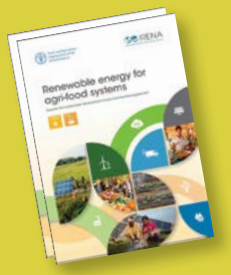
SOURCES



Solar Energy in Agriculture Principles and Applications

Kumar Ranjay Singh, Priyabrata Santra, Surendra Poonia, 2019, NIPA, 288 pages, ISBN 9789387973848

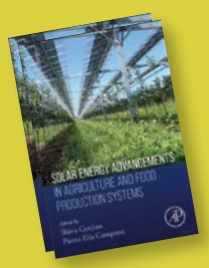
The book focuses on all the possible options of solar energy use and generation in Agriculture sector. The book covers basic fundamentals of solar energy resources and technologies are discussed in detail. Overall, the book contains 23 chapters. Out of these, first two chapters focus on solar energy use pattern in agriculture sector in India at present time along with future scopes. The next eight chapters (Chapter No. 3-10) give a basic knowledge on fundamental principles of solar photovoltaic and thermal technologies. Last 13 chapters (Chapter No. 11-23) presents the applications of solar thermal and photovoltaic technology in different farm operations and postharvest processing in agriculture sector. The book will cater the needs for students, researchers, various stakeholders, entrepreneurs etc by providing valuable information on solar energy and its applications specifically focusing on agriculture.



Renewable energy for agri-food systems

International Renewable Energy Agency, Food and Agriculture Organization of the United Nations, 2021, Food & Agriculture Org., 89 pages, ISBN 9789251352359

In 2021, the United Nations Secretary-General will convene the Food Systems Summit to advance dialogue and action towards transforming the way the world produces, consumes and thinks about food guided by the overarching vision of a fairer, more sustainable world. The Secretary-General will also convene the High-Level Dialogue on Energy (HLDE) to promote the implementation of the energy-related goals and targets of the 2030 Agenda for Sustainable Development. Given the inextricable linkages between the energy and agriculture sectors, integrating the nexus perspective within the FSS and the HLDE is crucial to formulate a joint vision of actions to advance the 2030 Agenda for Sustainable Development and the Paris Agreement. In this context, IRENA and FAO have decided to jointly develop a report on the role of renewable energy used in food chain to advance energy and food security as well as climate action towards the achievement of Sustainable Development Goals and the Paris Agreement. While energy has a key enabling role in food system transformation and innovation in agriculture, its current use is unsustainable because of the high dependence on fossil fuels and frequent access to energy in developing countries. The challenge is to disconnect fossil fuel use from food system transformation without hampering food security. The use of renewable energy in food systems offers vast opportunities to address this challenge and help food systems meet their energy needs while advancing rural development while contributing to rural development and climate action.



Solar Energy Advancements in Agriculture and Food Production Systems

Pietro Elia Campana, Shiva Gorjian, 2022, Elsevier Science, 496 pages, ISBN 9780323886253

Solar Energy Advancements in Agriculture and Food Production Systems aims to assist society and agricultural communities in different regions and scales to improve their productivity and sustainability. Solar energy, with its rapidly growing technologies and nascent market, has shown promise for integration into a variety of agricultural activities, providing an alternative, sustainable solution to current practices. To meet the future demands of modern sustainable agriculture, this book addresses the major existing problems by providing innovative, effective, and sustainable solutions using environment-friendly, advanced, energy-efficient, and cost-optimized solar energy technologies. This comprehensive book is intended to serve as a practical guide for scientists, engineers, policymakers, and stakeholders involved in agriculture and related primary industries, as well as sustainable energy development, and climate change mitigation projects. By including globally implemented solar-based agriculture projects in each chapter and highlighting the key associated challenges and benefits, it aims to bridge the knowledge gap between the market/ real-world applications and research in the field.

Empowering rural India

The RE way

India has considerable experience and is home to several innovations and successful examples of providing energy access to the remotest areas of the country. Around 28 inspiring success stories from different parts of the country which are the living examples of the zeal to bring about a change, a determination to surpass the barriers, and an urge to adopt and promote renewable energy technologies to suit local requirements, have been compiled into a compendium titled 'Empowering rural India the RE way: inspiring success stories'. In this issue, we present two such inspiring stories of use of renewable energy in the farming sector.

Case 1

Fresh vegetables in Ladakh

Situated at an altitude of more than 3500 m above sea level, the Ladakh district of Jammu and Kashmir is one of the famous cold deserts of the world characterized by cold breeze and blazing sun. Ladakh receives very low rainfall. In winters, the temperature can be as low as –25 ºC. The climate makes it difficult to grow fresh vegetables and other crops in the open for almost nine months in a year as plants die because of freezing cold. Airlifting the vegetables from the plains in winter and bringing them by road in summer is a normal practice for the people living in Ladakh, making these fresh vegetables expensive and their availability limited. Most of the locals rarely get to eat fresh vegetables and hence, many suffer from malnutrition. Being a rainshadow area means the sky is mainly devoid of clouds. Ladakh experiences clear sunny days for almost 300 days in a year. Exploiting this sunny climate of Ladakh, GERES (Groupe Energies Renouvelables, Environment et Solidarités) started developing improved passive solar greenhouses to grow fresh vegetables and other crops indoors even during the winter season. For the last 10 years, GERES is working in this area in collaboration with LEHO (Ladakh Environmental Health Organization), LEDEG (Ladakh Ecological Development Group), the Leh Nutrition Project, and STAG (SKARCHEN and SPITI Trans-Himalayan Action Group/Ecosphere).

GERES developed an IGH (improved greenhouse) to maximize the capture of solar energy during the day, minimize the heat loss at night, and thus prevent

Woman in her green house

Photo: GERES

plants from dying due to freezing. The greenhouses are designed in such a way that they are sufficiently heated using only solar energy and do not require any empowering rural India supplementary heating. Some of the salient features of the improved greenhouses are as follows.

- The greenhouse is oriented along an east–west axis with a long south-facing side.
- This long south side has a transparent cover made of heavy duty polythene with an extra stabilizer to withstand the intense UV rays present in the sunlight. The polythene is built to last for a period of more than five years. A double layer of polythene is used in severely cold places.
- The north, east, and west side walls of the greenhouse are constructed using mud bricks in low and medium snow fall areas and with stone or rock in heavy snow fall areas to enable the green house to absorb maximum heat from the sun during the day and release the stored heat at night to maintain a temperature suitable for healthy growth of plants inside the greenhouse.
- The walls on the north, east, and west sides are constructed as cavity walls to help in minimizing heat loss from the greenhouse. The 100-mm cavity in these walls is filled with insulating material such as sawdust or straw. The roof is slanted at an angle of 35º to allow maximum direct sunlight during the winter season. At night, the roof is covered with thatch and the polythene on the south side is covered with a cloth or tarpaulin to prevent heat loss.
- Vents are provided on the walls and on the roof to avoid excess humidity and heat and also to allow controlled natural ventilation.
- The inner side of the north- and west-facing walls are painted black to improve heat absorption and the east-facing wall is painted white to reflect the morning sunlight on to the crops. There is a door in the wall at one end.

Except the polythene used for covering the south side, the entire greenhouse is constructed using locally available material. The main frame of the roof is made using local poplar wood, willows are used for struts, and straw or water-resistant local grass is used for the thatch. Rock, stone, mud bricks or rammed earth are used in the construction of walls. The polythene sheet has to be procured from places like Mumbai. Local masons were employed to construct the greenhouse by providing them with special training wherever required. The greenhouse comes in two sizes. A smaller greenhouse with 4.5 m breadth and 9.7 m length for domestic use and a bigger greenhouse with 4.8 m breadth and 27.3 m length for commercial use. The construction cost of a domestic use IGH is approximately Rs 30,000. The owner of the domestic IGH has to either pay or collect all the locally available material like wood for the roof frame, straw for thatch, mud bricks, and the material used for insulation. He has to provide the labour or pay for the labour required for and provides the doors, vents, and the special UV stabilized polythene, which comes to about 25% of the total cost. Some subsidy is given for domestic IGH.

Construction of the greenhouses is timed in such a way that it matches the agricultural cycle of Ladakh.

GERES monitors the IGH construction by providing the methodology and design. LEHO and other local NGOs coordinate in selecting the prospective owners, training them on greenhouse maintenance and operation, and providing other support needed for constructing the greenhouse to local owners.

Local NGOs have set up certain criteria to select the prospective owners of a domestic IGH.

- Families should belong to the BPL (below the poverty line) category.
- They should have a site suitable for greenhouse construction.
- The family must be keen to use the greenhouse successfully and also willing to share the products with the community at large.

A wide variety of vegetables including spinach, coriander, garlic, radish, onions, lettuce, and strawberries are grown in winter. Tomatoes, cucumbers, and grapes are grown in autumn and in spring seedlings are grown in the greenhouses. Some families have even started growing flower plants and potted plants.

Improved greenhouses have benefited the people of Ladakh, especially in terms of health. Prior to introduction of IGH, during winter people used to consume fresh vegetables only once or twice in a month. However, since the time IGHs were introduced, the consumption has increased to two to three times in a week. On an average one IGH owner provides fresh vegetables to nine other families and barters with six

Photo: GERES

Solar Greenhouse in Ladakh, India. Designed to trap and store the sun's heat to grow food during the winter

other families, resulting in an improvement in their health. On an average, the villagers are able to save Rs 500 to Rs 1000 on vegetable purchases as locally grown fresh vegetables cost less when compared to imported vegetables.

Production of fresh vegetables locally reduces dependency on imports from plains, thus saving the expenditure on transportation. According to some estimates of GERES, the 560 greenhouses presently in operation are able to save about 460 tonnes of carbon emissions per year.

The IGH has also brought employment opportunities to locals. About 220 masons and 15 carpenters have received training and got livelihood through constructing greenhouses.

The IGHs have increased income generation for their owners, as now they can earn additional income by selling vegetables and seedlings for cash. Surveys conducted have revealed that on an average an IGH owner earns Rs 8250 per year by selling their excess produce providing a 30% increase in their income levels.

The scale-up potential for IGHs in the high-altitude Himalayan states is very large. In Ladakh, alone the potential demand for IGH to produce fresh vegetables for civilian consumption is about 3000 units. It may double up to 6000 units, if military requirement for fresh vegetables is included. At present, replacement of UV-resistant polythene sheet every five years and also lack of awareness among agricultural/horticulture departments at the state level is proving to be a barrier in the promotion of IGHs. The solar passive concepts of south-facing glazings, high thermal mass, and insulation can also be used in other constructions like individual houses, public buildings, schools, hospitals, and government offices.

Biomass gasification system

Case 2

Providing biomass energy for rural India

The story from Karnataka villages

The BERI (Biomass Energy for Rural India) project is conceptualized at developing and implementing a bioenergy technology package to reduce GHG (greenhouse gas) emissions and to promote sustainable and participatory approach in meeting rural energy needs. The total budget for the initiative is $8,623,000 and the project proponents include the GoK (Government of Karnataka); Gram Panchayat people's representatives, private investors, and people residing in the targeted project villages; UNDP (United Nations Development

Programme) funded by the GEF (Global Environment Facility); and co-financed by the ICEF (India-Canada Environment Facility); GoK; MNRE (Ministry of New and Renewable Energy), GoI (Government of India); and beneficiaries.

The project is being implemented since 2001 in five village clusters consisting of 28 villages in Tumkur district of Karnataka. The project has been designed to showcase bioenergy technologies that include bioelectricity produced from biomass gasification, community biogas plants, and efficient cookstoves. It was designed in such a way that the bioelectricity produced makes use of the biomass coming from energy plantations raised for the purpose.

Energy plantation, biomass gasifier plants, and evacuation of power

It was estimated that to run a 1000-kW biomass gasifier plant, approximately 3000 ha of land and a biomass yield estimated at 12,000 tonnes per year (4.2 tonnes per hectare per year) were required. Tree plantations were raised in 2930 ha (1983 ha of forest land and 947 ha of treebased farming) to support the biomass requirements of the power plants. It has supported the livelihoods of over 240 women in 81 SHGs (self-help groups) who raised about one million seedlings. Thirty households have been employed for tree-based farming.

Gasifier-based plants were established in three clusters. A 500-kW capacity system was installed in Kabbigere (including two gasifier systems of 100 kW each and one of 200 kW using 100% producer gas and another with 100 kW dual fuel). These plants together have generated 1,520,000 kWh of electricity as of June 2012. In addition, two more gasifier-based power plants of 250-kW capacity each have been installed in Seebanayanapalya and Borigunte. The power generated is evacuated to the BESCOM (Bangalore Electricity Supply Company) grid. Generation and distribution are synchronized to the grid through a dedicated 11-kV transmission line. The BERI Society and Tovinakere Grama Panchayat have signed a first-of-its-kind PPA (power purchase agreement) with BESCOM to sell the power produced to the state power utility. The tariff set was Rs 2.85/kWh.

Operations of the gasifier power plant

Biomass is raised on the plantation. The VFCs (village forest committees) are involved in managing the plantation. The VBEMC (Village Biomass Energy Management Committee) and panchayat together are involved in taking decisions in biomass procurement and gasifier plant management. The power generated is metered and evacuated to the grid. A diagrammatic representation of these linkages is shown in figure 1.

Table 1: NGOs involved in the project

S.No	NGO	Cluster
1	BIRD-K	Koratagere (5 villages)
2	BIRD-K	Madhugiri (5 villages)
3	MOTHER	Gubbi (7 villages)
4	IYD	Tumkur (5 villages)
5	SRIJAN	Sira (6 villages)

Engagement with the local community

Four NGOs (non-governmental organizations) were identified to work with the communities to create awareness on energy issues and promote the project. They are BIRD-K, Mother, IYD, and Srijan (Table 1). The activities included provision of borewells, laying of drip irrigation systems, and construction of community biogas plants and improved cookstoves for village households.

Community borewells, biogas plants, and improved cookstoves

Fifty-six borewells were dug benefiting 127 households. The borewell water is shared among three to four neighbouring families. These borewells are connected with drip irrigation systems that ensure saving water and have reduced the energy required for pumping it from a depth of over 300 feet. The project has leveraged other schemes of the government, such as RLMS (Rural Load Management Scheme) that has ensured better quality of power for longer durations, to benefit the villagers.

Other initiatives have been construction of 51 small community biogas plants estimated to have generated more than 95,000 m3 of biogas. Provision of improved cookstoves in households has helped reduce the fuel consumption and indoor air pollution.

Community irrigation programme

The creation of WUAs (water users associations) is one of the most critical initiatives of this project. The project

area is primarily rainfed and farmers in the project area mostly grew rain-fed crops like ragi and jowar. As an entry point activity, and a long-term strategy, the establishment of community irrigation systems was facilitated. The borewells were dug in the project village and the plan was that they would be ultimately run through biomass-based electricity produced under the project. The main purpose of this programme was to augment existing livelihoods, generate income, improve the socio-economic condition of poor farmers, and cultivate the habit of paying fee for service. Most importantly, these activities brought in and put in place platforms for discussions, discipline, awareness, and rules and norms, which bound the larger community. These served a larger purpose of community ownership and the spirit of working together.

Project impacts on the community, its scalability

Under the project, a 1-MW biomass gasifier power plant has been installed in three villages in Koratagere taluk. These systems together have generated approximately 1.5 million units of electricity by 30 June 2012 contributing to a reduction of 1200 tCO2.

An analysis during the last year showed that the cost of power generated is in the range of Rs 4.50 to Rs 8.28 per kWh depending on the PLF (plant load factor), quality and cost of biomass, optimization in operation, and so on. The revenue generated by selling it to the grid was only Rs 2.85 per kWh (tariff support by the government). Hence, the tariff support needs to be addressed to encourage small scale power production. The small-scale power production has significant intangible benefits such as green cover, increase in rural economy, and employment. The energy plantation in 3000 ha was expected to yield 12,000 tonnes annually. However, it is yielding only about 5000 tonnes per year.

One of the estimates indicates that these plantations have resulted in sequestering approximately 26,580 tCO2 annually. Fifty-one group biogas plants were installed and according to a survey carried out in 2010, 40 of them were functional. These reduce 148 tCO2 annually. The project details and technical performance data are uploaded on the website, which is perhaps the only project uploading basic data (www.bioenergyindia.in).

The distribution of cost of production of this biomass power is as follows: 57% on fuel (biomass), 18% fixed cost, 15% maintenance, and 10% on labour. Thus, the project provided enormous social benefits as 45% of total generation cost remain within the community. The project spread in 28 villages also provided 32 borewells for 127 farmers, and 20 community borewells. These have resulted in increased crop intensity – more than two crops per year now – which, in turn, has increased farm income by 20%–30% (now it is about Rs 40,000–50,000 per acre).

The project established 26 village bio-energy management committees, 26 village forest committees, and 72 new SHGs, and strengthened 68 old SHGs covering 2244 households (74%), 31 WUAs (216 hhs) and 33 biogas user groups (BUGs). The project has invested about Rs 7 crore on the 1-MW power plant. When fully operational, it can generate Rs 1.5–2.5 crore per year by selling power. Assuming a per capita income of Rs 12,000 per year (Tumkur district), in a typical grama panchayat with about 8000 persons, the turnover can be about Rs 9 crore. The project is spread over 4 grama panchayats, and thus the total turnover is about Rs 35 crore. Therefore, such a green intervention can enhance the overall income by about 7%–8%. It can also add to employment. About 100 people can be employed in the management of bioenergy packages that largely include biomass power generating units. In addition, employment in the plantations management and nursery arrangement can also add to green outcomes.

Scale-up potential

BERI appears to be a replicable model of provision of tail-end support to base loads and has showcased how distribution of decentralized power can benefit local communities. If tariff support is restructured, especially at sub-megawatt scale, it has the potential to replicate, proliferate, encourage entrepreneurs and benefit rural populace. The decentralized unit would ensure no or low transit loss and cost associated with energy losses during transmission. Fast-growing species like *Prosopis juliflora*, *Lantana camara*, Epil-epil (Subabool), Glyciridia, and bamboo in dedicated energy plantations can provide the fuel supply linkages and can enhance the green cover and carbon sequestration.

◆

Source: V K Jain and S N Srinivas (Eds.), 'Empowering rural India the RE way: inspiring success stories', © Ministry of New and Renewable Energy, 2012, ISBN: 978-81-920040-0-6

Solar energy has ensured timely irrigation to crops

Solar energy models for sustainable farming

Arunkumar Shivaray

Sufficient and timely availability of water is essential to irrigate crops during critical stages of crop growth. This shall ensure improved farm productivity and incomes. However, a critical prerequisite is a reliable energy-based system which enables timely extraction and distribution of water supply. Solar models have shown the way.

In rural areas, the farm's energy needs are supported by public distributed electricity which supports diverse appliances. Uncertainties like power cuts, supply with dangerous fluctuations resulting in burning out and damaging motors, are challenges the farmers face. This is in addition to vagaries of weather and unpredictable markets. Even when they have enough ground water too, farmers are unable to irrigate their entire land, owing to irregular power supplies.

To mitigate these challenges, Kalike Livelihoods team with the support of Sustain Plus, Selco and Villgro Foundation, conceptualized and implemented models based on renewable energy and promoted sustainable

agriculture practices. Motivated by the keenness of communities and backed by suitable geography, the Trust implemented alternative solar powered project models.

The overall purpose was to help farmers in multiple ways.

1) Ensuring better access to water supply to enhance crop diversity and productivity by installing reliable solar models
2) Exploring development of new enterprises like solar operated hydroponics for better fodder access and Panchagavya units for improved nutrient management to crops
3) Promoting community benefit sharing mechanisms between Lead farmer and fellow farmers
4) Enabling Lead farmer to install the model with partial financial support as well as by linking with banks for availing loan.

Following are some of the examples.

1. Community Solar Irrigation Model (CSIM 5 HP model) for efficient utilization of water and enhancing incomes

The model was planned and implemented holistically by focusing on solar pump installation, multi crop layering, soil and water conservation practices and convergence with government line departments.

The first measure was to install solar pumps to ensure timely irrigation and to expand the net irrigated area. Gradually, the farmer was trained and guided to adopt Multi–crop layering by introduction of multiple crops in the same field to increase farmer's incomes. Simultaneously, the farmer was guided to adopt soil and water conservation measures through installation of micro irrigation systems and suitable NRM measures, besides avoiding the water intensive crops. Lastly, to enable convergence, farmer was linked with government line departments to avail suitable government schemes / facilities on priority basis for solar energy application.

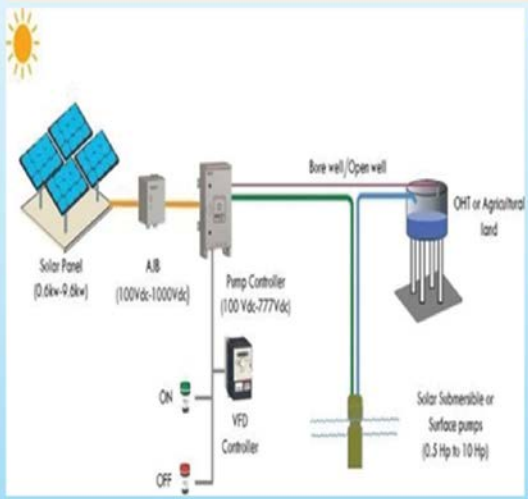
A community-based model was designed in such a way that each solar pump installed, served 4 farmers covering 8-10 acres of land. The farmers who installed the solar pump is called lead farmer and he has to provide water to 3 fellow farmers which is mandatory. The terms of water service is based purely on internal commitment between the lead and fellow farmers. Fellow farmers may pay for the service in monetary terms or in kind (sharing crop harvest) as per mutual understanding. This model also helps the lead farmer to repay his loan against solar pump investment.

Individual solar pump design is based on the results from village aquifer mapping and technical site survey done by the engineers/professionals. In October 2020, on a pilot basis, a community solar irrigation model with 3 HP pump was installed. Pump can be operated from 7am to 5pm with minimum temperature of 21° C. The pressure from the pump is highly sufficient for operating the drip system and sprinklers.

A total of 125 such CSIM units have been installed in Yadgir, Gurmitkal and Wadigera blocks of Yadgir district. The total installation cost is Rs. 3,60,000 per unit, of which the contribution from the project is Rs.1,49,000. Farmers contributed Rs. 36,000 and a loan component of Rs. 1,75,000 was facilitated through the bank. The loan is to be repaid over a period of 5 years in ten installments of Rs. 24,000 each

Box: 1

Technical specifications



BOM for 5 HP shakti solar system

sl no	Material	unit	qty
1	solar panel	300 watt	16
2	Solar panel structure	8 plate	2
3	Solar Motor Pump	5 HP	1
4	Solar VFD drive	5 HP	1
5	earthling unit	NA	1
6	lightning arrester	NA	1
7	enclose box with change over switch SPD MCB		1
8	Transport	NA	
9	Installation	NA	
10	insurance	5 years	
11	sq MM Shakti submersible cabl	40 mtr	
12	Upvc Colum Pipe 2 ich 15 kg/cm^2	20	

Box: 2 Inspiring cases

Venkatesh Rayappa of Belagera village Yadgir has been involved in farming since decades. He owns 6 acres of land. He grows green gram, groundnut, paddy and leafy vegetables. After attending training conducted by Kalike Tata Trusts, he installed the solar pump irrigation system, learnt different techniques in farming guided by field co-ordinators of the project. Venkatesh Rayappa is the first one to take up the initiative. The solar pump is switched on for 6-7 hours (his six acres) and water is shared with other farmers on a daily basis. After the solar pump installation, the financial status of his family got better. He says, *"providing crops with timely irrigation resulted in 30-40% increase in the crop yield"*. Through water sharing with fellow farmers on 7 acres of land, he earns Rs.6,500/acre which is additional source of income.

Ramalingappa owns 8 acres of land. He owns a borewell with 5hp motor. Before installation, during Kharif and Rabi season, he cultivated groundnut and cotton. Frequent power cuts and fluctuations were faced by him in which motor got damaged. With solar pumps, he diversified crop cultivation, irrigating them, whenever needed. He started growing leafy vegetables, onion, radish, chilli, okra, gourds and watermelons. For home consumption he grows organic paddy in Kharif. Before installing the solar model, his yearly earnings were Rs. 3,00,000/-. With this arrangement, he earns around Rupees 6 lakhs. He also earns additionally from sharing water with the adjacent farmers. He irrigates 8 acres of his own farm while sharing to support 4 acres for fellow farmers.

Irappa Bhemmanna of Balichakra village of Yadgir taluk, a practicing farmer since three decades, owns 6 acres of land. After solar installation, in December 2020, he started growing horticulture crops i.e., chillies, brinjal, tomato, watermelon etc. Irappa says, *"Easy management of power usage, continuous supply of uninterrupted power makes him 100% satisfied with installation of solar powered irrigation system on his farm"*. During summer he cultivated watermelon in 4.6 acres of land which fetched him an income of Rupees 1.4 lakhs. In 0.6 acres of land, he has grown Cucumber and okra with net profit of Rs. 25,000/-. In Rabi he cultivates chilli fetching him Rs. 45,000/- and onion with an income of Rs. 25,000/-. Six Solar traps were installed on his farm with the support of Horticulture department. He installed insect traps on his farm. Pests are controlled naturally without spraying any chemicals. Water sharing is done with 3 fellow farmers. As agreed among them, one quarter of the profit of the selling price of the crops amount was given to Irappa by other farmers who shared water.

Irappa Bheemanna with the Solar powered insect trap in his Redgram field

Lead farmers

Besides irrigating diverse crops, Lead farmers provide "Water Service" to fellow farmers for at least two crops in a year on a paid service basis, which is utilised for the repayment of bank installment.

Fellow farmers

As water is available throughout the year, fellow farmers cultivate their entire area with wider crop choices with tecnical support from professionals.

every six months once. Financial support was provided by Sustain plus Foundation, through a multi-stakeholder's approach involving Suco Bank and SBI. After-sales services are ensured for 5 years from the day of installation which covers minor/major repairs within 48 hours and replacement of any part in case of damage with insurance coverage. And this is being taken up by Kadam Agri. Pvt Ltd., Bangalore.

The model backed by sound technical specifications (see Box 1) was installed on lead farmer's farm based on irrigation requirements and willingness to make investment. Farmers identified in the group for sharing were those who have their land adjacent to the water pump or within the catchment area which the pump can cater to. Generally, an operator nominated within the group kept track of the usage of solar pump by different members and a service charge is levied based on the quantum of water delivered to various members.

Continuous hand holding and technical support was done by Kalike-Tata Trusts, on a daily basis. To enable farmers to get more income from diversified cropping

Growing fodder using solar hydroponics

through sustainable agriculture practices, the project team facilitated training programs with Agriculture Department, Agriculture Universities, KVKs and other prime institutions. Linkages were established with line departments to ensure timely supply of inputs and services.

It has been observed that there is a huge expansion in the area under irrigation resulting in improved income for farmers. Besides the lead farmers who installed the solar model, fellow farmers have also benefitted from irrigation supported multiple cropping (See Box 2).

Solar powered fermenter unit for bulk production of Panchagavya and Jeevamrutha

2. Solar powered hydroponic unit for cultivating green fodder

In rural communities, farmer struggles a lot to get appropriate and sufficient fodder for his livestock which include goats, buffaloes, cows, ox etc. The situation was more acute during quarantine period. Serious fodder shortage was experienced to meet the feed needs, especially of Sirohi breeds. High cost fodder was purchased and transported at additional cost to maintain them.

To address this issue a pilot project was initiated in Gondenoor and Joladadgi villages of Wadigera Yadgir. Mr. Piddappa and Mr. Rajasekhar Patil, involved in farming for more than 15 years, were identified for the experiment.

The pilot project included Solar panel operated hydroponic system along with five Sirohi breed goats for rearing and breeding. The systems are essentially energy-efficient. Based on a soil-less farming technique, this unit requires a minimal amount of water. It runs on solar energy that makes it highly suitable for off-grid areas. The highlight of the product is its design and the time taken to generate fodder. Also, as an enterprise, the sale of fodder could also be conceived in future, as a means of additional income for hydroponic farmers. The system could be utilized for mushroom cultivation too.

With assured irrigation, cropping area expanded resulting in improved income for farmers

Solar powered fermenter unit: Bulk production of Panchagavya and Jeevamrutha

Another model experimented by the project is Solar powered fermenter unit for preparing Panchagavya and Jeevamrutha.

Since the Green Revolution phase, the high cost of cultivation and production of pesticide residue free food has been a big challenge for the farmers. This is especially critical, in the region of Yadgir where more than 80% of farmers are small holders. In small patches farmers grow vegetables and a few high valued horticulture crops like watermelon, which need costly inputs.

Solar powered fermenter is introduced to produce liquid manures like Panchagavya and Jeevamrutha in volumes. The solar energy operated stirrer machine is placed in the drum. The stirrer machine is operated by the solar charged batteries on an hourly basis. In a day, the stirring is done six times. The process is continued for 10 days. After 10 days, the fermented ingredients are filtered using the connected filter tubes and poured into plastic bottles. Panchagavya is sold to the farmers at Rs.80/liter each, for application to the crop at the time of sowing, flowering, and fruiting stage.

Conclusion

With the kind of energy demands in India, solar powered systems would be a good and suitable alternative for helping farmers as a reliable energy-based system. Though requiring some primary investment, they are eco-friendly and enable the farmer to get enhanced income in the long run through planned diversification.

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