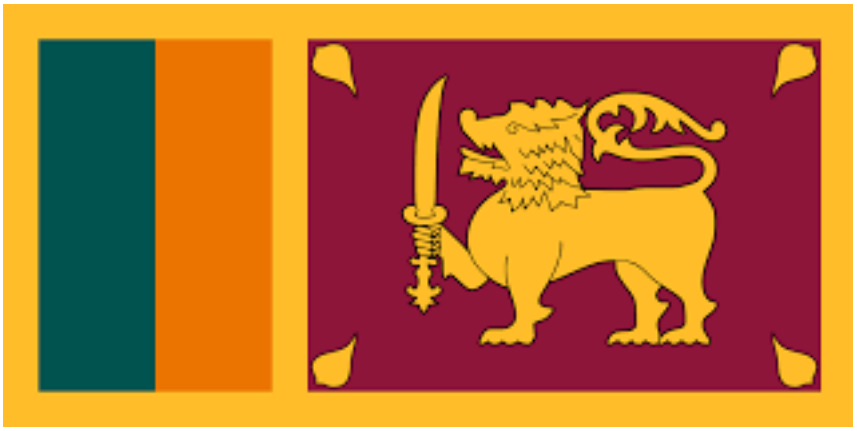
Technology Application Priorities
Sri Lanka

Agriculture, Livestock & Fisheries Sub Sectors



Submitted to

Biogas, Biomass and Solar Trilateral Cooperation
Transitioning to Sustainable Energy Uses
in the Agro-Industry Project
Sri Lanka - China – Ethiopia

United Nations Development Programme, Sri Lanka

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Content

Executive Summary

Introduction

The purpose of this report is to identify the technology transfer priorities of selected five Provinces of Sri Lanka for the consideration of Chinese counterparts of the Trilateral South-South Cooperation (TSSC) Project. The report consists of an executive summary where technology application Priorities of 5 Provinces are summarized followed by individual reports of Provinces highlighting their priorities along with the status of agriculture, livestock and fisheries sectors.

TSSC Project in Brief

Trilateral South-South Cooperation initiative in Sri Lanka builds upon existing GEF-UNDP engagements on renewable energy technology (RET) adoption and dissemination, and government development priorities.

This project frames Chinese technology transfer within broader development objectives. The selected technologies, solar, biogas and biomass, are already technologies targeted under the GEF project to achieve emission reduction through changes in energy resources used and reduced electricity consumption within households' domestic, commercial and agricultural activities. Building upon the GEF project framework the TSSC project:

1. Supports capacity development for GHG emission inventory in the agro-industry.

This TSSC project component brings additional support to the GEF projects by targeting another end-use sector and developing an overview of the carbon footprint of different agricultural activities. The support opens the GEF project to other government priorities and commitment to voluntary emission reduction by targeting emission reduction in the agriculture, livestock, and agro-processing sectors. The TSSC project will also result in increased coordination between energy institutions and other governmental organizations, as well as between national and local agencies, enabling condition for NAMAs implementation.

2. Tests biogas and solar potential for energy savings and GHG emission reduction potential including technology demonstration, and as such the TSSC project will support around 15-20 demonstration of solar, biogas and biomass uses in the agro-industry sector.

3. Tests solar, biogas and biomass potential for agro-industry productivity gains and income generation.

The overall objective is to reach a state of climate resilient economic growth. In that sense, this project brings additional value by demonstrating the technology potential to enhance the productivity and development of the agro-industry sector, which still stands as a major economic driver for people's livelihoods and Sri Lanka growth.

The innovation in the TSSC project approach lies in the organizational setting of the project. Various stakeholders are brought together under the umbrella of a unique project, addressing multiple development challenges and government priorities in both countries.

This project utilizes UNDP's global experience in encouraging climate-resilient economic development. UNDP has a large environmental portfolio globally and has accumulated abundant experience in tackling climate change mainly through carrying out GEF projects. Based on China's expertise in renewable energy technology transfer and climate change mitigation, this project will foster exchanges and cooperation between China and Sri Lanka, and support the transition to sustainable energy uses in the agro-industry sector for GHG emission reduction and increased income and productivity gains.

The project supports China's new policy on Climate Change South-South Cooperation as well as well as Sri Lanka's policy on climate change mitigation through adoption and dissemination of renewable energy technologies. The TSSC has been formulated with a focus on priority areas identified by Sri Lanka in light of China's capacity to provide support to the renewable energy sector. By engaging expertise, knowledge and technology from multiple Chinese entities, the project also increases coordination and coherence among Chinese government agencies in delivering assistance.

Through its capacity development activities, the project also supports Chinese institutions in carrying out relevant capacity development in South partner countries.

Background

Until the mid-1990's most of the electricity demand in Sri Lanka was met by hydropower. Economically viable hydropower sites have since then been exploited, and with a growing demand for electricity, Sri Lanka is increasingly relying on fossil fuel for power production. This has become a challenge for Sri Lanka's energy security and with the rise of the international price of petroleum products, consumers' tariffs have spiked.

Sri Lanka had planned coal-fired thermal power stations development. However, acknowledging Sri Lankan climate vulnerability, the government of Sri Lanka is now turning to renewable energy and energy efficiency options.

According to the "Second National Communication" (SNC) in 2011, energy industries and the agriculture sector are the largest Green-House Gas (GHG) emitters, respectively representing around 59%, and 27% of the total national GHG emissions. They are therefore sectors where energy savings and use of RETs can have a significant impact in terms of emission reductions.

Exploited renewable energy sources are dominated by hydropower and wind resources, which are used for power production. In recent years, solar technology has spread over the country supported by government programs such as the "Solar Battle" program (Roof top solar systems) and the setting-up of supportive policies (i.e. feed-in tariff, regulations for investments in renewable energies and standardized power purchase agreements) to supply to the electricity grid. The biomass energy has the potential to supply a significant portion of Sri Lanka's energy needs, while revitalizing rural economies, increasing energy independence, and reducing pollution. Promoting biomass energy technologies (BETs) in the agriculture sector could largly benefitted through improving crop management practices and quality improvement of the end products by adopting cost effective BETs. In the past, biogas programs in Sri Lanka have primarily been implemented to increase energy access for cooking in off-grid areas. As the power grid has been extended to rural areas, community systems have increasingly been abandoned. Domestic biogas programs are however still underway,

highlighting the Government commitment to sustainable and efficient domestic cooking energy access.

The development of the biogas sector in Sri Lanka is still limited by the availability of cost-efficient technologies, limited services offered by energy service companies, lack of skilled technicians, and limited credit facilities.

Context

Even though Sri Lanka's economy is no longer driven by the agriculture sector, agricultural activities still account for more than 30% of total employment. While 100,000 additional jobs are created in support industries. The agro-industry sector varies in size and type of activities, from small livelihoods agriculture and farming activities to medium industrial and large export-oriented processing activities.

- **Export-oriented crops**: Commercial crops include cinnamon, pepper, cocoa, coffee, and others, and are grown on small and medium land holdings. Plantation crops—coconut, rubber, and tea—are cultivated in large estates and on small and medium land holdings. Export oriented crops are primarily grown in rain-fed areas. This sub-sector also produces vast amounts of fuelwood used by the industrial sector of and also consumes part of this for thermal energy requirements.

- **Domestic food crops production**: Food crops comprise rice, maize, fruits, vegetables and other crops cultivated by smallholder farms. About 1.65 million smallholder farmers operate on average less than 2 hectares, and contribute 80 percent of the total annual food production. These crops are mostly cultivated using irrigation. Based on the findings of North Western Province, most water pumps used for irrigation are powered by diesel and kerosene. Replacing fuelled powered generators as well as introducing organic wastes disposal management represent a potential for GHG emission reduction. Agriculture waste products are increasingly being used to produce densified biomass energy products in Sri Lanka making the transport of these products feasible over long distances. Processed agricultural waste provides a potential source of fuel for biomass co-generation plants.

- **Livestock**: Around 30% of smallholder farmers are engaged in mixed crop production and livestock. The dairy sector is the most important of all livestock sub-sectors; however, the poultry sub-sector has emerged as a dynamic industry, most prominently in the broiler sector. It is estimated that 30% of agriculture sector GHG emissions come from livestock. There is therefore a potential for emission reductions through manure treatment.

- **Agro-processing**: Emerging industries have developed around manufacturing and preserving food derived from agriculture, animal husbandry and fisheries. Activities include salting, curdling, drying, pickling, as well as processing and frosting fruits, vegetables, fisheries, and meat products. The agro-industrial sector is the fastest growing industrial category, with an average annual growth rate of around 5%. With this growth rate, it is probable that energy savings from reduced electricity and biomass consumption may significantly contribute to GHG emission reduction.

Energy savings potential and GHG emission reduction in the agro-industry has not received due attention at national level. This may be attributed to the complexity of the sector (which covers numerous activities), and the informal nature of smallholder farmer's activity. Furthermore,

the data for the agro-industry is spread out over different energy end-use sectors. As a result, there is a:

- Lack of understanding on current energy demand and needs in the agro-industry;
- Lack of knowledge on GHG emission from the agro-industry sector;
- Lack of awareness on RET potential for agro-industry development.

The potential of RETs in energy savings and GHG emission reduction while stimulating productivity and income gains in the agro-industry sector has not yet been fully tested.

Methodology Adopted

The methodology adopted in identifying the technology transfer priorities of selected five Provinces of Sri Lanka was through extensive consultations of Provincial stakeholders consisting both high level decision makers and sector experts. For this purpose, one-day workshops were conducted in all 5 Provinces. Given below is a typical agenda;

Workshop to Identify, Prioritize and Document the Provincial Requirements to be Facilitated through TSSC Project

..... Provincial Council

Date : .....
Venue : .....
Number of Participants : Approx. 50

Time	Description	Speaker / Presenter
9.00 - 9.10 am	Welcome Remarks	Provincial Council Official s
9.10 – 9.20 am	Self-Introduction of Participants	
9.20 – 09.45 am	Project Objectives and Objectives of the Workshop	Mr. Sampath Ranasinghe, Programme Coordinator (Energy & Environment), UNDP
09.45 - 10.10 am	Opening Remarks	Mr. Harsha Wickramasinghe, Deputy Director General, Sri Lanka Sustainable Energy Authority
10.00 - 10.15 am	Opening remarks	Chief Secretary, ... Province
10.15 – 10.45 am	Brief Presentations of Provincial Ministries / Departments	
	Status of the Agriculture sector in ..... Province (10 Mins- Maximum of 3 Power point Slides)	by Relevant Officials of ..... Provincial Ministry / Department of Agriculture
	Status of the Livestock Sector in ..... Province (10 Mins- Maximum of 3 Power point Slides)	by Relevant Officials of ..... Provincial Ministry / Department of Livestock
	Status of the Fisheries Sector in ..... Province (10 Mins- Maximum of 3 Power point Slides)	by Relevant Officials of ..... Provincial Ministry / Department of Fisheries
10.45 - 11.00 am	**Tea Break**	
11.00 - 11.15 am	Renewable Energy Technologies for Agriculture Sector Development	Eng. Ranjith Padmasiri, Chief Technical Advisor, UNDP
11.15 - 11.30 am	Q & A Session	Eng. Ranjith Padmasiri and Eng. Gamini Senanayake, National Consultant, UNDP
11.30 - 12.30 noon	Group Breakout session - 4 groups 1. Agriculture Sector 2. Livestock Sector 3. Fisheries Sector 4. Biomass Sector	Group Discussion Moderated by Eng. Gamini Senanayake and Eng. Ranjith Padmasiri
12.30 – 01.15 pm	**Lunch**	
01.15 - 02.30 pm	Group Presentations 1. Identified existing challenges in RET application in the sectors 2. Sector priorities identified for the TSSC Project	Moderated by Eng. Gamini Senanayake and Eng. Ranjith Padmasiri
02.30 – 03.30 pm	Finalization of the provincial activities for TSSC Project	Moderated by Eng. Gamini Senanayake and Eng. Ranjith Padmasiri
03.30 – 04.00 pm	Wrap-up of the day	By Mr. Sampath Ranasinghe, Eng. Ranjith Padmasiri and Eng. Gamini Senanayake
04.00 pm	**End of the workshop with evening refreshments**	

After the objective of the TSSC Project was explained, a brief presentation on renewable energy was made followed by the presentations of 3 sectors (Agriculture, livestock and fisheries) by sectors representatives in a plenary session as the basis for group discussions. Thereafter, participants were requested to identify technology transfer priorities of respective sectors in a breakout session facilitated by the Project team. Upon completion of the group work, sectoral presentations were made allowing other sector representatives to make their contributions in a plenary session which was moderated by the Project team.

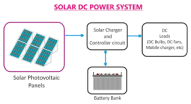
Within a week upon conducting the workshop, a draft report prepared by the Project team was sent for review and validation of Provincial representatives. Validated Provincial reports are given in this combined report.

Summary of Technology Application Priorities of Five Provinces in Sri Lanka

Given below is the summary of technology application priorities of the Agriculture, Livestock and Fisheries sub sectors of Sri Lanka.

Technology Application			Province						Potential	
	Image	Technology	U	S	E	N	W	Total	B	R
Agriculture Sector										
1		Solar Electrification of Greenhouses (Protected Agriculture)	3,000	50	-	50	-	3,100		
2		Solar Electrification of Small-Scale Cold Rooms	1,000	10	1,000	20	10	2,040		
3		Solar Powered Sprayers	10,000	-	-	-	-	10,000		
4		Solar Insect Traps	10,000	500	-	-	-	10,500		
5		Solar Water Pumps	3,000	70	-	500	1,000	4,570		
6		Solar Powered Electric Fence	500	30	-	1,500	1,000	3,030		
7		Solar or Biomass Fired dryers for Crop Drying	1,500	100	1,000	50	50	2,700		
8		Solar Powered Dehumidifiers for Crop Drying	-	20	-	1,000	-	1,020		
9		Bio-diesel Producing Machine	-	5	-	-	-	5		
10		Solar or Biomass Fired dryers for Paddy Drying	-	-	1,500	10	-	1,510		

11		Agriculture Farm Mechanization	-	-	500	500	1,000	2,000		
12		Solar Powered Elephant Repellent Systems	-	-	1,500	1,000	50	2,550		
13		Solar Powered Desalinated Water for Agriculture Purposes	-	-	500	5	-	505		
14		Solar Powered Automatic Irrigation Control Systems	-	-	-	500	-	500		
15		Biogas Powered Flame Weeders	-	-	-	20		20		
16		Solar Powered Vacuum Dryers for Crop & Seed Drying	-	-	-	-	50	50		
17		Solar Powered Automatic Control Systems for Polytunnels	-	-	-	-	250	250		
18		Solar Powered Small-Scale Rice Milling Plants	-	-	-	-	100	100		
19		Renewable Energy Powered Integrated Farm for Demonstration	-	-	-	-	1	1		
20		Solar Powered Water Management Systems for Minor Irrigation Tanks	-	-	-	-	1	1		
Livestock Sector										
21		Biogas for Large-scale Farms & Slaughter Houses	50	6	40	100	50	246		

22		Can Coolers for Milk Producers	3,000	-	74,000	-	-	77,000		
23		Livestock Farm Mechanization	2,500	-	-	-	-	2,500		
24		Biogas Systems for Large Scale Dairy Processors (Biogas Upgrading)	6	-	-	-	-	6		
25		Milk Chilling Centers	28	25	30	100	1,035	1,218		
26		Solar Powered Poultry Farms	25	25	90	100	80	320		
27		Solar Powered Freezers for Meat Storage	-	-	-	-	150	150		
28		Direct Current (DC) Systems for Solar Photovoltaic (PV) Applications	-	-	-	-	1	1		
Fisheries Sector										
29		Solar Fish Dryers	5	2,000	200	50	150	2,405		
30		Solar Powered Battery Charging Stations for Fishermen	-	20	-	-	100	120		
31		Solar Powered Fishing Boats	-	2,000	-	1,000	-	3,000		
32		Solar Powered Ice Plants	-	10	-	4	-	14		
33		Solar Powered Fish Meal Making Machines	-	50	-	10	-	60		

34		Solar Powered Cold Rooms in Fishery Harbours	-	10	-	25	-	35		
35		Solar Powered Aquariums	-	300	-	-	500	800		
36		Solar Powered Lobster Collecting Centres	-	10	-	-	-	10		
37		Solar Powered Desalination Plants for Multiday Boats (IMUL)	-	1,000	-	250	150	1,400		
38		Solar Powered Medium Scale Refrigerators / Mini Ice Plants for Fish Vendors	-	-	500	100	200	800		
39		Biogas Driven Fishing Boats	-	-	1		-	1		
40		Solar Powered Refrigeration Systems for Fishermen	-	-	1,000		-	1,000		
41		Solar Powered Aerators for Shrimp Farming	-	-	800	10	500	1,310		
42		Solar Powered Ice Plants for Multiday Boats (IMUL)	-	-	-	-	100	100		
43		Solar Powered Identification Boarders for Fishing Nets	-	-	-	-	100	100		
44		Solar Powered Lighting in Boatyards	-	-	-	-	100	100		
Biomass										
45		Briquetting / Pelletizing of Biomass	100		-	-	100	200		

46		Movable Biomass Gasifiers for Crop Drying		200		500		700		
47		Biomass Fired Thermal Energy Generators	-	-	-	-	-	-		
48		Biomass Fired Domestic Type Stoves	-	-	-	-	-	-		
49		Small Scale Dendro Power Plants	-	-	-	-	100	100		
General										
50		Solar Powered Parking Lots for Electrical Vehicle Charging	-	-	30	-	-	30		
51		Solar Powered Water Management with Alternate Wetting & Drying (AWD)	-	-	-	-	1	1		
52		Heat Extraction from a Large Rocks	-	-	-	-	1	1		

Key
U – Uva Province
S – Southern Province
E – Eastern Province
N – Northern Province
W – Wayamba Province

B – Business development prospects
R – Research potential

Fifty-two (52) technology applications have been identified for the consideration of the TSSC Project and they are listed in the above table. Provincial priorities are indicated with estimated demand for each application. Applications having high prospects for business development and high prospects for further research and development also have been identified and marked in green colour.

Technology Application Priorities
Uva Province

Agriculture, Livestock & Fisheries Sub Sectors

Submitted to

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Submitted by

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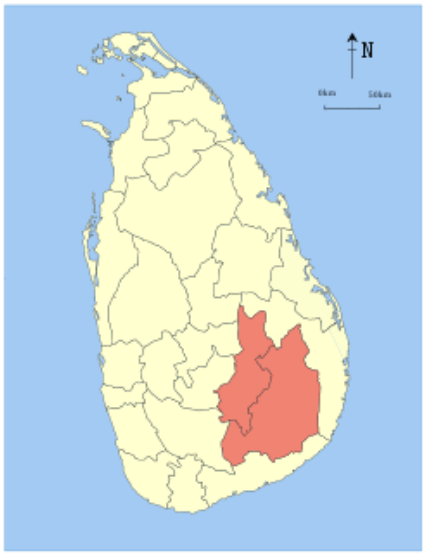
Content

Overview of Uva Province of Sri Lanka



Uva Province is the Sri Lanka's second least populated province, with around 1,259,880 people. It consists of two districts: Badulla (2,861 km^2) and Moneragala (5,639 km^2). The provincial capital is Badulla. Other major cities are; Bandarawela, Haputale, Monaragala & Welimada. Uva is bordered by Eastern, Southern and Central provinces. Its major tourist attractions are Dunhinda falls, Diyaluma Falls, Rawana Falls, the Yala National Park (lying partly in the Southern and Eastern Provinces) and Gal Oya National Park (lying partly in the Eastern Province). The Gal Oya hills and the Central mountains are the main uplands, while the Mahaweli river and the Senanayake Samudraya and Maduru Oya Reservoirs are the major waterways. There are 26 divisional secretariats in Uva Province; 15 in Badulla District and 11 in Moneragala District.

Overview of Agriculture Sector of Uva Province
(Including Livestock & Fisheries)

There are about 200,000 farm families in 3,304 villages. Provincial contribution to the national agriculture GDP is 30% (Central Bank Annual Report 2017). Employment in agriculture sector is 53.3% (Department of Census & Statistics 2017). The potential growth sectors of the Uva Province constitute crop agriculture, livestock farming and fisheries along with agriculture related industries and trade. Out of the total land area of the Province, 31% is used for crop cultivation. Paddy is the predominant crop in the province followed by the other field crops (OFC) and vegetable and floriculture.

According to 2016 Annual Report of the Central Bank of Sri Lanka, the livestock sector contributes 0.6% to GDP. According to the Department of Animal Production & Health year 2016 statistical information, Uva Provincial cattle population was 111,840 and Badulla and Monaragala districts cattle population was 56,924 and 54,914 respectively. Buffalo population was 4,132 in Badulla district and 50,236 in Monaragala district. Provincial goat, swine and poultry population were 16,232, 4,206 and 381,230 respectively. Comparing the milk production with other provinces in the country, Uva Province holds 4th place by producing 46,959,773 Liters milk in year 2016. Beef and mutton production in year 2016 was 1,263,584 kg and 40,145 kg respectively. The egg production was 71,335.

As a Province in year 2016, Uva Provincial daily average milk production of cow milk was 84,581 Liters and buffalo milk 22,400 Liters and its contribution to the national national milk production was 11%. The provincial milk production has been increasing during the last few years by means of 35.51 million milk Liters in 2013 up to 46.95 million milk Liters in 2016.

Technology Application Priorities of Uva Province

Given below is the summary of technology application priorities of the Agriculture, Livestock and Fisheries sub sectors of the Uva Province.

Intervention No	Intervening Technology	Specific Technology	Specific Application	Market Potential	Provincial Priority	Business Prospects	Prospects for Research & Development
Agriculture Sector							
1	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Solar electrification of Greenhouses (Protected Agriculture)	3,000 green houses	High	High	High
2	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Solar Electrification of small scale cold rooms	1,000 cold rooms	High	High	_
3	Solar PV	Off-grid solar PV systems with battery charging facility	Solar Powered Sprayers	10,000 sprayers	Medium	High	_
4	Solar PV	Off-grid solar PV systems with battery charging facility	Solar insect traps (Lights)	10,000 traps	Medium	High	High
5	Solar PV	Off-grid solar PV systems	Solar water pumps	3,000 pumps	Low	High	_
6	Solar PV	Off-grid solar PV systems with battery storage	Solar powered electric fences	500 sets for around 500 km fencing	Low	_	_
7	Solar thermal or biomass	Solar or biomass fired dryers	Solar or biomass fired dryers for crop drying	1,500 dryers	Low	_	_
8	Biomass	Briquetting of biomass	Briquetting of biomass (pelletizing)	100 units	Low	_	_
9	Biogas	Biogas digesters	Large scale farms, slaughter houses and market places	50 digesters	Low	_	_
Livestock Sector							
10	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Can coolers for milk producers (Refrigerated cans)	3,000 cans	High	High	_
11	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Livestock farm mechanization (Powering farm machinery with solar power)	2,500 farms	High	High	High
12	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Milk chilling centres	28 Centres	Medium	_	_
13	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Broiler farms	25 farms	Low	_	_
14	Biogas	Entire value chain of the biogas (Feedstock management, Generation, Cleaning / Filtration, Compression / Storage, Electricity generation / Thermal energy generation)	Large scale dairy farms	6 farms	Medium	High	High
Fisheries Sector							
15	Solar thermal	Solar dryers	Community fish drying centres	5 centres	Low	_	_

Fifteen technology applications have been identified for the consideration of the TSSC Project and they are listed in the above table. Provincial priorities are indicated under three levels; “High”, “Medium” and “Low”. Applications having high prospects for

business development and high prospects for further research and development also have been identified and marked as “high”.

Intervention No 1 – Solar Electrification of Greenhouses (Protected Agriculture)

There are over 3,000 commercial scale farmers in the Uva Province mostly engaged in conventional agriculture depriving them of high quality and higher yields. Cultivation of crops in a protected area is known as protected agriculture and the crops are protected from external factors such as sunlight, wind, rain, pest and disease. There are hosts of other benefits when protected agriculture is adopted; (1) Optimal usage of fertilizer and water under micro irrigation systems (2) Crops can be grown under non-availability of fertile soil with the help of some other growing media's like coir pith (3) High quality of produce compared to conventional farming (4) Increased crop duration (prolong cultivation) (5) Possibility of adopting some advanced techniques like hydroponics, aeroponics, etc. Although protected agriculture provides high quality and higher yield, it requires substantial amount of energy for various activities such as Misters, Micro-irrigation Systems, Exhaust Fans, Lighting, etc.

As one of the priority interventions, stakeholders of Uva Province wish to promote protected agriculture powered by grid connected or off-grid solar PV systems with or without battery storage which are affordable to the target group. It is estimated that around 3,000 Green Houses can be promoted with the capacity around 1,000 ft^3 among farmers of the Uva Province for the first round and the entire country’s requirement could be as high as 10,000 Green Houses.

Intervention No 2 – Solar Electrification of Small-Scale Cold Rooms

Uva Province agricultural sector provides employment to nearly 53% of its population. Whilst productivity levels are one point of possible intervention, the post-harvest chain of food supply cannot be neglected. About 40% of fruits and vegetables go waste mainly due to lack of food processing and cold storage facilities. Targeting post-harvest losses instead of solely focusing on the production can offer higher internal rates of return, have a significant impact on poverty alleviation, and improvement of health and food security whilst ensuring a more sustainable use of resources.

Many small-scale agro producers in Uva Province struggle with limited storage options and even access to basic cold

storage facilities. Due to the lack of cold storage, small-scale farmers are forced to sell their produce as close as possible to their farms after the time of harvest since the market value of vegetables decreases with time. It is estimated that around 10% of the loss occurs in farmer's markets driving down prices in times of excess supply and in the worst case leads to price crashes resulting in prices that do neither cover production, harvesting or transportation cost. On the other hand, consumers suffer under peaking prices during supply gaps and off-seasons. Storage facilities can help to store seasonal produce for which year-round demand exists and to create buffer stocks stabilizing food prices for producers and consumers alike. Majority of cold storage facilities cater to single commodities only. However, though single commodity storages are easier to manage, the trend is towards multi commodity storages offering higher returns.

As one of the priority interventions, stakeholders of Uva Province wish to have solar powered (grid connected or off-grid solar PV systems with or without battery storage) cold storages facilities preferably using absorption technology instead of vapor compression. It is estimated that the demand for cold storages will be around 1,000 units.

Intervention No 3 – Solar Powered Sprayers

Uva Province agricultural sector provides employment to nearly 53% of its population. Most of them use manually operated sprayers and few uses either kerosene or petrol driven engines.

Now there are solar powered agricultural pesticide sprayers consisting of a solar panel of around 20 W capacity, a 12V DC battery, charged by solar energy received by the solar panel, a DC motor, operated by the battery, a pump, to spray the pesticide and a tank to hold the pesticide (in the form of solution / liquid). The entire unit is portable and can be operated by one person. As the equipment does not use any other external source of power and that it is operated by the user himself, it reduces drudgery, is quite economical and eco-friendly as it uses solar energy which can be easily affordable by small-scale farmers. Further, its power can also be used for multi-purpose applications such as charging the batteries of mobile phones, operating radios and for emergency domestic lighting, etc., which makes it more economically viable technology.

As one of the priority interventions, stakeholders of Uva Province wish to have solar powered (off-grid solar PV systems with battery storage) sprayers for farmers. It is estimated that the demand for solar powered sprayers will be around 10,000 units.

Intervention No 4 – Solar Insect Traps

Agriculture is the main occupation of people in the Uva Province. Farmers encounter the problems of various types of insect pests that harm crops and result in loss of productivity. Therefore, it is necessary for farmers to use pesticides to prevent crop damage. However, when pesticides are used in large quantities, they cause adverse impacts on people, animals and the environment. Instead of using pesticides, there are other ways to prevent insect pests, including the use of biological agents and ultraviolet light of light emitting diode tubes powered by solar energy. Normally 12-volt batteries are used as power supply to light emitting diode tube. The battery charging system derives electrical energy from around 20 watts of solar PV cell for use at night. This type of solar energy-based insect pests traps are fitted with automatic control systems to lure insect pests when there is no sunlight and the system will be stopped when the sun shines. Solar energy-based insect pests trap could lure several types of insect pests in vegetable, fruits and even in coconut plantations.

As one of the priority interventions, stakeholders of Uva Province wish to have solar powered (off-grid solar PV systems with battery storage) insect traps for farms. It is estimated that the demand for solar powered insect traps will be around 10,000 units.

Intervention No 5 – Solar Water Pumps

Water is essential for agriculture, health of livestock and many other uses. The need to irrigate agricultural land efficiently, economically and sustainably is critical for food security.

Solar PV water pumping systems are reliable and very cost-effective and can replace manual or fossil fuel fired engine driven pumps. A solar water pumping system does not have to use batteries to provide the power as the pump will operate during the day by pumping water into a tank for use at night. A storage battery is needed only if the pump is used at night time or during cloud and rainy climate. These systems are available in different models according to the water consumption and depth of well and can be used for various irrigation methods such as direct irrigation, drip irrigation and sprinkler irrigation. This will either reduce electricity bills or avoid the use of fossil fuel and hence the carbon footprint.

As one of the priority interventions, stakeholders of Uva Province wish to have solar powered (off-grid solar PV systems with or without battery storage) water pumps for agricultural purpose. It is estimated that the demand for solar powered pumps will be around 3,000 units.

Intervention No 6 – Solar Powered Electric Fence

As settlements and arable areas spread, conflict between human and animal builds up - especially with wild elephants. Ecological considerations demand that man and animal live in harmony. The only way to ensure that man and beast co-exist peacefully is by erecting non-lethal high voltage electric fences, which repel intruders without harming them. These help to secure human lives, guard wildlife from human intrusion and also to bring large tracts of fertile land under cultivation. Most fences have to be built in remote areas where mains electricity is not available.

Solar powered electric fences are an ideal solution for animal containment or exclusion fences in areas where 230 V power is not available or is inconvenient to obtain. A small solar PV panel simply collects and converts sunlight into energy that is stored in a battery. The battery supplies current to the grounded energizer that then sends about one pulse of electric current per second down the fence. When an animal touches the fence the circuit between the fence and the ground is completed and the animal receives a short, sharp, but safe shock.

As one of the priority interventions, stakeholders of Uva Province wish to have solar powered (off-grid solar PV systems with battery storage) electric fences to protect farms from wild animal attacks including wild elephants. It is estimated that the demand for solar powered electric fence will be around 500 sets for around 500 km of fencing.

Intervention No 7 – Solar or Biomass Fired dryers for Crop Drying

Drying offers a multitude of advantages which includes reduction in volume, easy handling and transportation, less chance of pest and microbial attack during storage for almost all agricultural products. The basic essence of drying is to reduce the moisture content of the product to a level that prevents deterioration within a certain period of time. For some products, drying is an absolute necessity for size reduction and to have a powdered end product. In the Uva Province, grid-connected electricity and supplies of other non-renewable sources of energy are either unavailable, unreliable or, for many farmers, too expensive. Thus, in such areas, crop drying systems that employ motorized fans and electrical heating are inappropriate. The large initial and running costs of fossil fuel powered dryers present such barriers that they are rarely adopted by small scale farmers. The traditional open sun drying utilized widely by rural farmers has inherent limitations. The crop also requires an undesirably long period to reach this equilibrium moisture content. In hot and humid climates, crop deterioration is obviously worse, as both warmth and high moisture contents promote the growth of fungi, bacteria, mites and insects in crops. Thus, these climatic conditions dictate the need for more effective

drying methods. In such conditions, solar-energy crop dryers or biomass fired dryers appear to be attractive commercial propositions.

As one of the priority interventions, stakeholders of Uva Province wish to have a solution to the above problem by making available solar or biomass fired dryers which are affordable to the target group. It is estimated that the demand for solar powered or biomass fired dryers will be around 1,500 units.

Intervention No 8 – Briquetting / Pelletizing of Biomass

The most available forms of biomass types in the Uva Province are fuel wood, municipal waste, industrial waste and agricultural waste and industries have been moving to operate their thermal energy generators such as boilers, driers, furnace, etc. using biomass instead of fossil fuel. However, maintaining a regular supply of biomass has been a major problem. Continuous and sustained supply of quality-assured biomass as an industrial fuel need to be ensured. This implies increasing the availability of biomass-based fuel by planting fuel wood species and developing supply chains with facilities for pre-processing and storage. The choice of Gliricidia as fuel wood is supported by government policy (i.e., by declaring the species as a plantation crop in line with tea, rubber and coconut) and there are number of on-going government-supported schemes to promote it as an organic fertilizer in coconut, tea, spice plantations and in farms/home gardens.

Briquetting or pelletizing is the process of compaction or densification of biomass residues into different sizes and shapes by pressing loose biomass residues, or waste to produce a solid and they have numerous applications which include both domestic and industrial applications. Briquetting improves the biomass fuel characteristics mainly bulk density and other physical properties than of raw material and increment in calorific value of the end product.

As one of the priority interventions, stakeholders of Uva Province wish to have briquetting or pelletizing machines for farmers. It is estimated that the demand for briquetting or pelletizing machine will be around 100 units.

Intervention No 9 – Biogas for Large-scale Farms & Slaughter Houses

Biogas technology is not new to Sri Lanka. However, its adoption has been confined to small scale domestic and farm use for low level applications such as lighting, hot water generation, cooking, etc.

With the environmental regulations becoming more stringent, there is a tendency to use biogas generators as a waste management

solution for environmental compliance by large-scale farms, slaughter houses and market places. Anaerobic digestion serves to reduce the volume of wastes and the associated problem of their disposal such as contamination of groundwater, surface water, and other resources and effectively destroys harmful pathogens. Eluent from biogas digesters can serve as high quality organic fertilizer, displacing import of synthetic nitrogenous fertilizers.

As one of the priority interventions, stakeholders of Uva Province wish to have large-scale biogas systems for about 50 large-scale farms, slaughter houses and market places in the Province.

Intervention No 10 – Can Coolers for Milk Producers

There are over 10,000 milk producers in the Uva Province selling raw milk to Chilling Centres operating in the area either under the management of large-scale milk processing companies or under the Farmer Cooperative Societies. These chilling centers are supplied by 50 to 100 milk producers. They use various types of cans made out of aluminium, plastic or stainless steel for transporting / delivering raw milk from their farms to Chilling Centres mostly using bicycles. In order to maintain the required quality standards and hygienic conditions, raw milk has to be transported / delivered to a chilling centre within a short period of time from the time of milking if not refrigerated / chilled. Farmers find it difficult to fulfil this requirement due to various reasons such as long distance from their farms to the nearest chilling centre, their other important engagements in the morning hours, etc. This results in either poor quality of milk reached chilling centers or loss of revenue to farmers if their supply is totally rejected due to unacceptable quality. Very high quality of raw milk is required to make liquid milk for which the demand is on the increase. In the absence of a viable solution to keep raw milk overnight without allowing it to rot, many farmers do the milking only in the morning but not in the evening depriving them of probable high yield and hence high income.

As one of the priority interventions, stakeholders of Uva Province wish to have a solution to the above problem by making available can coolers / refrigerated cans powered by grid connected or off-grid solar PV systems with or without battery storage which are affordable to the target group. It is estimated that around 3,000 can coolers will be required for the milk producing farmers of the Uva Province for the first round and the entire country's requirement could be as high as 20,000 cans. Such a high number offers a good business opportunity for a Chinese producer or a supplier of can coolers possibly with a Sri Lankan counterpart as a joint venture partner. Even there could be a possibility of doing either part or full assembly or even manufacturing aiming at other bigger markets in the region.

Intervention No 11 – Livestock Farm Mechanization

Operations of many farms are carried out manually due to either non-availability of machineries at affordable prices or high cost of energy (electricity as well as fossil fuel) required to operate them. Manual operations not only reduce the overall productivity but also lead to product contamination due to excessive human handling especially in milking.

As one of the priority interventions, stakeholders of Uva Province wish to have a considerable number of dairy farms mechanized by making available suitable machineries such as chaff cutters, milking machines, etc. powered by grid connected or off-grid solar PV systems with or without battery storage which are affordable to the target group. It is estimated that around 2,500 farms can be mechanized in the first round and the entire country's requirement could be as high as 15,000 farms. Such a high number offers a good business opportunity for Chinese producers or suppliers of such machineries possibly with a Sri Lankan counterpart as a joint venture partner. Even there could be a possibility of doing either part or full assembly or even manufacturing aiming at other bigger markets in the region.

Compared to other technology applications, farm mechanization needs and provides ample opportunities for research and development for productivity gains and product quality improvements.

Intervention No 12 – Biogas Systems for Large Scale Dairy Processors (Biogas Upgrading)

Though the biogas technology is not new to Sri Lanka, its adoption has been confined to small scale domestic and farm use for low level applications such as lighting, hot water generation, cooking, etc. There had been some isolated attempts to operate relatively large-scale bio gas generators with limited success. Biogas upgrading has never been tried out in Sri Lanka in commercial scale other than a few attempts to generate electricity in small standby generators. With the environmental regulations becoming more stringent, there is a tendency to use biogas generators as a waste management solution for environmental compliance by commercial establishments and large-scale animal farms but not for energy generation.

As one of the priority interventions, stakeholders of Uva Province wish to have fully integrated biogas systems (upgraded biogas systems) for about six large scale dairy processors in the Province. This has to be for the entire value chain of the biogas (Feedstock management, Generation, Cleaning / Filtration, Compression / Storage, Electricity generation / Thermal energy generation) including SMART performance monitoring arrangements at every stage.

Intervention No 13 – Milk Chilling Centers

There are over 12 milk chilling centers operating in the Uva Province managed either by large-scale milk processing companies or by Farmer Cooperative Societies. These chilling centers need electrical energy for chiller operation and hot water for equipment cleaning including the milk cans brought by milk producing farmers. Cost of electricity comprises of the major portion of cost of production.

As one of the priority interventions, stakeholders of Uva Province wish to have grid connected or off-grid solar PV systems with or without battery storage to supply electricity for the chilling centers. It is estimated that there are around 28 chilling centers to benefit from this intervention.

Intervention No 14 – Broiler Farms

There are over 380 broiler farms in the Uva Province selling their birds either to large scale broiler chicken processing companies as sub-contractors or selling directly to consumers in the areas they operate. These broiler farms need electrical energy to operate various machinery and equipment (Brooding, defeathering, freezing, etc.). Cost of electricity comprises of the major portion of cost of production.

As one of the priority interventions, stakeholders of Uva Province wish to have grid connected or off-grid solar PV systems with or without battery storage to supply electricity for broiler farms. It is estimated that there are around 25 broiler farms to benefit from this intervention.

Intervention No 15 – Solar Fish Dryers

There are over 3,120 fishermen in the Uva Province engaged in inland fishing. The demand is mainly for fresh fish. Fishermen have to preserve unsold daily catch for future use either by freezing or by drying. As frozen inland fish varieties are not in demand and also many fishermen cannot afford freezing equipment, they mainly do open sun drying or smoking. Open sun drying affects the quality of dried fish due

to contamination with dust, insects and bird droppings, etc. apart from discoloration.

As one of the priority interventions, stakeholders of Uva Province wish to have a solution to the above problem by making available solar dryers which are affordable to the target group. It is estimated that there will be around 5 fishing community centers where solar dryers could be installed so that fishermen could share this facility in rotation.

Training and Capacity Building

All technology applications require training and capacity building for following three categories;

(1) Decision makers to make them aware of interventions and for policy and administrative supports
(2) Intermediary service providers for installations and commissioning as well as for further training of beneficiaries
(3) Final beneficiaries for operation and maintenance

Furthermore, establishment following setups are also recommended;

(1) Regional maintenance pool with the involvement of relevant authorities
(2) Implementation coordinating mechanism
(3) Chamber of Renewable Energy
(4) Research & development unit with the collaboration with Uva University & technical colleges of Badulla and Bandarawela

Environmental Safeguards

As a precautionary measure for environmental safeguards, it is suggested to incorporate Extended Producer Responsibility (EPR) to all interventions of TSSP project to make the battery suppliers of Solar PV systems responsible for end of life disposal.

Reference

Uva Province – Five Year Vision Oriented Integrated Sustainable Development Plan 2019-2023

Technology Application Priorities Southern Province

Agriculture, Livestock & Fisheries Sub Sectors

Submitted to

Biogas, Biomass and Solar Trilateral Cooperation
Transitioning to Sustainable Energy Uses
in the Agro-Industry Project
Sri Lanka - China – Ethiopia

United Nations Development Programme, Sri Lanka

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Content

Overview of Southern Province of Sri Lanka

The Southern Province of Sri Lanka is one of the nine provinces of Sri Lanka. It is the 7th largest province by area and is home to 2.5 million people, the 3rd most populated province. The province is bordered by Sabaragamuwa Province and Uva Province to the North, Eastern Province to the Northeast, Western Province to the Northwest and the Indian Ocean to the South, West and East. The Province's capital is Galle. The Southern Province is consisting of the districts of Galle, Matara and Hambantota. Subsistence farming and fishing is the main source of income for the vast majority of the people of this region.

Southern Provincial Council is the only Council out of 9 Provincial Councils in the country which is having a statute on renewable energy (Statute No 02 of 2007 of Southern Provincial Council). This is a testimony for its commitment to utilize alternative energy for domestic as well as economic activities.

Overview of Agriculture Sector of Southern Province
(Including Livestock & Fisheries)

Agriculture Sector

Population of Southern Province is around 1.1 million and around 30% is engaged in agriculture. There are about 460,211 farm families in 2,121 villages. Provincial contribution to the national agriculture GDP is 16 % (Central Bank Annual Report 2018). The potential growth sectors of the Southern Province constitute crop agriculture, fisheries farming and livestock along with related industries and trade. Out of the total land area of the Province, 41 % is used for crop cultivation. Paddy is the predominant crop in the province followed by tea, other field crops (OFC), coconut, cinnamon and rubber.

Contact points (Agriculture Sector)

Mr Sumith Alahakoon, Secretary to Ministry of Agriculture, Southern Province – 0716821879

Ms D.N.Gunawardhana, Assistance Director of Agriculture, Galle - 0714932268

Livestock Sector

Given below are some vital statics of the livestock sector of Southern Province;

Livestock Farms (End 2018)				
District	**Cattle**	**Buffalo**	**Goat**	**Swine**
Galle	4,292	936	597	56
Matara	3,022	569	581	7

Hambantota	5,978	2,780	572	49
Total	**13,292**	**4,285**	**1,750**	**112**

Livestock Population (End 2018)				
District	**Cattle**	**Buffalo**	**Goat**	**Swine**
Galle	12,416	7,811	4,457	2,144
Matara	9,576	5,973	3,662	430
Hambantota	40,997	58,512	7,441	1,987
Total	**62,989**	**72,296**	**15,560**	**4,561**

Livestock Production (End 2018)					
District	**Milk (Liters)**	**Eggs**	**Broiler meat (kg)**	**Goat meat (kg)**	**Swine meat (kg)**
Galle	8,844,152	46,689,801	2,193,231	322,021	204,280
Matara	6,733,528	19,583,116	1,408,447	291,097	4,190
Hambantota	14,657,308	26,460,001	1,076,293	176,615	195,958
Total	**30,234,988**	**92,732,918**	**4,677,971**	**789,733**	**404,428**

According to 2018 Annual Report of the Central Bank of Sri Lanka, the livestock sector contributes 0.6 % to GDP. According to the Department of Animal Production & Health year 2018 statistical information, Southern Provincial cattle population was 62,989. Buffalo population was 72,296. Provincial goat and swine population were 15,560 and 4,561 respectively. As a Province in year 2018, Southern Provincial daily average milk production of cow milk was 44,535 Liters and buffalo milk 38,300 Liters and its contribution to the national milk production was 6.11 %. The provincial milk production has been increasing during the last few years by means of 28,102,533 million milk Liters in 2016 up to 30,234,988 million milk Liters in 2018. Broiler chicken meat production in year 2018 was 4,677,971 kg.

Contact points (Livestock Sector)

Dr Sunil Keraminiyage, APD – 0718434490
Dr Sulochana Jinasena, DD - 0716289085

Fisheries Sector

Given below are some vital statics of the livestock sector of Southern Province;

Marine Fishers and marine fishing households

District	NO. of fisheries inspector divisions	Number of Fishing households	No of Active Fishermen
Galle	9	9,200	11,400
Matara	9	11,620	14,430
Hambanthota	12	8,920	13,520
Southern Province	**30**	**29,740**	**39,350**

Source: Statistics Unit - Ministry of Fisheries and Aquatic Resources Development Estimated Based on the annual reports submitted by Fisheries Inspectors of DFAR for their FI Divisions

Operating fishing boats by district - 2017

District	IMUL	IDAY	OFRP	MTRB	NTRB	NBSB	Total Boats
Galle	628	20	412	198	232	38	1528
Matara	956	84	806	273	636	7	2762
Tangalle	514	24	840	129	687	101	2295
Total	**2098**	**128**	**2058**	**600**	**1555**	**146**	**6585**

Source: Statistics Unit, Ministry of Fisheries and Aquatic Resources Development Estimated based on the monthly reports submitted by the Fisheries Inspectors of DFAR for their FI Divisions

Note : IMUL - Inboard Multi-day Boats, IDAY - Inboard Single-day Boats, OFRP - Out-board engine Fiberglass Reinforced Plastic Boats, MTRB - Motorized Traditional Boats, NTRB - Non-motorized Traditional Boats NBSB - Non Motorized Beach Seine Crafts

Active ice plants and production capacity by districts - 2017

District	No. of Ice Plants	Capacity (MT/day)
Galle	5	120
Matara	11	452
Tangalle	6	130
Total	22	702

Source: Statistics Unit, Ministry of Fisheries and Aquatic Resources Development

Fisheries industry in Southern Province - An outlook

Distribution of reservoirs and lagoons in Southern Province

District	Seasonal Tanks	Perennial Tanks	Lagoons
Galle	-	04	06
Matara	-	34	03
Hambanthota	836	40	05
Southern Province	836	78	14

Inland fishers in Southern Province

District	No of Active Fishermen
Galle	1604
Matara	674
Hambantota	8939
Southern Province	**11,217**

Source: National Aquaculture Development Authority of Sri Lanka (NAQDA)

Ornamental fishery industry in Southern Province

District	No of Active Industrialists.
Galle	220
Matara	156
Hambantota	50
Southern Province	**426**

Source: National Aquaculture Development Authority of Sri Lanka (NAQDA)

The Southern Province has a 150 km long costal belt and there are over 32,000 active marine fishermen deploying over 6,500 fishing boats of various types.

Contact points (Fisheries Sector)

Mr Sooriyarachchi, DD(P) – 0718740483
Mr Sampath D/O - 0714464962

Technology Application Priorities of Southern Province

Given below is the summary of technology application priorities of the Agriculture, Livestock and Fisheries sub sectors of the Southern Province.

Intervention No	Intervening Technology	Specific Technology	Specific Application	Market Potential	Provincial Priority	Business Prospects	Prospects for Research & Development
Agriculture Sector							
1	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Solar Electrification of small scale cold rooms	10 cold rooms	High	Low	_
2	Solar thermal or biomass	Solar or biomass fired dryers	Solar or biomass fired dryers for crop drying	100 dryers	High	Low	_
3	Solar PV or thermal	Solar powered dehumidifiers	Solar powered dehumidifiers for crop drying	20 Dehumidifiers	High	Low	
4	Solar PV	Off-grid solar PV systems	Solar water pumps	70 pumps	High	Low	_
5	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Solar electrification of Greenhouses (Protected Agriculture)	50 green houses	High	High	High
6	Bio-diesel	Small scale bio-diesel producing machines	Producing biodiesel using scraped coconut waste	5 units	Low	Low	Medium
7	Biomass	Biomass fired gasifiers	Movable biomass gasifiers for drying of various crops such as cinnamon	200 units	Medium	Medium	_
8	Solar PV	Off-grid solar PV systems with battery storage	Solar powered electric fences	30 sets for around 30 km fencing	Low	Low	_
9	Solar PV	Off-grid solar PV systems with battery charging facility	Solar insect traps (Lights)	500 traps	Medium	Low	Medium
Livestock Sector							
10	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Milk chilling centres	25 Centres	High	Low	_
11	Biogas	Entire value chain of the biogas (Feedstock management, Generation, Cleaning / Filtration, Compression / Storage, Electricity generation / Thermal energy generation)	Large scale dairy farms	6 farms	High	Medium	High
12	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Poultry farms	25 farms	Medium	Low	_
Fisheries Sector							
13	Solar PV	Grid connected solar PV systems with or without battery storage	Solar Powered Battery Charging Stations for Fishermen	200 units	High	Low	_
14	Solar PV	Off-grid solar PV systems with battery charging facility	Solar powered fishing boats	2,000 units	High	High	_
15	Solar PV	Grid connected solar PV systems with or without battery storage	Solar Powered ice plants	10 units	High	Low	_
16	Solar thermal	Solar dryers	Solar powered small-scale fish dryers	2,000 units	High	High	_
17	Solar PV	Grid connected solar PV systems with or without battery storage	Solar Powered Fish Meal Making Machines	50 units	Medium	Low	_
18	Solar PV	Grid connected solar PV systems with or without battery storage	Solar Powered Cold Rooms in Fishery Harbours	10 units	Medium	Low	_
19	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Solar Powered Aquariums	300 units	Medium	Low	_
20	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Solar Powered Lobster Collecting Centres	10 units	Low	Low	_
21	Solar PV	Off-grid solar PV systems with battery charging facility	Solar Powered Desalination Plants for Multiday Boats	1,000 units	High	High	_
Biomass							
22	Biomass	Biomass Fired Thermal Energy Generators	Efficient thermal energy generators for tea, coconut, minor export crops (cinnamon, pepper, etc.), food processing, clay and bakery industries	_	High	Low	_

Twenty-two technology applications have been identified for the consideration of the TSSC Project and they are listed in the above table. Provincial priorities are indicated under three levels; “High”, “Medium” and “Low”. Applications having high prospects for business development and high prospects for further research and development also have been identified and marked as “high”.

Agriculture Sector

Intervention No 1 – Solar Electrification of Small-Scale Cold Rooms

Southern Province agricultural sector provides employment to nearly 36% of its population. Whilst productivity levels are one point of possible intervention, the post-harvest chain of food supply cannot be neglected. About 40% of fruits and vegetables go waste mainly due to lack of food processing and cold storage facilities. Targeting post-harvest losses instead of solely focusing on the production can offer higher internal rates of return, have a significant impact on poverty alleviation, and improvement of health and food security whilst ensuring a more sustainable use of resources.

Many small-scale agro producers in Southern Province struggle with limited storage options and even access to basic cold storage facilities. Due to the lack of cold storage, small-scale farmers are forced to sell their produce as close as possible to their farms after the time of harvest since the market value of vegetables decreases with time. It is estimated that around 10% of the loss occurs in farmer’s markets driving down prices in times of excess supply and in the worst case leads to price crashes resulting in prices that do neither cover production, harvesting or transportation cost. On the other hand, consumers suffer under peaking prices during supply gaps and off-seasons. Storage facilities can help to store seasonal produce for which year-round demand exists and to create buffer stocks stabilizing food prices for producers and consumers alike. Majority of cold storage facilities cater to single commodities only. However, though single commodity storages are easier to manage, the trend is towards multi commodity storages offering higher returns.

As one of the priority interventions, stakeholders of Southern Province wish to have solar powered (grid connected or off-grid solar PV systems with or without battery storage) cold storages facilities preferably using absorption technology instead of vapor compression. It is estimated that the demand for cold storages will be around 10 units.

Intervention No 2 – Solar, Biogas or Biomass Fired dryers for Crop Drying

Drying offers a multitude of advantages which includes reduction in volume, easy handling and transportation, less chance of pest and microbial attack during storage for almost all agricultural products. The basic essence of drying is to reduce the moisture content of the product to a level that prevents deterioration within a certain period of time. For some products, drying is an absolute necessity for size reduction and to have a powdered end product. In the Southern Province, grid-connected electricity and supplies of other non-renewable sources of energy are either unavailable, unreliable or, for many farmers, too expensive. Thus, in such areas, crop drying systems that employ motorized fans and electrical heating are inappropriate. The large initial and running costs of fossil fuel powered dryers present such barriers that they are rarely adopted by small scale farmers. The traditional open sun drying utilized widely by rural farmers has inherent limitations. The crop also requires an undesirably long period to reach this equilibrium moisture content. In hot and humid climates, crop deterioration is obviously worse, as both warmth and high moisture contents promote the growth of fungi, bacteria, mites and insects in crops. Thus, these climatic conditions dictate the need for more effective drying methods. In such conditions, solar-energy crop dryers or biomass fired dryers appear to be attractive commercial propositions.

As one of the priority interventions, stakeholders of Southern Province wish to have a solution to the above problem by making available solar or biomass fired dryers which are affordable to the target group. It is estimated that the demand for solar powered or biomass fired dryers will be around 100 units.

Intervention No 3 – Solar Powered Dehumidifiers for Crop Drying

Traditional drying systems use direct sunlight or indirect heating sources and hence difficult to control the drying conditions. Convective drying systems use hot air and because of high temperature, volatile compounds tend to remove from the product leading to a quality reduction. Use of dehumidified air for drying has been suggested as one of the solutions as drying can be done at relatively lower temperatures while preserving the volatile compounds.

As one of the priority interventions, stakeholders of Southern Province wish to have solar powered dehumidifiers which are affordable to the target group. It is estimated that the demand for solar powered dehumidifiers will be around 20 units.

Intervention No 4 – Solar Water Pumps

Water is essential for agriculture, health of livestock and many other uses. The need to irrigate agricultural land efficiently, economically and sustainably is critical for food security.

Solar PV water pumping systems are reliable and very cost-effective and can replace manual or fossil fuel fired engine driven pumps. A solar water pumping system does not have to use batteries to provide the power as the pump will operate during the day by pumping water into a tank for use at night. A storage battery is needed only if the pump is used at night time or during cloud and rainy climate. These systems are available in different models according to the water consumption and depth of well and can be used for various irrigation methods such as direct irrigation, drip irrigation and sprinkler irrigation. This will either reduce electricity bills or avoid the use of fossil fuel and hence the carbon footprint.

As one of the priority interventions, stakeholders of Southern Province wish to have solar powered (off-grid solar PV systems with or without battery storage) water pumps for agricultural purpose including the removal of saline water and for rain water harvesting. It is estimated that the demand for solar powered pumps will be around 70 units.

Intervention No 5 – Solar Electrification of Greenhouses (Protected Agriculture)

There are over 100 commercial scale farmers in the Southern Province mostly engaged in conventional agriculture depriving them of high quality and higher yields. Cultivation of crops in a protected area is known as protected agriculture and the crops are protected from external factors such as sunlight, wind, rain, pest and disease. There are hosts of other benefits when protected agriculture is adopted; (1) Optimal usage of fertilizer and water under micro irrigation systems (2) Crops can be grown under non-availability of fertile soil with the help of some other growing media's like coir pith (3) High quality of produce compared to conventional farming (4) Increased crop duration (prolong cultivation) (5) Possibility of adopting some advanced techniques like hydroponics, aeroponics, etc. Although protected agriculture provides high quality and higher yield, it requires substantial amount of energy for various activities such as Misters, Micro-irrigation Systems, Exhaust Fans, Lighting, etc.

As one of the priority interventions, stakeholders of Southern Province wish to promote protected agriculture powered by grid connected or off-grid solar PV systems with or without battery storage which are affordable to the target group. It is estimated that around 50 Green Houses can be promoted with the capacity around 1,000 ft^3 among farmers of the Southern Province for the first round.

Intervention No 6 – Bio-diesel Producing Machine

Biodiesel is an alternative fuel similar to conventional or 'fossil' diesel. Biodiesel can be produced from vegetable oil, animal oil/fats, tallow and waste cooking oil. The process used to convert these oils to Biodiesel is called transesterification.

Obtaining cheaper raw materials are one of the continuous targets of many biodiesel producing facilities since most of the production costs are attributed to raw materials. One of the main options is to use waste material from animal and plant sources. Biodiesel can be produced using scraped coconot waste from domestic and other commercial users if a simple and cost effective collection system can be introduced. The coconut waste is used to produce biodiesel using ethanol and NaOH. The oil content of coconut waste varies from 10-11% weight. The biodiesel could be used as pure fuel or as a blend with petro diesel, which is stable in all ratio.

As one of the priority interventions, stakeholders of Southern Province wish to have small scale bio-diesel producing machines. It is estimated that the demand for such machines will be around 5 units.

Intervention No 7 – Movable Biomass Gasifiers for Crop Drying

The most available forms of biomass types in the Southern Province are fuel wood, saw dust, rice husk, agricultural waste, municipal waste, and industrial waste and industries have been moving to operate their thermal energy generators such as boilers, driers, furnace, etc. using biomass instead of fossil fuel.

A biomass gasifier is a device that converts biomass into a combustible gas called "producer gas". Dryers powered by biomass gasifiers appear to be an attractive proposition especially for small scale farmers. As in the case of hiring other agricultural machineries such as tractors, harvesters, etc., such farmers could hire dryers powered by movable biomass gasifiers for drying of various crops such as cinnamon.

As one of the priority interventions, stakeholders of Southern Province wish to have such units. It is estimated that the demand for dryers powered by movable biomass gasifiers will be around 200 units.

Intervention No 8 – Solar Powered Electric Fence

As settlements and arable areas spread, conflict between human and animal builds up - especially with wild elephants. Ecological considerations demand that man and animal live in harmony. The only way to ensure that man and beast co-exist peacefully is by erecting non-lethal high voltage electric fences, which repel intruders without harming them. These help to secure human lives, guard wildlife from human intrusion and also to bring large tracts of fertile land under cultivation. Most fences have to be built in remote areas where mains electricity is not available.

Solar powered electric fences are an ideal solution for animal containment or exclusion fences in areas where 230 V power is not available or is inconvenient to obtain. A small solar PV panel simply collects and converts sunlight into energy that is stored in a battery. The battery supplies current to the grounded energizer that then sends about one pulse of electric current per second down the fence. When an animal touches the fence the circuit between the fence and the ground is completed and the animal receives a short, sharp, but safe shock.

As one of the priority interventions, stakeholders of Southern Province wish to have solar powered (off-grid solar PV systems with battery storage) electric fences to protect farms from wild animal attacks including wild elephants. It is estimated that the demand for solar powered electric fence will be around 30 sets for around 30 km of fencing.

Intervention No 9 – Solar Insect Traps

Agriculture is the main occupation of people in the Southern Province. Farmers encounter the problems of various types of insect pests that harm crops and result in loss of productivity. Therefore, it is necessary for farmers to use pesticides to prevent crop damage. However, when pesticides are used in large quantities, they cause adverse impacts on people, animals and the environment. Instead of using pesticides, there are other ways to prevent insect pests, including the use of biological agents and ultraviolet light of light emitting diode tubes powered by solar energy. Normally 12-volt batteries are used as power supply to light emitting diode tube. The battery charging system derives electrical energy from around 20 watts of solar PV cell for use at night. This type of solar energy-based insect pests traps are fitted with automatic control systems to lure insect pests when there is no sunlight and the system will be stopped when the sun shines. Solar energy-based insect pests trap could lure several types of insect pests in vegetable, fruits and even in coconut plantations.

As one of the priority interventions, stakeholders of Southern Province wish to have solar powered (off-grid solar PV systems with battery storage) insect traps for farms. It is estimated that the demand for solar powered insect traps will be around 500 units.

Livestock Sector

Intervention No 10 – Milk Chilling Centers

There are over 50 milk chilling centers operating in the Southern Province managed either by large-scale milk processing companies or by Farmer Cooperative Societies. These chilling centers need electrical energy for chiller operation and hot water for equipment cleaning including the milk cans brought by milk producing farmers. Cost of electricity comprises of the major portion of cost of production.

As one of the priority interventions, stakeholders of Southern Province wish to have grid connected or off-grid solar PV systems with or without battery storage to supply electricity for the chilling centers. It is estimated that there are around 25 chilling centers to benefit from this intervention.

Intervention No 11 – Biogas Systems for Large Scale Dairy Processors & Broiler Farms (Biogas Upgrading)

Biogas technology is not new to Sri Lanka. However, its adoption has been confined to small scale domestic and farm use for low level applications such as lighting, hot water generation, cooking, etc.

There had been some isolated attempts to operate relatively large-scale bio gas generators with limited success. Biogas upgrading has never been tried out in Sri Lanka in commercial scale other than a few attempts to generate electricity in small standby generators. With the environmental regulations becoming more stringent, there is a tendency to use biogas generators as a waste management solution for environmental compliance by large-scale farms, slaughter houses and market places. Anaerobic digestion serves to reduce the volume of wastes and the associated problem of their disposal such as contamination of groundwater, surface water, and other resources and effectively destroys harmful pathogens. Eluent from biogas digesters can serve as high quality organic fertilizer, displacing import of synthetic nitrogenous fertilizers.

As one of the priority interventions, stakeholders of Southern Province wish to have fully integrated biogas systems (upgraded biogas systems) for about six large scale dairy processors and broiler farms in the Province. This has to be for the entire value chain of the biogas (Feedstock management, Generation, Cleaning / Filtration, Compression /

Storage, Electricity generation / Thermal energy generation) including SMART performance monitoring arrangements at every stage.
Electricity generated using biogas can be used to supplement the grid electricity for various operations of dairy processing and broiler farms.

Intervention No 12 – Solar Powered Poultry Farms

There are many broiler farms in the Southern Province selling their birds either to large scale broiler chicken processing companies as sub-contractors or selling directly to consumers in the areas they operate. These farms need electrical energy to operate various machinery and equipment (Feed mixing, ventilation, incubation, brooding, defeathering, freezing, etc.). Cost of electricity comprises of the major portion of cost of production.

As one of the priority interventions, stakeholders of Southern Province wish to have grid connected or off-grid solar PV systems with or without battery storage to supply electricity for poultry farms. It is estimated that there are around 25 broiler farms to benefit from this intervention.

Fisheries Sector

The fisheries sector plays a key role in Southern Province's social and economic life. From an economic viewpoint, there is significant scope for increasing the level of contribution from the sector through increased output, exploiting the potential for value addition and import substitution. The fisheries sector of the Province consists of three main subsectors, namely coastal (marine); offshore and deep sea; and inland and aquaculture. These three subsectors employ around 40,000 active fishers and another around 16,000 in support services.

Given below are prospective applications in the fishery sector to utilize renewable energy (Solar, Biogas and Biomass) which would realize multiple benefits; economic, social and environment.

Intervention No 13 – Solar Powered Battery Charging Stations for Fishermen

As one of the priority interventions, stakeholders of Southern Province wish to have solar powered battery charging systems for fishermen at anchorages, harbours & landing sites. It is estimated that the demand for solar powered battery charging systems will be around 20 units.

Intervention No 14 – Solar Powered Fishing Boats

Solar energy could be used for various purposes such as GPS, VMS, SSB radios, phone charging, desalination of sea water for drinking purpose, cold rooms and lighting in fishing boats.

As one of the priority interventions, stakeholders of Southern Province wish to have solar powered fishing boats. It is estimated that the initial demand will be around 2,000 units. Such a high number offers a good business opportunity for a Chinese producer or a supplier of such equipment possibly with a Sri Lankan counterpart as a joint venture partner. Even there could be a possibility of doing either part or full assembly or even manufacturing aiming at other bigger markets in the region.

Intervention No 15 – Solar Powered Ice Plants

As one of the priority interventions, stakeholders of Southern Province wish to have solar powered ice plants. It is estimated that the demand will be around 10 units. As per the information of the Provincial Fisheries Ministry of Southern Province, there were around 22 active ice plants in 2017 with the total capacity of over 700 MT of ice per day.

Intervention No 16 – Solar Fish Dryers

There are around 40,000 fishermen in the Southern Province engaged in marine as well as inland fishing. The demand is mainly for fresh fish. Fishermen have to preserve unsold daily catch for future use either by freezing or by drying. As frozen inland fish varieties are not in demand and also many fishermen cannot afford freezing equipment, they mainly do open sun drying or smoking. Open sun drying affects the quality of dried fish due to contamination with dust, insects and bird droppings, etc. apart from discoloration.

As one of the priority interventions, stakeholders of Southern Province wish to have a solution to the above problem by making available solar dryers which are affordable to the target group. It is estimated that the demand for solar powered small-scale fish dryers will be around 2,000 units.

Intervention No 17 – Solar Powered Fish Meal Making Machines

As one of the priority interventions, stakeholders of Southern Province wish to have solar powered fish meal making machines using fish offal and waste. It is estimated that the demand will be around 50 units.

Intervention No 18 – Solar Powered Cold Rooms in Fishery Harbours

As one of the priority interventions, stakeholders of Southern Province wish to have solar powered cold rooms in fishery harbours. It is estimated that the demand will be around 10 units.

Intervention No 19 – Solar Powered Aquariums

As one of the priority interventions, stakeholders of Southern Province wish to have solar powered aquariums. It is estimated that the demand will be around 300 units.

Intervention No 20 – Solar Powered Lobster Collecting Centres

As one of the priority interventions, stakeholders of Southern Province wish to have solar powered lobster collecting centres. It is estimated that the demand will be around 10 units.

Intervention No 21 – Solar Powered Desalination Plants for Multiday Boats (IMUL)

As one of the priority interventions, stakeholders of Southern Province wish to have solar powered desalination plants for multiday boats (IMULs). It is estimated that the demand will be around 1,000 units. As per the information of the Provincial Fisheries Ministry of Southern Province, there were over 2,000 IMULs in 2017.

IMUL - Inboard Multi-day Boats
IDAY - Inboard Single-day Boats
OFRP - Out-board engine Fiberglass Reinforced Plastic Boats
MTRB - Motorized Traditional Boats
NTRB - Non-motorized Traditional Boats
NBSB - Non-motorized Beach Seine Crafts

Biomass

The most available forms of biomass types in the Southern Province are paddy husk, saw dust, coconut shells, coconut husks, fuel wood (Rubber, coconut, etc.) and agricultural waste and industries have been moving to operate their thermal energy generators such as boilers, hot water generators, driers, furnace, hot air generators, etc. using biomass instead of fossil fuel.

Contact points (Biomass)

Mr Krisantha Mahendra, Provincial Director, Industries – 071449797, 0777302047

Intervention No 22 – Biomass Fired Thermal Energy Generators

As one of the priority interventions, stakeholders of Southern Province wish to have more efficient thermal energy generators for tea, coconut, minor export crops (cinnamon, pepper, etc.), food processing, clay and bakery industries.

Training and Capacity Building

All technology applications require training and capacity building as stated below;

Agriculture sector
- Technology awareness, maintenance and monitoring

Fisheries sector
- Training for fisheries folk (2,500) and officials (150)

Livestock sector
- Advanced training for officers & stakeholders
- Instrument bank (or supply of instruments) for entrepreneurs

Environmental Safeguards

As a precautionary measure for environmental safeguards, it is suggested to incorporate Extended Producer Responsibility (EPR) to all interventions of TSSC project to make the battery suppliers of Solar PV systems responsible for end of life disposal.

Sources of Statistical Information

1. Department of Land Use
2. National Aquaculture Development Authority of Sri Lanka (NAQDA)
3. National Fisheries Federation
4. Statistical Data base 2014 - Chief Secretariat, Southern Province
5. Statistics Unit - Ministry of Fisheries and Aquatic Resources Development

Technology Application Priorities Eastern Province

Agriculture, Livestock & Fisheries Sub Sectors

Submitted to

Biogas, Biomass and Solar Trilateral Cooperation
Transitioning to Sustainable Energy Uses
In the Agro-Industry Project
Sri Lanka - China – Ethiopia

United Nations Development Programme, Sri Lanka

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Content

Overview of Eastern Province of Sri Lanka

The Eastern Province of Sri Lanka is one of the nine provinces of Sri Lanka and consists of three administrative districts viz; Trincomalee, Batticaloa and Ampara. The population of the Eastern Province is around 1.7 million. The boundaries of the Eastern Province are; in the North by the Northern Province, East by the Bay of Bengal, South by the Southern Province and the West by North Central and Uva Provinces.

It is endowed with plethora of natural resources with high potential for development in several areas including commercialized agriculture, tourism and fisheries. Availability of natural harbor in Trincomalee and connected network of transportation by land and air provide enormous opportunities for the harnessing of potential for related development projects.

It has a total land area of 9,996 sq.km of which 635 sq.km are inland water bodies. Water bodies include the lagoons, bays, freshwater tanks and streams in the area. With regard to land utilization, the province has 393,742 Ha of agricultural land (42.06 % of the land area of the province). The coastal line of 431 km extends from Kokilai in the northern boundary to Panama in the southern boundary of the province.

The agriculture, fisheries, forestry and mining sectors in the Eastern Province have significant potential and presently make important contribution to economic growth. The agriculture sector including crop agriculture, livestock farming and fisheries is the dominant productive sector in the Province and contributes 16.8% of the provincial GDP.

Overview of Agriculture Sector of Eastern Province
(Including Livestock & Fisheries)

Agriculture Sector

The Agriculture sector is the dominant productive sector contributing much in the economy of the Province as 70 % of the total population involve in agriculture and its related activities for their livelihood, resulting in rapid development of the agriculture sector in the Province. Paddy which is the dominant and important crop in the province is being cultivated in 45.6 % of the total agricultural land area and it is 19.2% of the land area of the province. Paddy harvesting yield was 1.1 Mn Mt in 2018 and OFC cultivation was 60,397.88 Mt in year 2017.

Contact point (Agriculture Sector)

Dr S.M.Hussain – 0773876356, segumatharaliyar@yahoo.com

Fisheries Sector

Fisheries sector is the second important productive sector of the province, next to agriculture. Existing long coastal shoreline (23% of total coastal line of the island) of the province contributes to marine fishing activities, giving opportunities to the fishing community to involve in fishing related activities including export of fish products. There are around 99,690 active marine and inland fishermen deploying over 12,736 mechanized fishing boats of various types and 2,475 inland fishing boats. In Eastern Province, inland fishing contributes 26.57% of national inland fish production while marine fishing contributes 16% of the national marine fish production.

Contact point (Fisheries Sector)

Mr S.Suthakaran – 0779003528, aquasutha@gmail.com

Livestock Sector

The livestock Industry has become an important sector for entrepreneurs in the Eastern Province as this province is one of the major milk producing regions in Sri Lanka. Milk production reached 171,600 liters per day and the egg production reached 6.6 Mn per month in 2018. Given below are some vital statics of the livestock sector of Eastern Province;

According to 2018 Annual Report of the Central Bank of Sri Lanka, the livestock sector contributes 0.85 % to GDP. According to the Department of Animal Production & Health year 2018 statistical information, Eastern Provincial cattle population was 500,948. Buffalo population was 206084. Provincial goat population is 232,967. Comparing the milk production with other provinces in the country, Eastern Province holds 3rd place by producing 66.8 Mn Liters milk in year 2018. As a Province, in year 2018, Eastern Provincial annual average milk production of cow milk was 49.8 Mn Liters and buffalo milk 17 Mn Liters and its contribution to the national milk production was 13.5 %. The provincial milk production has been increasing during the last few years by means of 96,411 Liters per day in 2006 to 171,600 Liters per day in 2018.

Contact point (Livestock Sector)

Dr M.A.M. Fazi – 0718452558, 0262221008, fazivet115@yahoo.com

Technology Application Priorities of Eastern Province

Given below is the summary of technology application priorities of the Agriculture, Livestock and Fisheries sub sectors of the Eastern Province.

Intervention No	Intervening Technology	Specific Technology	Specific Application	Market Potential	Provincial Priority	Business Prospects	Prospects for Research & Development
Agriculture Sector							
1	Solar thermal or biomass	Solar or biomass fired dryers	Solar or biomass fired dryers for crop drying	1,000 dryers	High	High	_
2	Solar thermal or biomass	Solar or biomass fired dryers	Solar or biomass fired dryers for paddy drying	1,500 dryers	High	Medium	_
3	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Solar Electrification of small scale cold rooms	1,000 cold rooms	High	High	_
4	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Agriculture farm mechanization	500 farms	High	Medium	_
5	Solar PV	Off-grid solar PV systems with battery storage	Solar powered elephant repellent systems	1,500 units	High	Low	_
6	Solar PV	Off-grid solar PV systems	Solar powered desalination systems for agriculture purposes	500 units	Medium	Low	_
Livestock Sector							
7	Biogas	Entire value chain of the biogas (Feedstock management, Generation, Cleaning / Filtration, Compression / Storage, Electricity generation / Thermal energy generation)	Large scale dairy farms	40 farms	High	Low	High
8	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Poultry farms	90 farms	High	Low	_
9	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Can coolers for milk producers (Refrigerated cans)	74,000 cans	High	High	_
10	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Milk chilling centres	30 Centres	High	Medium	_
Fisheries Sector							
11	Solar thermal	Solar dryers	Solar powered small-scale fish dryers	200 units	High	High	_
12	Solar PV	Off-grid solar PV systems with battery storage	Solar powered medium scale refrigerators / mini ice plants for fish vendors	500 units	High	Low	_
13	Biogas	Biogas for IC engines and for electricity generation	Biogas driven fishing boats	_	Low	Low	High
14	Solar PV	Off-grid solar PV systems with battery storage	Solar powered refrigeration systems for fishermen	1,000 units	High	Low	_
15	Solar PV	Off-grid solar PV systems with battery storage	Solar powered aerators for shrimp farming	800 units	High	High	_
General							
16	Solar PV	Off-grid solar PV systems with battery storage	Solar Powered Parking Lots for Electrical Vehicle	30 units	Low	Low	_

Sixteen technology applications have been identified for the consideration of the TSSC Project and they are listed in the above table. Provincial priorities are indicated under

three levels; “High”, “Medium” and “Low”. Applications having high prospects for business development and high prospects for further research and development also have been identified and marked as “high”.

Agriculture Sector

Intervention No 1 – Solar or Biomass Fired dryers for Crop Drying

Drying offers a multitude of advantages which includes reduction in volume, easy handling and transportation, less chance of pest and microbial attack during storage for almost all agricultural products. The basic essence of drying is to reduce the moisture content of the product to a level that prevents deterioration within a certain period of time. For some products, drying is an absolute necessity for size reduction and to have a powdered end product. In certain parts of the Eastern Province, grid-connected electricity and supplies of other non-renewable sources of energy are either unavailable, unreliable or, for many farmers, too expensive. Thus, in such areas, crop drying systems that employ motorized fans and electrical heating are inappropriate. The large initial and running costs of fossil fuel powered dryers present such barriers that they are rarely adopted by small scale farmers. The traditional open sun drying utilized widely by rural farmers has inherent limitations. The crop also requires an undesirably long period to reach this equilibrium moisture content. In hot and humid climates, crop deterioration is obviously worse, as both warmth and high moisture contents promote the growth of fungi, bacteria, mites and insects in crops. Thus, these climatic conditions dictate the need for more effective drying methods. In such conditions, solar-energy crop dryers or biomass fired dryers appear to be attractive commercial propositions.

As one of the priority interventions, stakeholders of Eastern Province wish to have a solution to the above problem by making available solar powered or biomass fired dryers which are affordable to the target group. It is estimated that the demand for solar powered or biomass fired dryers will be around 1,000 units.

Intervention No 2 – Solar or Biomass Fired dryers for Paddy Drying

Harvested paddy with high moisture content should be dried properly for safe storage and milling since high moisture in the harvested paddy promotes the development of insects and molds. The delay in drying, incomplete drying or uneven drying will result in the loss of the anticipated quality standard of rice. Paddy drying is often a problem for farmers and they have to sell their wet paddy stock at a lower price to the large-scale rice mill owners due to lack of proper on-farm drying technologies at affordable cost.

Problem is aggravated with large-scale mechanical threshers and combines harvesters. Presently, due to an increase in usage of such harvesters, moisture content of freshly

harvested paddy is being high as much as 18-24%. These combine harvesters with high capacity enable for both harvesting and threshing at once. Thus, the paddy harvested persists with high moisture content that affects adversely the operations of paddy processing such as cleaning, storing, and milling.

Therefore, as one of the priority interventions, stakeholders of Eastern Province wish to have a solution to the above problem by making available solar powered or biomass fired paddy dryers that can be used at field level for freshly harvested paddy (either mobile driers with a capacity of around 1 MT metric tons or stationary driers with a capacity of up to 6 MT for farmer organizations) which are affordable to the target group. It is estimated that the demand will be around 1,500 units.

Intervention No 3 – Solar Electrification of Small-Scale Cold Rooms

Eastern Province agricultural sector provides employment to nearly 28.3% of its population. Whilst productivity levels are one point of possible intervention, the post-harvest chain of food supply cannot be neglected. About 40% of fruits and vegetables go waste mainly due to lack of food processing and cold storage facilities. Targeting post-harvest losses instead of solely focusing on the production can offer higher internal rates of return, have a significant impact on poverty alleviation, and improvement of health and food security whilst ensuring a more sustainable use of resources.

Many small-scale agro producers in Eastern Province struggle with limited storage options and even access to basic cold storage facilities. Due to the lack of cold storage, small-scale farmers are forced to sell their produce as close as possible to their farms since the market value of vegetables decreases with time. It is estimated that around 10% of the loss occurs in farmer's markets driving down prices in times of excess supply and in the worst case leads to price crashes resulting in prices that do neither cover production, harvesting or transportation cost. On the other hand, consumers suffer under peaking prices during supply gaps and off-seasons. Storage facilities can help to store seasonal produce for which year-round demand exists and to create buffer stocks stabilizing food prices for producers and consumers alike. Majority of cold storage facilities cater to single commodities only. However, though single commodity storages are easier to manage, the trend is towards multi commodity storages offering higher returns.

As one of the priority interventions, stakeholders of Eastern Province wish to have solar powered (grid connected or off-grid solar PV systems with or without battery storage) cold storages facilities preferably using absorption technology instead of vapor compression. It is estimated that the demand for cold storages will be around 1,000 units.

Intervention No 4 – Agriculture Farm Mechanization

Operations of many agriculture farms are carried out manually due to either non-availability of machineries at affordable prices or high cost of energy (electricity as well as fossil fuel) required to operate them. Manual operations reduce the overall productivity.

As one of the priority interventions, stakeholders of Eastern Province wish to have a considerable number of agricultural farms mechanized by making available suitable machineries for operations such as land preparation, transplanting, weeding, spraying of agro chemicals, harvesting, etc. powered by grid connected or off-grid solar PV systems with or without battery storage which are affordable to the target group. It is estimated that around 500 farms can be mechanized in the first round.

Compared to other technology applications, farm mechanization needs and provides ample opportunities for research and development for productivity gains and product quality improvements.

Intervention No 5 – Solar Powered Elephant Repellent Systems

As settlements and arable areas spread, conflict between human and animal builds up - especially with wild elephants. Ecological considerations demand that man and animal live in harmony. One way to ensure that man and beast co-exist peacefully is by erecting non-lethal repellers, which repel intruders without harming them. These help to secure human lives, guard wildlife from human intrusion and also to bring large tracts of fertile land under cultivation. Repellers have to be built in remote areas where grid electricity is not available. Solar powered repellers are an ideal solution for animal containment in areas where 230 V power is not available or is inconvenient to obtain.

Repellers use ultrasonic sound technology to deter without harming a wide range of animals including dogs, cats, bird, pigeon, foxes, squirrels, deer, rats, mice, elephants, etc. Repellers have different settings to selectively repel those animals that are unwanted but do not affect people, fish or birds.

As one of the priority interventions, stakeholders of Eastern Province wish to have solar powered (off-grid solar PV systems with battery storage) repellers to protect farms from wild animal attacks including wild elephants. It is estimated that the demand for solar powered repellers will be around 1,500 units.

Intervention No 6 – Solar Powered Desalinated Water for Agriculture Purposes

With worldwide concerns about water scarcity, agriculture is under pressure to improve water management and explore available options to match supply and demand. Desalination is a technical option to increase the availability of freshwater both in coastal areas with limited resources and in areas where brackish waters – such as saline groundwater, drainage water and treated wastewater – are available. Desalinated water can also be crucial in emergency situations where water sources have been polluted by saline incursions. Saline water intrusion is a major issue in the coastal areas of the Eastern Province.

Water desalination is a well-established technology mainly for drinking-water supply in water scarce regions. However, with agriculture accounting for around 69 percent of all water withdrawals compared to domestic use of about 10 percent and industry about 21 percent, it is the main source of potable water in many islands around the world and it is also being used in certain countries to irrigate high-value crops.

As one of the priority interventions, stakeholders of Eastern Province wish to have solar powered desalination systems for agriculture purposes. It is estimated that the demand will be around 500 units.

Livestock Sector

Intervention No 7 – Biogas Systems for Large Scale Dairy Processors & Broiler Farms (Biogas Upgrading)

Biogas technology is not new to Sri Lanka. However, its adoption has been confined to small scale domestic and farm use for low level applications such as lighting, hot water generation, cooking, etc.

There had been some isolated attempts to operate relatively large-scale bio gas generators with limited success. Biogas upgrading has never been tried out in Sri Lanka in commercial scale other than a few attempts to generate electricity in small standby generators. With the environmental regulations becoming more stringent, there is a tendency to use biogas generators as a waste management solution for environmental compliance by large-scale farms, slaughter houses and market places. Anaerobic digestion serves to reduce the volume of wastes and the associated problem of their disposal such as contamination of groundwater, surface water, and other resources and effectively destroys harmful pathogens. Eluent from biogas digesters can serve as high quality organic fertilizer, displacing import of synthetic nitrogenous fertilizers.

As one of the priority interventions, stakeholders of Eastern Province wish to have fully integrated biogas systems (upgraded biogas systems) for about 40 large scale dairy processors and broiler farms in the Province. This has to be for the entire value chain of the biogas (Feedstock management, Generation, Cleaning / Filtration, Compression / Storage, Electricity generation / Thermal energy generation) including SMART performance monitoring arrangements at every stage.

Electricity generated using biogas can be used to supplement the grid electricity for various operations of dairy processing and broiler farms.

Intervention No 8 – Solar Powered Poultry Farms

There are many broiler farms in the Eastern Province selling their birds either to large scale broiler chicken processing companies as sub-contractors or selling directly to consumers in the areas they operate. These farms need electrical energy to operate various machinery and equipment (Feed mixing, ventilation, incubation, brooding, defeathering, freezing, etc.). Cost of electricity comprises of the major portion of cost of production.

As one of the priority interventions, stakeholders of Eastern Province wish to have grid connected or off-grid solar PV systems with or without battery storage to supply electricity for poultry farms. It is estimated that there are around 90 broiler farms to benefit from this intervention.

Intervention No 9 – Can Coolers for Milk Producers

There are over 65,000 small holder milk producers in the Eastern Province selling raw milk to Chilling Centers operating in the area either under the management of large-scale milk processing companies or under the Farmer Cooperative Societies. These chilling centers are supplied by individual or dairy cooperatives. They use various types of cans made out of aluminum, plastic or stainless steel for transporting / delivering raw milk from their farms to Chilling Centers mostly using bicycles. In order to maintain the required quality standards and hygienic conditions, raw milk has to be transported / delivered to a chilling center within a short period of time from the time of milking if not refrigerated / chilled. Farmers find it difficult to fulfill this requirement due to various reasons such as long distance from their farms to the nearest chilling centers, their other important engagements in the morning hours, etc. This results in either poor quality of milk reached chilling centers or loss of revenue to farmers if their supply is totally rejected due to unacceptable quality. Very high quality of raw milk is required to make liquid milk for which the demand is on the increase. In the absence of a viable solution to keep raw milk overnight without allowing

it to rot, many farmers do the milking only in the morning but not in the evening depriving them of probable high yield and hence high income.

As one of the priority interventions, stakeholders of Eastern Province wish to have a solution to the above problem by making available can coolers / refrigerated cans powered by grid connected or off-grid solar PV systems with or without battery storage which are affordable to the target group. It is estimated that around 74,000 can coolers will be required for the milk producing farmers of the Eastern Province. Such a high number offers a good business opportunity for a Chinese producer or a supplier of can coolers possibly with a Sri Lankan counterpart as a joint venture partner. Even there could be a possibility of doing either part or full assembly or even manufacturing aiming at other bigger markets in the region.

Intervention No 10 – Milk Chilling Centers

There are over 40 milk chilling centers with 90,000 liters chilling capacity operating in the Eastern Province managed either by large-scale milk processing companies or by Farmer Cooperative Societies. These chilling centers need electrical energy for chiller operation and hot water for equipment cleaning including the milk cans brought by milk producing farmers. Cost of electricity comprises of the major portion of cost of production.

As one of the priority interventions, stakeholders of Eastern Province wish to have grid connected or off-grid solar PV systems with or without battery storage to supply electricity for the chilling centers. It is estimated that there are around 30 chilling centers to benefit from this intervention.

Fisheries Sector

The fisheries sector plays a key role in Eastern Province's social and economic life. From an economic viewpoint, there is significant scope for increasing the level of contribution from the sector through increased output, exploiting the potential for value addition and import substitution. The fisheries sector of the Province consists of three main subsectors, namely coastal (marine); offshore and deep sea; and inland and aquaculture. These three subsectors employ around 99,690 active fishers and a larger number in providing support services and marketing.

Given below are prospective applications in the fishery sector to utilize renewable energy (Solar, Biogas and Biomass) which would realize multiple benefits; economic, social and environment.

Intervention No 11 – Solar or Biomass Fired Fish Dryers

There are around 99,690 fishermen in the Eastern Province engaged in marine as well as inland fishing. The demand is mainly for fresh fish. Fishermen have to preserve unsold daily catch for future use either by freezing or by drying. As frozen inland fish varieties are not in demand and also many fishermen cannot afford freezing equipment, they mainly do open sun drying or smoking. Open sun drying affects the quality of dried fish due to contamination with dust, insects and bird droppings, etc. apart from discoloration.

As one of the priority interventions, stakeholders of Eastern Province wish to have a solution to the above problem by making available solar or biomass fired dryers which are affordable to the target group. It is estimated that the demand for solar powered or biomass fired small-scale fish dryers will be around 200 units.

Intervention No 12 – Solar Powered Medium Scale Refrigerators / Mini Ice Plants for Fish Vendors

As one of the priority interventions, stakeholders of Eastern Province wish to have solar powered medium scale refrigerators / mini ice plants for fish vendors. It is estimated that the demand will be around 500 units.

Intervention No 13 – Biogas Driven Fishing Boats

The stakeholders of Eastern Province wish to explore the possibility of using biogas energy for various purposes of fishing boats (GPS, VMS, SSB radios, phone charging, desalination of sea water for drinking purpose, cold rooms and lighting) including vessel propulsion.

This may require either on board biogas production from fish offal (guts, trash fish and galley waste) or compressed / liquefied biogas in cylinders brought from out-board biogas production systems.

Certainly, for the on-board biogas production, a lot of space would be required for the digester and the gas holding tank. The gas from the biogas digester could be fed directly to the engine which could be switched over from regular fuel whenever sufficient biogas had been produced. One ton of trash fish or fish offal could produce over 500 m3 of biogas, equivalent to over 310 liters of diesel oil -- sufficient probably for 24 hours continuous engine operation though the storage might be a challenge.

As one of the priority interventions, stakeholders of Eastern Province wish to have biogas driven fishing boats.

Perhaps, this would be an excellent idea for further research and development (R&D) under the TSSC project. From the R&D of on-board biogas production, if it is found to be not feasible, other option of using compressed / liquefied biogas in cylinders brought from out-board biogas production systems could be pursued.

Intervention No 14 – Solar Powered Refrigeration Systems for Fishermen

As one of the priority interventions, stakeholders of Eastern Province wish to have solar powered refrigeration systems for fishermen. It is estimated that the demand will be around 1,000 units.

Intervention No 15 – Solar Powered Aerators for Shrimp Farming

The shrimp industry makes a substantial contribution to national economy through export earnings. Dissolved oxygen is one of the most critical aspects of water quality in fish culture systems. The shrimp farming requires a significant amount of energy for aeration systems to continuously maintain suitable dissolved oxygen levels in ponds for improving water quality and promoting shrimp growth. As most shrimp farms are located away from power lines, it is necessary to use renewable energy such as solar energy.

As one of the priority interventions, stakeholders of Eastern Province wish to have solar powered aerators for shrimp farming. It is estimated that the demand will be around 800 units.

General

Intervention No 16 – Solar Powered Parking Lots for Electrical Vehicle Charging

The concept of solar parking lots aims at coupling the development of clean solar electricity and electric mobility. Solar panels provide shade and generate electricity to charge parked electric vehicles.

Electric vehicles (EV) are growing in popularity as a credible alternative to fossil fuel powered vehicles as they are more energy efficient and environmentally friendly. These vehicles require their batteries to be “fueled up” for operation. But the lack of charging

stations restricts the wide adoption of EVs. As EV usage grows, there is a need to install EV charging stations in public spaces.

As one of the priority interventions, stakeholders of Eastern Province wish to have solar powered parking lots for electrical vehicle charging. It is estimated that the demand will be around 30 units.

Training and Capacity Building

All technology applications require training and capacity building as stated below;

Agriculture sector
- Technology awareness programmes
- Exposure and field visits
- Training on operation & maintenance

Fisheries sector
- Knowhow for technology transfer
- Awareness & training for fisheries folk and officials
- Equipment & resource pool for renting purposes (eg. Mini ice plant, mini smoker, etc._

Livestock sector
- Knowhow for technology transfer
- Training for officers, technicians & farmers

Reference

Eastern Province – Medium Term Development Plan 2016-2021
Eastern Province – Medium Term Sectoral Result Framework 2019-2021

Technology Application Priorities Northern Province

Agriculture, Livestock & Fisheries Sub Sectors

Submitted to

Biogas, Biomass and Solar Trilateral Cooperation
Transitioning to Sustainable Energy Uses
in the Agro-Industry Project
Sri Lanka - China – Ethiopia

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Content

Overview of Northern Province of Sri Lanka

The Northern Province of Sri Lanka is one of the nine provinces of Sri Lanka and consists of five administrative districts viz; Jaffna, Killinochchi, Mannar, Mulaitivu and Vavuniya.

The population of the Northern Province is around 1.23 million. The province is surrounded by the Gulf of Mannar and Palk Bay to the west, Palk Strait to the north west, the Bay of Bengal to the north and east and the Eastern, North Central and North Western provinces to the south.

The province is divided into two distinct geographic areas: Jaffna peninsula and the Vanni. Jaffna peninsula is irrigated by underground aquifers fed by wells whereas the Vanni has irrigation tanks fed by perennial rivers.

It is endowed with plethora of natural resources with high potential for development in several areas including commercialized agriculture, livestock and fisheries. Availability of a commercial harbor in Kankasanturei and connected network of transportation by land and air via Palai airport provide enormous opportunities for the harnessing of potential for related development projects.

It has a total land area of 8,884 sq.km which includes 594 sq. km. of water bodies. Water bodies include the lagoons, bays, freshwater tanks and streams in the area. With regard to land utilization, the province has 167,368 Ha of cultivable land (19 % of the land area of the province). The coastal line is 594 km.

The agriculture, fisheries and livestock sectors in the Northern Province have significant potential and presently make important contribution to economic growth. The agriculture sector including crop agriculture, livestock farming and fisheries is the dominant productive sector in the Province.

Overview of Agriculture Sector of Northern Province
(Including Livestock & Fisheries)

Agriculture Sector

The Agriculture is the dominant productive sector contributing much in the economy of the Province as 44 % of the total population involve in agriculture and its related activities for their livelihood in this province, resulting in rapid development of the agriculture sector in the Province. Paddy which is the dominant and important crop in the province, is being cultivated in 99,642b ha and it is around 60% of the total cultivable land area of the province. Paddy production was 357,649 MT in both Yala 2019 and Maha 2019/2020 together.

Contact point (Agriculture Sector)

Mr Sivakumar, Provincial Director of Agriculture – 0773868581, npagriculture@gmail.com

Fisheries Sector

Fisheries sector is the second important productive sector of the province, next to agriculture. Existing long coastal shoreline (44% of total coastal line of the island) of the province contributes to marine fishing activities, giving opportunities to the fishing community to involve in fishing related activities including export of fish products. There are over 38,688 active marine fishermen deploying over 21,183 fishing boats of various types. In Northern Province, inland fishing contributes 3% of national inland fish production while marine fishing contributes 13%.

Note: Marine fisheries data should have to be obtained from Ministry of fisheries and aquatic resources development. The above Statistical data is obtained by calculation from some information we got from the Regional office of Fisheries department and related websites. In the case of Inland Fisheries, the statistical data is officially published by NAQDA (National Authority for Aquaculture Development) that belongs to Ministry of Fisheries and Aquatic Resources Development.

Contact point (Fisheries Sector)

Mr E.Surendranathan, AD, Planning – 0774840199, minadrinp@gmail.com

Livestock Sector

The livestock Industry has become an important sector for entrepreneurs in the Northern Province as this province is one of the major milk producing regions in Sri Lanka. Milk production reached 169,490 liters per day and the egg production reached 178,047 Nos. per day in 2016. Given below are some vital statics of the livestock sector of Northern Province;

According to 2019 Annual Report of the Central Bank of Sri Lanka, the livestock sector contributes 0.9 % to GDP. According to the Department of Animal Production & Health year 2019 statistical information, Northern Provincial cattle population was 332,271. Buffalo population was 24,38. Provincial goat and swine population were 179,256 (Highest in the country) and 4,395 respectively. Comparing the milk production with other provinces in the country, Northern Province holds Fourth place by producing 42.28 Mn Liters milk in year 2019. As a Province, in year 2019, Northern Provincial daily average milk production of cow milk was 115,835 Liters and buffalo milk 4,630 Liters and its contribution to the national milk production was 10 %. The provincial milk production has been increasing during the last 10 years by means of 8.76 million milk Liters in 2010 up to 42,28 million milk Liters in 2019 Broiler chicken meat production in year 2019 was 7,860 MT.

Contact point (Livestock Sector)

Dr Vaseekaran, DAPH - 0773868584

Technology Application Priorities of Northern Province

Given below is the summary of technology application priorities of the Agriculture, Livestock and Fisheries sub sectors of the Northern Province.

Intervention No	Intervening Technology	Specific Technology	Specific Application	Market Potential	Provincial Priority	Business Prospects	Prospects for Research & Development
Agriculture Sector							
1	Solar PV	Off-grid solar PV systems	Solar water pumps	500 pumps	High	High	_
2	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Solar electrification of Greenhouses (Protected Agriculture)	50 green houses	High	High	High
3	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Solar Electrification of small scale cold rooms	20 cold rooms	High	High	_
4	Solar thermal or biomass	Solar or biomass fired dryers	Solar or biomass fired dryers for crop drying	50 dryers	High	Medium	_
5	Solar PV or thermal	Solar powered dehumidifiers	Solar powered dehumidifiers for crop drying	1,000 Dehumidifiers	High	High	
6	Solar thermal or biomass	Solar or biomass fired dryers	Solar or biomass fired dryers for paddy drying	10 dryers	High	Medium	_
7	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Agriculture farm mechanization	500 farms	High	Medium	_
8	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Solar Powered Automatic Irrigation Control Systems	500 units	Medium	Low	
9	Solar PV	Off-grid solar PV systems	Solar powered desalination systems for agriculture purposes	5 units	Medium	Low	_
10	Biogas	Biogas cylinders	Biogas Powered Flame Weeders	20 units	Low	Low	
11	Solar PV	Off-grid solar PV systems with battery storage	Solar powered elephant repellent systems	1,000 units	Medium	Medium	_
12	Solar PV	Off-grid solar PV systems with battery storage	Solar powered electric fences	1,500 sets for around 1,500 km fencing	Medium	Low	_
Livestock Sector							
13	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Milk chilling centres	100 Centres	High	Medium	_
14	Biogas	Biogas digesters	Large scale farms, slaughter houses and market places	100 digesters	Low	Low	_
15	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Poultry farms	100 farms	Medium	Low	_
Fisheries Sector							
16	Solar thermal	Solar dryers	Solar powered small-scale fish dryers	50 units	High	High	_
17	Solar PV	Grid connected solar PV systems with or without battery storage	Solar Powered ice plants	4 units	High	Low	_
18	Solar PV	Grid connected solar PV systems with or without battery storage	Solar Powered Cold Rooms in Fishery Harbours	25 units	Medium	Low	_
19	Solar PV	Off-grid solar PV systems with battery charging facility	Solar powered fishing boats	1,000 units	High	High	_
20	Solar PV	Off-grid solar PV systems with battery charging facility	Solar Powered Desalination Plants for Multiday Boats (IMUL)	250 units	High	High	
21	Solar PV	Off-grid solar PV systems with battery storage	Solar Powered Shrimp Farms Hatcheries	10 farms	Medium	Medium	
22	Solar PV	Off-grid solar PV systems with battery storage	Solar powered medium scale refrigerators / mini ice plants for fish and milk vendors	100 units	High	Low	_
23	Solar PV	Grid connected solar PV systems with or without battery storage	Solar Powered Fish Meal Making Machines	10 units	Medium	Low	_
24	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Solar Powered Aquariums		Medium	Low	_
Biomass							
25	Biomass	Biomass fired gasifiers	Movable biomass gasifiers for drying of various crops such as cinnamon	500 units	Medium	Medium	_
26	Biomass	Biomass in pellets forms	Biomass Fired Domestic Type Stoves	500 units	High	Medium	

Twenty-six five technology applications have been identified for the consideration of the TSSC Project and they are listed in the above table. Provincial priorities are indicated under three levels; “High”, “Medium” and “Low”. Applications having high prospects for business development and high prospects for further research and development also have been identified and marked as “high”.

Agriculture Sector

Intervention No 1 – Solar Water Pumps

Water is essential for agriculture, health of livestock and many other uses. The need to irrigate agricultural land efficiently, economically and sustainably is critical for food security.

Solar PV water pumping systems are reliable and very cost-effective and can replace manual or fossil fuel fired engine driven pumps. A solar water pumping system does not have to use batteries to provide the power as the pump will operate during the day by pumping water into a tank for use at night. A storage battery is needed only if the pump is used at night time or during cloud and rainy climate. These systems are available in different models according to the water consumption and depth of well and can be used for various irrigation methods such as direct irrigation, drip irrigation and sprinkler irrigation especially for high value crops like chilli, onion, grapes, banana, moringa, etc. This will either reduce electricity bills or avoid the use of fossil fuel and hence the carbon footprint.

As one of the priority interventions, stakeholders of Northern Province wish to have solar powered (off-grid solar PV systems with or without battery storage) water pumps for agricultural purpose. It is estimated that the demand for solar powered pumps will be around 500 units.

Intervention No 2 – Solar Electrification of Greenhouses (Protected Agriculture)

There are over 37,285 commercial scale farmers in the Northern Province mostly engaged in conventional agriculture depriving them of high quality and higher yields. Cultivation of crops in a protected area is known as protected agriculture and the crops are protected from external factors such as sunlight, wind, rain, pest and disease. There are hosts of other benefits when protected agriculture is adopted; (1) Optimal usage of fertilizer and water under micro irrigation systems (2) Crops can be grown under non-availability of fertile soil with the help of some other growing media's like coir pith (3) High quality of produce compared to conventional farming (4)

Increased crop duration (prolong cultivation) (5) Possibility of adopting some advanced techniques like hydroponics, aeroponics, etc. Although protected agriculture provides high quality and higher yield, it requires substantial amount of energy for various activities such as Misters, Micro-irrigation Systems, Exhaust Fans, Lighting, etc.

As one of the priority interventions, stakeholders of Uva Province wish to promote protected agriculture powered by grid connected or off-grid solar PV systems with or without battery storage which are affordable to the target group. It is estimated that around 50 Green Houses can be promoted with the capacity around 1,000 ft^3 among farmers of the Northern Province for the first round.

Intervention No 3 – Solar Electrification of Small-Scale Cold Rooms and Ware Houses

Northern Province agricultural sector provides employment to nearly 44% of its population. Whilst productivity levels are one point of possible intervention, the post-harvest chain of food supply cannot be neglected. About 40% of fruits and vegetables go waste mainly due to lack of food processing and cold storage facilities. Targeting post-harvest losses instead of solely focusing on the production can offer higher internal rates of return, have a significant impact on poverty alleviation, and improvement of health and food security whilst ensuring a more sustainable use of resources.

Many small-scale agro producers in Northern Province struggle with limited storage options and even access to basic cold storage facilities. Due to the lack of cold storage and warehousing facilities, small-scale farmers are forced to sell their produce as close as possible to their farms since the market value of vegetables decreases with time. It is estimated that around 10% of the loss occurs in farmer's markets driving down prices in times of excess supply and in the worst case leads to price crashes resulting in prices that do neither cover production, harvesting or transportation cost. On the other hand, consumers suffer under peaking prices during supply gaps and off-seasons. Storage facilities can help to store seasonal produce for which year-round demand exists and to create buffer stocks stabilizing food prices for producers and consumers alike. Majority of cold storage facilities cater to single commodities only. However, though single commodity storages are easier to manage, the trend is towards multi commodity storages offering higher returns. Warehousing is required for paddy and other grains.

As one of the priority interventions, stakeholders of Northern Province wish to have solar powered (grid connected or off-grid solar PV systems with or without battery storage) cold storages and warehousing facilities preferably using absorption technology instead of vapor compression. It is estimated that the demand for cold storages will be around 20 units.

Intervention No 4 – Solar or Biomass Fired dryers for Crop Drying

Drying offers a multitude of advantages which includes reduction in volume, easy handling and transportation, less chance of pest and microbial attack during storage for almost all agricultural products. The basic essence of drying is to reduce the moisture content of the product to a level that prevents deterioration within a certain period of time. For some products, drying is an absolute necessity for size reduction and to have a powdered end product. In certain parts of the Northern Province, grid-connected electricity and supplies of other non-renewable sources of energy are either unavailable, unreliable or, for many farmers, too expensive. Thus, in such areas, crop drying systems that employ motorized fans and electrical heating are inappropriate. The large initial and running costs of fossil fuel powered dryers present such barriers that they are rarely adopted by small scale farmers. The traditional open sun drying utilized widely by rural farmers has inherent limitations. The crop also requires an undesirably long period to reach this equilibrium moisture content. In hot and humid climates, crop deterioration is obviously worse, as both warmth and high moisture contents promote the growth of fungi, bacteria, mites and insects in crops. Thus, these climatic conditions dictate the need for more effective drying methods. In such conditions, solar-energy crop dryers or biomass fired dryers appear to be attractive commercial propositions.

As one of the priority interventions, stakeholders of Northern Province wish to have a solution to the above problem by making available solar powered or biomass fired dryers for agro products including yams and indigenous medicinal plants which are affordable to the target group. It is estimated that the demand for solar powered or biomass fired dryers will be around 50 units.

Intervention No 5 – Solar Powered Dehumidifiers for Crop Drying

Traditional drying systems use direct sunlight or indirect heating sources and hence difficult to control the drying conditions. Convective drying systems use hot air and because of high temperature, volatile compounds tend to remove from the product leading to a quality reduction. Use of dehumidified air for drying has been suggested as one of the solutions as drying can be done at relatively lower temperatures while preserving the volatile compounds.

As one of the priority interventions, stakeholders of Northern Province wish to have solar powered dehumidifiers for produce like mushrooms which are affordable to the target group. It is estimated that the demand for solar powered dehumidifiers will be around 1,000 units.

Intervention No 6 – Solar or Biomass Fired dryers for Paddy Drying

Harvested paddy with high moisture content should be dried properly for safe storage and milling since high moisture in the harvested paddy promotes the development of insects and molds. The delay in drying, incomplete drying or uneven drying will result in the loss of the anticipated quality standard of rice. Paddy drying is often a problem for farmers and they have to sell their wet paddy stock at a lower price to the large-scale rice mill owners due to lack of proper on-farm drying technologies at affordable cost.

Problem is aggravated with large-scale mechanical threshers and combined harvesters. Presently, due to an increase in usage of such harvesters, moisture content of freshly harvested paddy is being high as much as 18-24%. These combined harvesters with high capacity enable for both harvesting and threshing at once. Thus, the paddy harvested persists with high moisture content that affects adversely the operations of paddy processing such as cleaning, storing, and milling.

Therefore, as one of the priority interventions, stakeholders of Northern Province wish to have a solution to the above problem by making available solar powered or biomass fired paddy dryers that can be used at field level for freshly harvested paddy (either mobile driers with a capacity of around 1 MT metric tons or stationary driers with a capacity of up to 6 MT for farmer organizations) which are affordable to the target group. It is estimated that the demand will be around 10 units.

Intervention No 7 – Agriculture Farm Mechanization

Operations of many agriculture farms are carried out manually due to either non-availability of machineries at affordable prices or high cost of energy (electricity as well as fossil fuel) required to operate them. Manual operations reduce the overall productivity.

As one of the priority interventions, stakeholders of Northern Province wish to have a considerable number of agricultural farms mechanized by making available suitable machineries for operations such as land preparation, transplanting, weeding, spraying of agro chemicals, harvesting, etc. powered by grid connected or off-grid solar PV systems with or without battery storage which are affordable to the target group. It is estimated that around 500 farms can be mechanized in the first round.

Compared to other technology applications, farm mechanization needs and provides ample opportunities for research and development for productivity gains and product quality improvements.

Intervention No 8 – Solar Powered Automatic Irrigation Control Systems

Agriculture is the source of living of majority in Northern Province and it also has a countless influence on economy of the country. The purpose of automatic irrigation control systems is to reduce the human intervention by automating to enhance water use for agricultural crops. The farmers working in farm lands are mainly dependent on the rains and bore wells for irrigation of lands. Even if the farm land has a water-pump, manual involvement by farmers is required to turn the pump on/off when needed. The advantage of using these systems is to reduce human intervention and still ensure proper irrigation.

Solar power can be used to control the irrigation systems. Sensors are placed on the field and these sensors continuously sense the moisture level and give the message to the farmer informing the moisture level. Without physically visiting the fields, farmers can get the information about the moisture level. Based on the moisture level, a farmer can control the motor by sending a message from his cellular phone even from a remote place. However, if the moisture level reaches to the danger level; the motor will automatically start without confirmation of farmer to ensure the proper moisture level in the field.

As one of the priority interventions, stakeholders of Northern Province wish to have solar powered automatic irrigation control systems which are affordable to the target group. It is estimated that the demand will be around 500 units.

Intervention No 9 – Solar Powered Desalinated Water for Agriculture Purposes

With worldwide concerns about water scarcity, agriculture is under pressure to improve water management and explore available options to match supply and demand. Desalination is a technical option to increase the availability of freshwater both in coastal areas with limited resources and in areas where brackish waters – such as saline groundwater, drainage water and treated wastewater – are available. Desalinated water can also be crucial in emergency situations where water sources have been polluted by saline incursions. Saline water intrusion is a major issue in the coastal areas of the Northern Province.

Water desalination is a well-established technology mainly for drinking-water supply in water scarce regions. However, with agriculture accounting for around 69 percent of all water withdrawals compared to domestic use of about 10 percent and industry about 21

percent, it is the main source of potable water in many islands around the world and it is also being used in certain countries to irrigate high-value crops.
As one of the priority interventions, stakeholders of Northern Province wish to have solar powered desalination systems for agriculture purposes. It is estimated that the demand will be around 5 units.

Intervention No 10 – Biogas Powered Flame Weeders

The flame-weeder is a device used to eliminate emergent weeds by "burning" them technically, subjecting them to a form of heat shock that causes damage at the cellular level. For flame-weeding to be successful, the flames of the torch must make contact with the soil substrate, and the weeds must be small enough for the relatively brief flame exposure to kill them.

Flame weeding is safe than using harsh chemicals that can contaminate groundwater and leave toxic residue on the ground and crops.

Flame weeding is passing a flame over a weed briefly to heat the plant tissues just enough to kill them. The goal is not to burn up the weed, but to destroy plant tissue so that the weed dies. Flame weeding kills the above ground portion of the weed, but it doesn't kill the roots. Flame weeding kills some annual weeds for good, but perennial weeds often regrow from the roots left in the soil. Perennial weeds require several treatments at two- to three-week intervals. As with any weeding method, if the tops are killed back often enough, the weeds eventually give up and die.

As one of the priority interventions, stakeholders of Northern Province wish to have biogas powered flame weeders which are affordable to the target group. It is estimated that the demand will be around 20 units.

Intervention No 11 – Solar Powered Wild Animal Repellent Systems

As settlements and arable areas spread, conflict between human and animal builds up - especially with wild elephants. Ecological considerations demand that man and animal live in harmony. One way to ensure that man and beast co-exist peacefully is by erecting non-lethal repellers, which repel intruders without harming them. These help to secure human lives, guard wildlife from human intrusion and also to bring large tracts of fertile land under cultivation. Repllers have to be built in remote areas where grid electricity is not available. Solar powered repellers are an ideal solution for animal containment in areas where 230 V power is not available or is inconvenient to obtain.

Repellers use ultrasonic sound technology to deter without harming a wide range of animals including dogs, cats, bird, pigeon, foxes, squirrels, deer, rats, mice, elephants,

etc. Repellers have different settings to selectively repel those animals that are unwanted but do not affect people, fish or birds.
As one of the priority interventions, stakeholders of Northern Province wish to have solar powered (off-grid solar PV systems with battery storage) repellers to protect farms from wild animal attacks including wild elephants. It is estimated that the demand for solar powered repellers will be around 1,000 units.

Intervention No 12 – Solar Powered Electric Fence

As settlements and arable areas spread, conflict between human and animal builds up - especially with wild elephants. Ecological considerations demand that man and animal live in harmony. The only way to ensure that man and beast co-exist peacefully is by erecting non-lethal high voltage electric fences, which repel intruders without harming them. These help to secure human lives, guard wildlife from human intrusion and also to bring large tracts of fertile land under cultivation. Most fences have to be built in remote areas where mains electricity is not available.

Solar powered electric fences are an ideal solution for animal containment or exclusion fences in areas where 230 V power is not available or is inconvenient to obtain. A small solar PV panel simply collects and converts sunlight into energy that is stored in a battery. The battery supplies current to the grounded energizer that then sends about one pulse of electric current per second down the fence. When an animal touches the fence the circuit between the fence and the ground is completed and the animal receives a short, sharp, but safe shock.

As one of the priority interventions, stakeholders of Uva Province wish to have solar powered (off-grid solar PV systems with battery storage) electric fences to protect farms from wild animal attacks including wild elephants. It is estimated that the demand for solar powered electric fence will be around 1,500 sets for around 1,500 km of fencing.

Livestock Sector

Intervention No 13 – Milk Chilling Centers

There are over 20 milk chilling centers operating in the Northern Province managed either by large-scale milk processing companies or by Farmer Cooperative Societies. These chilling centers need electrical energy for chiller operation and hot water for equipment cleaning including the milk cans brought by milk producing farmers. Cost of electricity comprises of the major portion of cost of production.

As one of the priority interventions, stakeholders of Northern Province wish to have grid connected or off-grid solar PV systems with or without battery storage to supply electricity for the chilling centers. It is estimated that there are around 100 chilling centers with the capacity of around 500 lt to benefit from this intervention.

Intervention No 14 – Biogas Systems for Large Scale Dairy Processors & Broiler Farms (Biogas Upgrading)

Biogas technology is not new to Sri Lanka. However, its adoption has been confined to small scale domestic and farm use for low level applications such as lighting, hot water generation, cooking, etc.

There had been some isolated attempts to operate relatively large-scale bio gas generators with limited success. Biogas upgrading has never been tried out in Sri Lanka in commercial scale other than a few attempts to generate electricity in small standby generators. With the environmental regulations becoming more stringent, there is a tendency to use biogas generators as a waste management solution for environmental compliance by large-scale farms, slaughter houses and market places. Anaerobic digestion serves to reduce the volume of wastes and the associated problem of their disposal such as contamination of groundwater, surface water, and other resources and effectively destroys harmful pathogens. Eluent from biogas digesters can serve as high quality organic fertilizer, displacing import of synthetic nitrogenous fertilizers.

As one of the priority interventions, stakeholders of Northern Province wish to have fully integrated biogas systems (upgraded biogas systems) for about 100 large scale farms, dairy processors and broiler farms in the Province. This has to be for the entire value chain of the biogas (Feedstock management, Generation, Cleaning / Filtration, Compression / Storage, Electricity generation / Thermal energy generation) including SMART performance monitoring arrangements at every stage.

Electricity generated using biogas can be used to supplement the grid electricity for various operations of agricultural farms, dairy processing and broiler farms.

Intervention No 15 – Solar Powered Poultry Farms

There are many broiler farms in the Northern Province selling their birds either to large scale broiler chicken processing companies as sub-contractors or selling directly to consumers in the areas they operate. These farms need electrical energy to operate various machinery and equipment (Feed mixing, ventilation, incubation, brooding, automated slaughtering, defeathering, processing, freezing, etc.). Cost of electricity comprises of the major portion of cost of production.

As one of the priority interventions, stakeholders of Northern Province wish to have grid connected or off-grid solar PV systems with or without battery storage to supply electricity for poultry farms. It is estimated that there are around 100 broiler farms to benefit from this intervention.

Fisheries Sector

The fisheries sector plays a key role in Northern Province's social and economic life. From an economic viewpoint, there is significant scope for increasing the level of contribution from the sector through increased output, exploiting the potential for value addition and import substitution. The fisheries sector of the Province consists of three main subsectors, namely coastal (marine); offshore and deep sea; and inland and aquaculture. These three subsectors employ around 42,234 active fishers.

Note: Number of Inland Fisherman is 3,546 and annual production of inland fish is approximately 4,500 MT.

Given below are prospective applications in the fishery sector to utilize renewable energy (Solar, Biogas and Biomass) which would realize multiple benefits; economic, social and environment.

Intervention No 16 – Solar or Biomass Fired Fish Dryers

Fishermen in the Northern Province are engaged in marine as well as inland fishing. The demand is mainly for fresh fish. Fishermen have to preserve unsold daily catch for future use either by freezing or by drying. As frozen inland fish varieties are not in demand and also many fishermen cannot afford freezing equipment, they mainly do open sun drying or smoking. Open sun drying affects the quality of dried fish due to contamination with dust, insects and bird droppings, etc. apart from discoloration.

As one of the priority interventions, stakeholders of Northern Province wish to have a solution to the above problem by making available solar or biomass fired dryers for fish, prawns, see weeds, sea cucumber, etc. which are affordable to the target group. It is estimated that the demand for solar powered or biomass fired small-scale fish dryers will be around 30 units.

Intervention No 17 – Solar Powered Ice Plants

As one of the priority interventions, stakeholders of Northern Province wish to have solar powered ice plants. It is estimated that the demand will be around 4 units.

Intervention No 18 – Solar Powered Cold Rooms in Fishery Harbours

As one of the priority interventions, stakeholders of Northern Province wish to have solar powered cold rooms in fishery harbours. It is estimated that the demand will be around 25 units.

Intervention No 19 – Solar Powered Fishing Boats

Solar energy could be used for various purposes such as GPS, VMS, SSB radios, phone charging, desalination of sea water for drinking purpose, cold rooms and lighting in fishing boats.

As one of the priority interventions, stakeholders of Northern Province wish to have solar powered fishing boats. It is estimated that the initial demand will be around 1,000 units. MT of ice per day.

Intervention No 20 – Solar Powered Desalination Plants for Multiday Boats (IMUL)

As one of the priority interventions, stakeholders of Northern Province wish to have solar powered desalination plants for multiday boats (IMULs). It is estimated that the demand will be around 250 units.

IMUL - Inboard Multi-day Boats
IDAY - Inboard Single-day Boats
OFRP - Out-board engine Fiberglass Reinforced Plastic Boats
MTRB - Motorized Traditional Boats
NTRB - Non-motorized Traditional Boats
NBSB - Non-motorized Beach Seine Crafts

Intervention No 21 – Solar Powered Shrimp Farms Hatcheries

The shrimp industry makes a substantial contribution to national economy through export earnings. These farms need electrical energy to for various purposes such as lighting, water pumping, aeration, etc.. Cost of electricity comprises of the major portion of cost of production. Dissolved oxygen is one of the most critical aspects of water quality in fish culture systems. The shrimp farming requires a significant amount of energy for aeration systems to continuously maintain suitable

dissolved oxygen levels in ponds for improving water quality and promoting shrimp growth. As most shrimp farms are located away from power lines, it is necessary to use renewable energy such as solar energy.

As one of the priority interventions, stakeholders of Northern Province wish to have solar powered shrimp farms. It is estimated that the demand will be around 10 farms initially units.

Intervention No 22 – Solar Powered Medium Scale Refrigerators / Mini Ice Plants for Fish & Milk Vendors

As one of the priority interventions, stakeholders of Northern Province wish to have solar powered medium scale refrigerators / mini ice plants for fish and milk venders vendors (preferably vehicle mounted). It is estimated that the demand will be around 100 units.

Intervention No 23 – Solar Powered Fish Meal Making Machines

As one of the priority interventions, stakeholders of Northern Province wish to have solar powered fish meal making machines using fish offal and waste. It is estimated that the demand will be around 10 units.

Intervention No 24 – Solar Powered Aquariums

As one of the priority interventions, stakeholders of Northern Province wish to have solar powered aquariums

Biomass

The most available forms of biomass types in the Northern Province are fuel wood, saw dust, rice husk, agricultural waste, municipal waste, and industrial waste and industries have been moving to operate their thermal energy generators such as boilers, hot water generators, driers, furnace, hot air generators, etc. using biomass instead of fossil fuel.

Intervention No 25 – Movable Biomass Gasifiers for Crop Drying

A biomass gasifier is a device that converts biomass into a combustible gas called "producer gas". Dryers powered by biomass gasifiers appear to be an attractive proposition especially for small scale farmers. As in the case of hiring other agricultural machineries such as tractors, harvesters, etc., such farmers could hire dryers powered by movable biomass gasifiers for drying of various crops such as cinnamon. Such gasifiers can even be used for par boiling of paddy at cottage level and making biochar required for organic and climate smart agriculture.

As one of the priority interventions, stakeholders of Northern Province wish to have such units. It is estimated that the demand for movable biomass gasifiers will be around 500 units.

Intervention No 26 – Biomass Fired Domestic Type Stoves

A biomass cook stoves normally use wood, charcoal, animal dung or crop residue. Cook stoves are commonly used for cooking and heating food in rural households. The main goal of most improved cooking stoves is to reduce the pressure placed on local forests by reducing the amount of wood the stoves consume, and to reduce the negative health impacts associated with exposure to toxic smoke from traditional stoves.

As one of the priority interventions, stakeholders of Northern Province wish to have biomass fired domestic type stoves (even for the use of "Ammacchi") which are affordable to the target group. It is estimated that the demand will be around 500 units.

Technology Application Priorities Wayamba Province

Agriculture, Livestock & Fisheries Sub Sectors

Submitted to

Biogas, Biomass and Solar Trilateral Cooperation
Transitioning to Sustainable Energy Uses
In the Agro-Industry Project
Sri Lanka - China – Ethiopia

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Submitted by

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Content

Overview of Wayamba Province of Sri Lanka

The Wayamba Province of Sri Lanka is one of the nine provinces of Sri Lanka and consists of two administrative districts viz; Kurunegala and Puttalam. The province has a population of 2,370,075 (2011 census).

The province is known mainly for its numerous coconut plantations. Fishing, prawn farming and rubber tree plantations are other prominent industries of the region.

Paddy is the main agricultural crop in the province. Wayamba is the third largest paddy-producing area in Sri Lanka. Wayamba has a highly developed agricultural economy, growing a variety of fruits and vegetables, flowering plants, spices, oil-seeds in addition to the traditional plantation crops such as Coconut, Rubber and Rice. Rich soils and varied climate give Wayamba a potential for growing of virtually any crop.

It has a total land area of 7,972.6 sq.km of which 370.88 sq.km are in land water bodies. Water bodies include the lagoons, bays, freshwater tanks and streams in the area. With regard to land utilization, the province has 302,141.2 Ha of agricultural land (60.3 % of the land area of the province). (Source: District Statistical hand Book, 2019)

The coastal line of 240 km extends from Waikkal at its Wayamba end to Dutch Bay in the Puttalam district at its northern boundary.

Overview of Agriculture Sector of Wayamba Province
(Including Livestock & Fisheries)

Agriculture Sector

The Agriculture sector is the dominant productive sector contributing much in the economy of the Province as 66 % of the total population involve in agriculture and its related activities for their livelihood, resulting in rapid development of the agriculture sector in the Province. Coconut which is the dominant and important plantation in the province and it is 37% of the land area of the province.

Contact point (Agriculture Sector)

Mr W.A.Seelarathna, Provincial Director of Agriculture – 0718431702, pdoanwp@gmail.com

Fisheries Sector

Fisheries sector is another important productive sector of the province. Existing long coastal shoreline (16 % of total coastal line of the island) of the province contributes to marine fishing activities, giving opportunities to the fishing community to involve in fishing related activities including export of fish products. There are around 31,642 active

marine and inland fishermen deploying over 8,469 fishing boats of various types and 910 inland fishing boats. In Wayamba Province, inland fishing contributes 12 % of national inland fish production while marine fishing contributes 15 % of the national marine fish production.

Contact point (Fisheries Sector)

Mr Suraj Sirisena – 0714416911, surajmof@gmail.com

Livestock Sector

The livestock Industry has become an important sector for entrepreneurs in the Wayamba Province as this province is one of the major milk producing regions in Sri Lanka. Milk production reached closed to around 6,259,000 Liters in 2018 and the egg production reached 138 Mn per month in 2019. Given below are some vital statics of the livestock sector of Wayamba Province;

According to 2018 Annual Report of the Central Bank of Sri Lanka, the livestock sector contributes 0.6 % to GDP. According to the Department of Animal Production & Health year 2019 statistical information, Wayamba Provincial cattle population was 209,946. Buffalo population was 32,890. Provincial goat population was 73,742. Provincial swine population was 37,602. Comparing the milk production with other provinces in the country, Wayamba Province holds 2nd place by producing 81 Mn Liters milk in year 2018. As a Province, in year 2018, Wayamba Provincial annual milk production of cow milk was 66 Mn Liters and buffalo milk 15 Mn Liters and its contribution to the national milk production was 17 %. The provincial milk production has been increasing during the last few years by means of 159,000 Liters per day in 2014 to around 200,000 Liters per day in 2019.

Contact point (Livestock Sector)

Dr B.C.S.Perera, Provincial Director – 0718363439, bcsperera123@yahoo.com

Technology Application Priorities of Wayamba Province

Given below is the summary of technology application priorities of the Agriculture, Livestock and Fisheries sub sectors of the Wayamba Province.

Intervention No	Intervening Technology	Specific Technology	Specific Application	Market Potential	Provincial Priority	Business Prospects	Prospects for Research & Development
Agriculture Sector							
1	Solar PV	Off-grid solar PV systems	Solar water pumps	1,000 pumps	High	Low	_
2	Solar thermal or biomass	Solar or biomass fired dryers	Solar or biomass fired dryers for crop drying	50 dryers	High	Low	_
3	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Solar Powered Vacuume Dryers for Crop & Seed Drying	50 units	Medium	Low	
4	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Solar Electrification of small scale cold rooms	10 cold rooms	High	Low	_
5	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Agriculture farm mechanization	1,000 farms	High	Medium	_
6	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Solar Powered Automatic Control Systems for Polytunnels	250 units	Medium	Medium	
7	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Solar Powered Small-Scale Rice Milling Plants	100 mills	Low	Low	
8	Solar PV, Solar thermal, Biogas & Biomass	Grid connected or off-grid solar PV systems with or without battery storage	Renewable Energy Powered Integrated Farm for Demonstration	1 unit	Low	Low	
9	Solar PV	Off-grid solar PV systems with battery storage	Solar powered elephant repellent systems	50 units	High	Low	_
10	Solar PV	Off-grid solar PV systems with battery storage	Solar powered electric fences	1,000 sets for around 5,000 km fencing	Low	Low	_
11	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Solar Powered Water Management Systems for Minor Irrigation Tanks	100 tanks	Medium	Medium	Medium
Livestock Sector							
12	Biogas	Entire value chain of the biogas (Feedstock management, Generation, Cleaning / Filtration, Compression / Storage, Electricity generation / Thermal energy generation)	Large scale dairy farms	50 farms	High	Medium	High
13	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Milk chilling centres	35 large & 1,000 small units	High	Low	_
14	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Poultry farms	80 farms	Medium	Low	_
15	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Solar Powered Freezers for Meat Storage	150 units	Medium	Low	
16	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Direct Current (DC) Systems for Solar Photovoltaic (PV) Applications	1 unit	Medium	Low	High
Fisheries Sector							
17	Solar thermal	Solar dryers	Solar powered small-scale fish dryers	150 units	High	High	_
18	Solar PV	Off-grid solar PV systems with battery storage	Solar powered aerators for shrimp farming	500 units	High	High	_
19	Solar PV	Off-grid solar PV systems with battery charging facility	Solar Powered Ice Plants for Multiday Boats (IMUL)	100 units	Medium	Medium	Medium
20	Solar PV	Off-grid solar PV systems with battery charging facility	Solar Powered Desalination Plants for Multiday Boats	150 units	High	High	_
21	Solar PV	Off-grid solar PV systems with battery charging facility	Solar Powered Identification Boarders for Fishing Nets	100 units	Medium	Low	
22	Solar PV	Off-grid solar PV systems with battery charging facility	Solar Powered Lighting in Boatyards	100 units	Low	Low	
23	Solar PV	Grid connected solar PV systems with or without battery storage	Solar Powered Battery Charging Stations for Fishermen	100 units	High	Low	_
24	Solar PV	Off-grid solar PV systems with battery storage	Solar powered medium scale refrigerators / mini ice plants for fish vendors	200 units	High	Low	_
25	Solar PV	Grid connected or off-grid solar PV systems with or without battery storage	Solar Powered Aquariums	500 units	Medium	Low	_
Biomass							
26	Biomass	Briquetting of biomass	Briquetting of biomass (pelletizing)	100 units	Low	Low	_
27	Biomass	Gassifiers	Small Scale Dendro Power Plants	100 units	Medium	Medium	Medium
General							
28	Solar PV	-	Solar Powered Water Management with Alternate Wetting & Drying (AWD)	1 unit	Low	Low	Medium
29	Solar thermal	Heat exchanger	Heat Extraction from a Large Rocks	1 unit	Low	Low	High

Twenty-nine (29) technology applications have been identified for the consideration of the TSSC Project and they are listed in the above table. Provincial priorities are indicated under three levels; “High”, “Medium” and “Low”. Applications having high prospects for business development and high prospects for further research and development also have been identified and marked as “high”.

Agriculture Sector

Intervention No 1 – Solar Water Pumps

Water is essential for agriculture, health of livestock and many other uses. The need to irrigate agricultural land efficiently, economically and sustainably is critical for food security.

Solar PV water pumping systems are reliable and very cost-effective and can replace manual or fossil fuel fired engine driven pumps. A solar water pumping system does not have to use batteries to provide the power as the pump will operate during the day by pumping water into a tank for use at night. A storage battery is needed only if the pump is used at night time or during cloud and rainy climate. These systems are available in different models according to the water consumption and depth of well and can be used for various irrigation methods such as direct irrigation, drip irrigation and sprinkler irrigation. This will either reduce electricity bills or avoid the use of fossil fuel and hence the carbon footprint.

As one of the priority interventions, stakeholders of Wayamba Province wish to have solar powered (off-grid solar PV systems with or without battery storage) water pumps for agricultural purpose. It is estimated that the demand for solar powered pumps will be around 1,000 units.

Intervention No 2 – Solar or Biomass Fired dryers for Crop Drying

Drying offers a multitude of advantages which includes reduction in volume, easy handling and transportation, less chance of pest and microbial attack during storage for almost all agricultural products. The basic essence of drying is to reduce the moisture content of the product to a level that prevents deterioration within a certain period of time. For some products, drying is an absolute necessity for size reduction and to have a powdered end product. In certain parts of the Wayamba Province, grid-connected electricity and supplies of other non-renewable sources of energy are either unavailable, unreliable or, for many farmers, too expensive. Thus, in such areas, crop drying systems that employ motorized fans and electrical heating are inappropriate. The large initial and running costs of fossil fuel powered dryers present such barriers that they are rarely adopted by small scale farmers. The traditional open sun drying utilized widely by rural farmers has inherent limitations. The crop also requires an undesirably long period to

reach this equilibrium moisture content. In hot and humid climates, crop deterioration is obviously worse, as both warmth and high moisture contents promote the growth of fungi, bacteria, mites and insects in crops. Thus, these climatic conditions dictate the need for more effective drying methods. In such conditions, solar-energy crop dryers or biomass fired dryers appear to be attractive commercial propositions.

As one of the priority interventions, stakeholders of Wayamba Province wish to have a solution to the above problem by making available solar powered or biomass fired dryers which are affordable to the target group. It is estimated that the demand for solar powered or biomass fired dryers will be around 50 units.

Intervention No 3 – Solar Powered Vacuum Dryers for Crop & Seed Drying

Traditional drying systems use direct sunlight or indirect heating sources and hence difficult to control the drying conditions. Convective drying systems use hot air and because of high temperature, volatile compounds tend to remove from the product leading to a quality reduction. Use of vacuum drying has been suggested as one of the solutions as drying can be done at relatively lower temperatures while preserving the volatile compounds. Although vacuum drying is thought to be too costly for large-scale production of a commodity, it may be more applicable to the small-scale production of high-valued crops (e.g. herbs).

As one of the priority interventions, stakeholders of Western Province wish to have solar powered vacuum dryers for crop & seed drying which are affordable to the target group. It is estimated that the demand will be around 50 units. There are over 2,000 seed producers in Wayamba province. Vacuum dryers could be deployed in central places such as farmer organizations and community centres.

Intervention No 4 – Solar Powered Large-Scale Cold Rooms for Agro Produce

Wayamba Province agricultural sector provides employment to nearly 66% of its population. Whilst productivity levels are one point of possible intervention, the post-harvest chain of food supply cannot be neglected. About 40% of fruits and vegetables go waste mainly due to lack of food processing and cold storage facilities. Targeting post-harvest losses instead of solely focusing on the production can offer higher internal rates of return, have a significant impact on poverty alleviation, and improvement of health and food security whilst ensuring a more sustainable use of resources.

Many small-scale agro producers in Wayamba Province struggle with limited storage options and even access to basic cold storage facilities. Due to the lack of cold storage, small-scale farmers are forced to sell their produce as close as possible to their farms since

the market value of vegetables decreases with time. It is estimated that around 10% of the loss occurs in farmer's markets driving down prices in times of excess supply and in the worst case leads to price crashes resulting in prices that do neither cover production, harvesting or transportation cost. On the other hand, consumers suffer under peaking prices during supply gaps and off-seasons. Storage facilities can help to store seasonal produce for which year-round demand exists and to create buffer stocks stabilizing food prices for producers and consumers alike. Majority of cold storage facilities cater to single commodities only. However, though single commodity storages are easier to manage, the trend is towards multi commodity storages offering higher returns.

As one of the priority interventions, stakeholders of Wayamba Province wish to have solar powered (grid connected or off-grid solar PV systems with or without battery storage) large-scale cold storages facilities preferably using absorption technology instead of vapor compression which can be deployed in central places such as farmer organizations and community centres. It is estimated that the demand for large scale cold storages will be around 10 units.

Intervention No 5 – Agriculture Farm Mechanization

Operations of many agriculture farms are carried out manually due to either non-availability of machineries at affordable prices or high cost of energy (electricity as well as fossil fuel) required to operate them. Manual operations reduce the overall productivity.

As one of the priority interventions, stakeholders of Wayamba Province wish to have a considerable number of agricultural farms mechanized by making available suitable machineries for operations such as land preparation, seeding, transplanting, inter cultivating, weeding, harvesting, etc. powered by grid connected or off-grid solar PV systems with or without battery storage which are affordable to the target group. It is estimated that around 1,000 farms can be mechanized in the first round.

Compared to other technology applications, farm mechanization needs and provides ample opportunities for research and development for productivity gains and product quality improvements.

Intervention No 6 – Solar Powered Automatic Control Systems for Polytunnels

Agriculture is the source of living of majority in Wayamba province and it also has a countless influence on economy of the country.

In conventional agronomical practices, the crops are being grown / cultivated in the open field under natural conditions where the crops are more susceptible to

sudden changes in climate i.e. temperature, humidity, light intensity, photo period and other conditions due to which the quality, yield of a particular crop can get affected and may be decreased.

In automated poly tunnels, crops are grown under a favorable controlled environment and other conditions viz. temperature, humidity, light intensity, ventilation, soil media, disease control, irrigation, fertigation and other agronomical practices throughout the season irrespective of the natural conditions outside. The purpose of automation is to reduce the human involvement.

As one of the priority interventions, stakeholders of Wayamba province wish to have solar powered automatic control systems for poly tunnels which are affordable to the target group. It is estimated that the demand will be around 250 units.

Intervention No 7 – Solar Powered Small-Scale Rice Milling Plants

As one of the priority interventions, stakeholders of Wayamba Province wish to have small scale rice milling plants powered by grid connected or off-grid solar PV systems with or without battery storage which are affordable to the target group. It is estimated that around 100 mills can be powered in the first round.

Intervention No 8 – Renewable Energy Powered Integrated Farm for Demonstration

As one of the priority interventions, stakeholders of Wayamba Province wish to have a fully integrated demonstration farm (Agriculture, livestock and fisheries production & processing) powered by renewable energy (Solar, biogas & biomass) either in a privately-owned farm or in a state-controlled farm.

Intervention No 9 – Solar Powered Elephant Repellent Systems

As settlements and arable areas spread, conflict between human and animal builds up - especially with wild elephants. Ecological considerations demand that man and animal live in harmony. One way to ensure that man and beast co-exist peacefully is by erecting non-lethal repellers, which repel intruders without harming them. These help to secure human lives, guard wildlife from human intrusion and also to bring large tracts of fertile land under cultivation. Repellers have to be built in remote areas where grid electricity is not available. Solar powered repellers are an ideal solution for animal containment in areas where 230 V power is not available or is inconvenient to obtain.

Repellers use ultrasonic sound technology to deter without harming a wide range of animals including dogs, cats, bird, pigeon, foxes, squirrels, deer, rats, mice, elephants, etc. Repellers have different settings to selectively repel those animals that are unwanted but do not affect people, fish or birds.

As one of the priority interventions, stakeholders of Wayamba Province wish to have solar powered (off-grid solar PV systems with battery storage) repellers to protect farms from wild animal attacks. It is estimated that the demand for solar powered repellers will be around 50 units.

Intervention No 10 – Solar Powered Electric Fence

As settlements and arable areas spread, conflict between human and animal builds up - especially with wild elephants. Ecological considerations demand that man and animal live in harmony. The only way to ensure that man and beast co-exist peacefully is by erecting non-lethal high voltage electric fences, which repel intruders without harming them. These help to secure human lives, guard wildlife from human intrusion and also to bring large tracts of fertile land under cultivation. Most fences have to be built in remote areas where mains electricity is not available.

Solar powered electric fences are an ideal solution for animal containment or exclusion fences in areas where 230 V power is not available or is inconvenient to obtain. A small solar PV panel simply collects and converts sunlight into energy that is stored in a battery. The battery supplies current to the grounded energizer that then sends about one pulse of electric current per second down the fence. When an animal touches the fence the circuit between the fence and the ground is completed and the animal receives a short, sharp, but safe shock.

As one of the priority interventions, stakeholders of Wayamba Province wish to have solar powered (off-grid solar PV systems with battery storage) electric fences to protect farms from wild animal attacks including wild elephants. It is estimated that the demand for solar powered electric fence will be around 1,000 sets for around 5,000 km of fencing.

Intervention No 11 – Solar Powered Water Management Systems for Minor Irrigation Tanks

The proposed project intends to establish a wireless sensory network system for 100 minor irrigation tanks within the North Western Province of Sri Lanka. This system should consist of three major components: cascade flood control, water resource management and water

quality. The proposal is to establish a data server that monitors the real time rainfall, tank's water capacity, turbidity, PH, dissolved Nitrogen, Phosphorous and Oxygen. These sensors within the main control board are designed as a low power sensor module. Thus, a solar panel is ideal for powering the whole system. The real-time data generated by these sensors could be transmitted through a GSM network and analyzed within a server to be visualized as a web app available for its users.

Based upon the data gathered, the intention is to resolve for the crop type that would produce the best yield based upon the capacity of water available for a specific season. The system will be using historical "Accuweather" data for the area alongside the sensed water capacity, evaporation rate derived from the variability of water level, rainfall and cloud cover derived by the solar panel powering the sensors.

It is intended to deploy an Artificial Neural Network (AI) on the server such that the data will be automatically analyzed to calculate future events of flooding and to alert its users to open the gates at just the right time to minimize flooding within the region. Further improvements could be made to these anicuts such that the flood gates are managed automatically using the AI program when certain factors such as increased discharge, stage, rainfall arise.

Majority of the 6,000 minor irrigation schemes within Northwestern province are covered by the invasive algal plants such as Japanjabara and Salvinia. Monitoring dissolved Phosphorous, Nitrogen and Oxygen along with turbidity allows respective authorities to automatically keep tabs on a tank's algae growth cycle, in which they could plan ahead to clean out the algae before it pollutes the water supply from increased Hydrogen Sulfide, Methane, and lowered Oxygen. By monitoring a tank, when the nitrogen/phosphorus levels exceed normal standards, it is possible to alert farmers within the feeding watershed to reduce fertilizer use. Distribution of these polluted tank water greatly hinders the agriculture. This Proposal also includes a strategy to use cleared-out algae for Biogas production or as biomass for fertilizer.

This would be an ideal technology application for further research and development for effective water management.

Proposed by Mr Anura Wijeratne, Irrigation Superintendent (0773425915)

Livestock Sector

Intervention No 12 – Biogas Systems for Large Scale Dairy Processors & Broiler Farms (Biogas Upgrading)

Biogas technology is not new to Sri Lanka. However, its adoption has been confined to small scale domestic and farm use for low level applications such as lighting, hot water generation, cooking, etc.

There had been some isolated attempts to operate relatively large-scale bio gas generators with limited success. Biogas upgrading has never been tried out in Sri Lanka in commercial scale other than a few attempts to generate electricity in small standby generators. With the environmental regulations becoming more stringent, there is a tendency to use biogas generators as a waste management solution for environmental compliance by large-scale farms, slaughter houses and market places. Anaerobic digestion serves to reduce the volume of wastes and the associated problem of their disposal such as contamination of groundwater, surface water, and other resources and effectively destroys harmful pathogens. Eluent from biogas digesters can serve as high quality organic fertilizer, displacing import of synthetic nitrogenous fertilizers.

As one of the priority interventions, stakeholders of Wayamba Province wish to have fully integrated biogas systems (upgraded biogas systems) for about 50 large scale dairy processors and broiler farms in the Province. This has to be for the entire value chain of the biogas (Feedstock management, Generation, Cleaning / Filtration, Compression / Storage, Electricity generation / Thermal energy generation) including SMART performance monitoring arrangements at every stage.

Electricity generated using biogas can be used to supplement the grid electricity for various operations of dairy processing and broiler farms.

Intervention No 13 – Milk Chilling Centers

There are over 300 milk chilling centers with over 3 million liters chilling capacity operating in the Wayamba Province managed either by large-scale milk processing companies or by Farmer Cooperative Societies. These chilling centers need electrical energy for chiller operation and hot water for equipment cleaning including the milk cans brought by milk producing farmers. Cost of electricity comprises of the major portion of cost of production.

As one of the priority interventions, stakeholders of Wayamba Province wish to have grid connected or off-grid solar PV systems with or without battery storage to supply electricity for the chilling centers. It is estimated that there are around 35 large scale (around 10,000 liters) and around 1,000 small scale chilling centers will benefit from this intervention.

Intervention No 14 – Solar Powered Poultry Farms

There are many broiler farms in the Wayamba Province selling their birds either to large scale broiler chicken processing companies as sub-contractors or selling directly to consumers in the areas they operate. These farms need electrical energy to operate various machinery and equipment (Feed mixing, ventilation, incubation, brooding, defeathering, freezing, etc.). Cost of electricity comprises of

the major portion of cost of production.

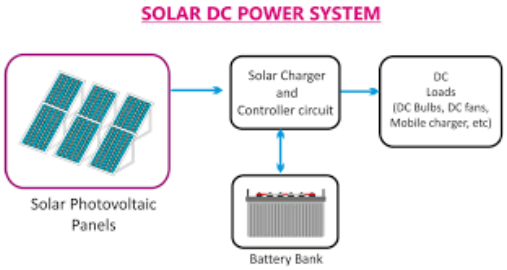
As one of the priority interventions, stakeholders of Wayamba Province wish to have grid connected or off-grid solar PV systems with or without battery storage to supply electricity for poultry farms (5,000 to 10,000 birds). It is estimated that there are around 80 broiler farms to benefit from this intervention.

Intervention No 15 – Solar Powered Freezers for Meat Storage

Solar powered freezers may include photo voltaic or solar thermal energy. Solar powered freezers are able to keep perishable goods such as meat (Broiler, pork, etc.) in hot climates, and are used to keep much needed vaccines at their appropriate temperature to avoid spoilage.

As one of the priority interventions, stakeholders of Wayamba Province wish to have solar powered freezers for meat storage. It is estimated that the demand will be around 150 units.

Intervention No 16 – Direct Current (DC) Systems for Solar Photovoltaic (PV) Applications



Compared to other technology applications, this application will provide ample opportunities for research and development for energy efficiency improvements.

DC systems for solar photovoltaic (PV) applications are gaining popularity due to high efficiency and reliability. Smart grid for the past few years has been the prime focus of research in power systems. Since generation from solar PV is in the form of DC and most of the appliances at domestic as well as industry level could be operated on DC, AC-DC hybrid distribution system with energy management system is proposed. It will demonstrate the practical implementation of DC-AC network with integration of solar PV and battery storage with existing infrastructure.

As one of the priority interventions (especially as a candidate application for R&D), stakeholders of Wayamba Province wish to have a distributed power management scheme based on DC generated through solar PV. Proposal is to try this out to convert a poultry farm to run on DC.

Fisheries Sector

The fisheries sector plays a key role in Wayamba Province's social and economic life. From an economic viewpoint, there is significant scope for increasing the level of contribution from the sector through increased output, exploiting the potential for value

addition and import substitution. The fisheries sector of the Province consists of three main subsectors, namely coastal (marine); offshore and deep sea; and inland and aquaculture. These three subsectors employ around 31,642 active fishers and a larger number in providing support services and marketing.

Given below are prospective applications in the fishery sector to utilize renewable energy (Solar, Biogas and Biomass) which would realize multiple benefits; economic, social and environment.

Intervention No 17 – Solar or Biomass Fired Fish Dryers

There are around 31,642 fishermen in the Wayamba Province engaged in marine as well as inland fishing. The demand is mainly for fresh fish. Fishermen have to preserve unsold daily catch for future use either by freezing or by drying. As frozen inland fish varieties are not in demand and also many fishermen cannot afford freezing equipment, they mainly do open sun drying or smoking. Open sun drying affects the quality of dried fish due to contamination with dust, insects and bird droppings, etc. apart from discoloration.

As one of the priority interventions, stakeholders of Wayamba Province wish to have a solution to the above problem by making available solar or biomass fired dryers which are affordable to the target group. It is estimated that the demand for solar powered or biomass fired small-scale fish dryers will be around 150 units.

Intervention No 18 – Solar Powered Aerators for Shrimp Farming

The shrimp industry makes a substantial contribution to national economy through export earnings. Dissolved oxygen is one of the most critical aspects of water quality in fish culture systems. The shrimp farming requires a significant amount of energy for aeration systems to continuously maintain suitable dissolved oxygen levels in ponds for improving water quality and promoting shrimp growth. As most shrimp farms are located away from power lines, it is necessary to use renewable energy such as solar energy.

As one of the priority interventions, stakeholders of Wayamba Province wish to have solar powered aerators (peddle wheels) for shrimp farming. It is estimated that the demand will be around 500 units. Four peddle wheels with 1 HP motor each would be required for one acre of shrimp farm. There are about 1,250 shrimp farms in Wayamba Province with the total extent of around 2,500 to 3,000 Acres.

Intervention No 19 – Solar Powered Ice Plants for Multiday Boats (IMUL)

As one of the priority interventions, stakeholders of Wayamba Province wish to have solar powered ice plants for multiday boats (IMULs). It is estimated that the demand will be around 100 units. As per the information of the Provincial Fisheries Ministry of Wayamba Province, there were over 189 IMULs in 2019.

Intervention No 20 – Solar Powered Desalination Plants for Multiday Boats (IMUL)

As one of the priority interventions, stakeholders of Wayamba Province wish to have solar powered desalination plants for multiday boats (IMULs). It is estimated that the demand will be around 150 units. As per the information of the Provincial Fisheries Ministry of Wayamba Province, there were over 189 IMULs in 2019.

IMUL - Inboard Multi-day Boats
IDAY - Inboard Single-day Boats
OFRP - Out-board engine Fiberglass Reinforced Plastic Boats
MTRB - Motorized Traditional Boats
NTRB - Non-motorized Traditional Boats
NBSB - Non-motorized Beach Seine Crafts

Intervention No 21 – Solar Powered Identification Boarders for Fishing Nets

As one of the priority interventions, stakeholders of Wayamba Province wish to have solar powered identification boarders for fishing nets. It is estimated that the demand for solar powered solar powered Identification boarders for fishing nets will be around 100 units. Around 20 bulbs would be sufficient for one fishing net.

Intervention No 22 – Solar Powered Lighting in Boatyards

As one of the priority interventions, stakeholders of Wayamba Province wish to have solar powered lighting at anchorages, harbours & landing sites. It is estimated that the demand for solar powered battery charging systems will be around 100 units. Two bulbs of 1,000 Watts each would be sufficient for one station.

Intervention No 23 – Solar Powered Battery Charging Stations for Fishermen

As one of the priority interventions, stakeholders of Wayamba Province wish to have solar powered battery charging systems for fishermen at anchorages, harbours & landing sites. It is estimated that the demand for solar powered battery charging systems will be around 100 units.

Intervention No 24 – Solar Powered Medium Scale Refrigerators / Mini Ice Plants for Fish Vendors

As one of the priority interventions, stakeholders of Wayamba Province wish to have solar powered medium scale refrigerators / mini ice plants for fish vendors. It is estimated that the demand will be around 200 units.

Intervention No 25 – Solar Powered Aquariums

As one of the priority interventions, stakeholders of Wayamba Province wish to have solar powered aquariums. It is estimated that the demand will be around 500 units.

Biomass

The most available forms of biomass types in the Wayamba Province are paddy husk, saw dust, coconut shells, coconut husks, fuel wood (Coconut, rubber etc.) and agricultural waste and industries have been moving to operate their thermal energy generators such as boilers, hot water generators, driers, furnace, hot air generators, etc. using biomass instead of fossil fuel.

Contact points (Biomass)

Eng. Dr Ajith Vidanagamage, Technical Director, ISB – 0777709774, ajithv@isb.lk

Intervention No 26 – Briquetting / Pelletizing of Biomass

Though industries are moving to operate their thermal energy generators using biomass instead of fossil fuel, maintaining a regular supply of biomass has been a major problem. Continuous and sustained supply of quality-assured biomass as an industrial fuel need to be ensured. This implies increasing the availability of biomass-based fuel by planting fuel wood species and developing supply chains

with facilities for pre-processing and storage. The choice of Gliricidia as fuel wood is supported by government policy (i.e., by declaring the species as a plantation crop in line with tea, rubber and coconut) and there are number of on-going government-supported schemes to promote it as an organic fertilizer in coconut, tea, spice plantations and in farms/home gardens.

Briquetting or pelletizing is the process of compaction or densification of biomass residues into different sizes and shapes by pressing loose biomass residues, or waste to produce a solid and they have numerous applications which include both domestic and industrial applications. Briquetting improves the biomass fuel characteristics mainly bulk density and other physical properties than of raw material and increment in calorific value of the end product.

As one of the priority interventions, stakeholders of Wayamba Province wish to have briquetting or pelletizing machines for farmers. It is estimated that the demand for briquetting or pelletizing machine will be around 100 units of 5-10 tons of biomass per day.

Intervention No 27 – Small Scale Dendro Power Plants

Dendro power, destined to be well suited to tropical countries like Sri Lanka, could effectively replace fossil fuel-based power generation to a considerable extent. However, many Dendro power plants developed in Sri Lanka recently have not been very successful, and appear to have been abandoned either temporarily or permanently due to various reasons such as technology issues, short supply of feedstock, policy and regulatory barriers.

Therefore, as one of the priority interventions, stakeholders of Wayamba Province wish to have modern and more efficient small scale Dendro power plants (Grid connected or off grid) of around 500 kW capacity using Gliricedia which can be grown as an under crop in coconut plantations. It is estimated that the demand will be around 100 units.

General (More suitable for R&D)

Intervention No 28 – Solar Powered Water Management with Alternate Wetting & Drying (AWD)

'Alternate wetting and drying' (AWD) is a water management technique, practiced to cultivate irrigated lowland paddy with much less water than the usual system of maintaining continuous standing water in the field. It is a method of controlled and intermittent irrigation. A periodic drying and re-flooding irrigation scheduling approach is followed in which the fields are allowed to dry for few days before re-irrigation, without stressing the plants. This method reduces water demand for irrigation and greenhouse gas emissions without reducing crop yields.

Though this is not related to any candidate energy source (Solar, biomass and biogas), as one of the priority interventions, stakeholders of Wayamba Province wish to try this out as a pilot project.

Intervention No 29 – Heat Extraction from a Large Rocks

Solar energy offers an alternative solution to the current energy demand from low to high-temperature domestic and industrial / commercial applications. The conversion of solar radiation to thermal energy for direct use is particularly more attractive for both industrial and domestic heating applications.

However, as solar energy is available in an intermittent way, and integrating an energy storage system with solar energy collection devices may promote uninterrupted supply of energy in the absence of the availability of solar energy. It has been shown that heat can be stored using rocks packed in a bed, but limited work has been reported on heat extraction from a charged rock bed. The use of rock particles to store heat has several advantages compared to other thermal energy storage: they are cheap and locally available, the technology is feasible and the storage containment design is similar to the conventional cooking oven which promotes cooking on the top part of the storage. In addition, rocks have fairly good heat transfer characteristics when used with air at low velocities and can withstand high temperatures.

As Wayamba Province has many large rocks, this proposal is to investigate the possibility of heat extraction from such rocks for suitable applications as a pilot project.

Training and Capacity Building

All technology applications require training and capacity building as stated below;

Agriculture sector
- Technology awareness programmes
- Training on operation & maintenance

Fisheries sector
- Technology awareness programmes
- Training on operation & maintenance
- Training for new appliances
- Awareness for laboratory testing

Livestock sector
- Technology awareness programmes
- Training on operation & maintenance