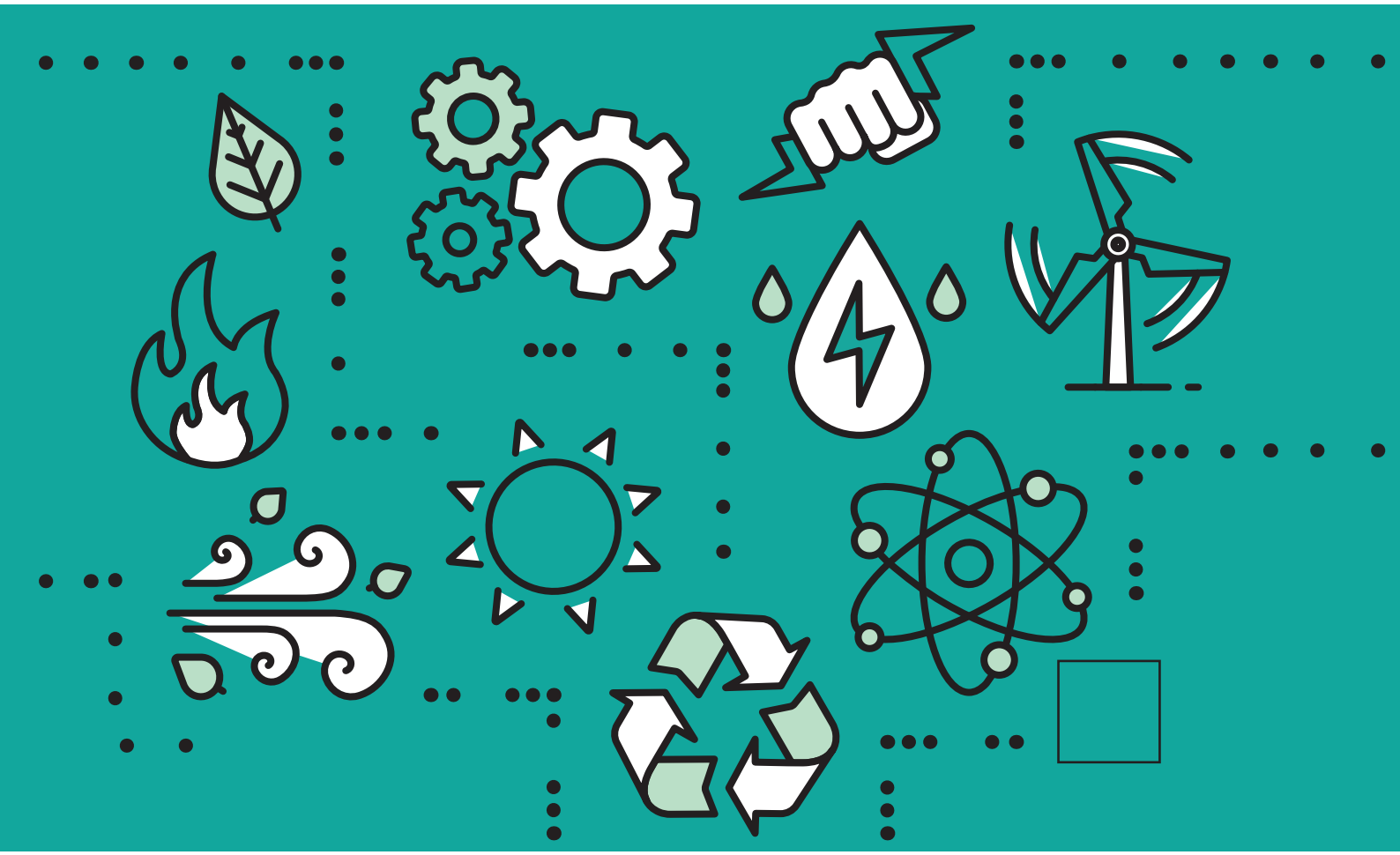

PROVINCIAL ENERGY PLAN FOR AGRICULTURE, LIVESTOCK AND FISHERIES SECTORS IN THE UVA PROVINCE

Under the Biogas, Biomass and Solar Trilateral Cooperation Project

October 2021

Prepared by
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Prepared For
United Nations Development Programme (UNDP) in Sri Lanka

United Nations
Office for South-South Cooperation

Acknowledgement

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I wish to express my sincere thanks to UNDP Sri Lanka for the trust and confidence placed in me by entrusting this task and thereafter very enthusiastic encouragement, assistance and excellent cooperation extended by the Project Management Unit guided by Dr. Buddika Hapuarachchi - Policy Specialist and Team Leader, Climate and Environment Team and Ms. Sureka Perera - Programme Quality & Design Analyst and led by Mr. Sampath Ranasinghe (Programme Coordinator), Eng. Suranga Karavita (Technical Coordinator) and Mr. Dasitha Premarathne (Project Assistant) in performing this task.

On behalf of UNDP project Management unit, I highly value and appreciate the guidance and support given by the partners of the project, Professor Dong Renjie and Dr Zhou Yuguang Associate Professor of the Chinese Agricultural University, Officials of Administrative Centre for China's Agenda 21 (ACCA 21) and Regional Coordinator Dr. Denis Nkala and team of the UNOSCC for making this valuable exercise possible.

I also appreciate and highly value the guidance and support given the provincial council in preparing the provincial energy plan lead by the Chief Secretary Mr. P. B. Wijayarathne, Secretary (Ministry of Agriculture) Mr. R.M.T.B. Hathiyaldeniya, Director Planning (Ministry of Power & Energy) Mr. D. M. Samarasekara, Additional Provincial Director (Department of Animal Production & Health) Dr. Sanath Gamage, Deputy Director Planning (Ministry of Agriculture) Mr. K. M. W. R. Bandara and all the other relevant staff members of respective ministries and departments of the province who supported.

Last but not least, I wish to express my sincere thanks and profound gratitude to all other parties without whose valuable contribution this report would not have been possible including district level officers, farmers and all others.

Eng M. M. R. Padmasiri

National Consultant Development of Energy Plans for the Agricultural Sector in Five Provinces
Trilateral South-South Corporation (TSSC) Project
UNDP Sri Lanka

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LIST OF ABBREVIATIONS

UP	- Uva Province
CCS	- Climate Change Secretariat
CEB	- Ceylon Electricity Board
GHG	- Green House Gas
NAMA	- Nationally Appropriate Mitigation Actions
NDC	-Nationally Determined Contribution
RETs	- Renewable Energy Technologies
SLSEA	- Sri Lanka Sustainable Energy Authority
UNDP	- United Nations Development Programme

EXECUTIVE SUMMARY

Energy and agriculture sectors are the largest Green-House Gas (GHG) emitters in Sri Lanka, representing around 59%, and 27% respectively of the total national GHG emissions (SNC, 2011). Thus, implementing energy efficiency measures and renewable energy technologies (RETs) in these sectors can have a significant impact in terms of emission reductions apart from significant socio-economic benefits to the country. However, the energy use and the energy generation (eg. Biogas) in agriculture, fisheries and livestock practices are not separately accounted in national or provincial level energy balances yet. The main reason may be the practical difficulties of collection of reliable and accurate data from the fields due to decentralized and scattered nature of operation. This report has been developed under the Biogas, Biomass and Solar Trilateral South South Cooperation (TSCC) Project which has been implemented with the objectives of introducing technologies and systems to enhance the Sustainable Energy Use in the Agriculture, Fisheries and Livestock (AFL) sector in Sri Lanka. Production and semi production process of the above mentioned sectors have been considered as the boundary of this analysis and technically viable renewable energy technologies have been analyzed and included in this action plan.

Agriculture Sector: There are about 615,000 hectares of agricultural land in Uva Province, and out of this about 87,900 hectares are paddy lands, 77180 ha are vegetable cultivating lands and around 2550 ha are fruit cultivating lands. Balance is for sugar cane and other crops.

Geographically both up and low country areas are represented in Uva province. Upcountry vegetables are cultivated in Boralanda, Welimada areas and Monaragala, Wellawaya, Mahiyangana areas are popular for low country agricultural crops such as pumpkin, water melon, maize etc.

Mini tillers are becoming popular in upcountry vegetable farming for land preparation and both 4 wheel and 2 wheel tractors are being used in low country farming. Rain fed crops are cultivated mainly in Uva Province during 'Maha' season from September to March using the North Eastern monsoon. Diesel pumps are used in these areas mainly for lifting water from irrigation channels or agricultural wells and the use of electric pumps are in the range of 20% of the total population.

Around 117.74 million liters of auto diesel, 64.24 million liters of petrol (Octane 92) and 370.5 GWh of electricity was used in 2019 [9] in Uwa Province. Out of these around 29.6% of diesel, 15.6% of petrol and 2.3% of electricity is used in agriculture sector.

The energy consumption in paddy cultivation is the highest in Uwa Province and rest of the energy is shared among vegetable and fruits cultivation. Out of the total energy consumption in agriculture sector (cultivation) land preparation and water pumping consume 37.5% and 25.4% respectively. Harwesting is the next and it shares around 21.5% of the total energy. In short rotation vegetable crops, more than 70% of total energy consumption shares are for water pumping and approximately 21% for land preparation.

Fisheries Sector: Production and semi production processes in marine fishing, inland fishing, ornamental fishing and shrimp farming are considered as the boundary of this report under fisheries sector. The mainly inland fishing industry is functioning in low line areas like Mahiyanganaya, Buttala, Monaragala etc. in both districts. Most of the day catches are sold during the same day since marine fish supply to these areas is considerably less. Dry fish is produced if surplus is available but the yield is very small. The average annual tank fish catch

in these two districts are 9700 tons and this is 10% of the total annual tank fish requirement in the country.

One ice manufacturing factory is available in Buttala, supplying ice to meet the requirement in Monaragala and Buttala area. Ice requirements for Mahiyanganaya and Rathkinda fishing centers are supplied from Ampara and Batticaloa areas.

Ornamental fishing is also available in moderate level in a few places in Uva province and those productions are mainly supplied to the export market

Livestock Sector: Energy usage in livestock sector productions in Uva Province is comparatively lower than the other Provinces. Few machineries are utilized in this sector. Biogas popularization programmes in different scales have been initiated in Uva Province by different institutions but most of the units are abandoned now due to lack of a proper MRV system in place.

Out of the total national requirement, about 9.6% of cow milk, 8.9% of buffalo milk, 1.6% of beef and 3.2% of mutton is produced in the Uva province.

Energy use in livestock sector is not significant and most of the activities are carrying out as a domestic industry.

Action Plan: This report presents a comprehensive activity plan to optimize the energy use in the Agro-Industry including agriculture, fisheries, and livestock sectors. The activity plan introduces 8 sector specific and cross sectoral interventions diverging in to 18 sub activities covering all major aspects including training and capacity building, renewable energy technology development, and financial mechanisms.

The energy share for land vehicles (land preparation and harvesting activities) in agriculture sector has been identified as the major contributor in the energy balance. Enhancement of energy efficiency in these machineries have been identified as one of the important activity but this has to be done in national level. Setting standards and quality control measures on machinery imports is more appropriate, as it will gradually lead efficient equipment to penetrate in to the market. Regulatory provisions are already available in section 35(2) and 36(2) of Sri Lanka Sustainable Energy Authority act no 35, 2007 for this purpose.

NDC Actions: Government of Sri Lanka submitted updated nationally determined contributions (NDCs) in July 2021 and it is expected to achieve a reduction of GHG emissions against the BAU scenario by 7% in the agriculture and livestock sectors (4% unconditionally and 3% conditionally) equivalent to an estimated mitigation level of 2,477,400 MT CO2e unconditionally and 1,858,000 MT CO2e conditionally (total of 4,335,400 MT CO2e) of carbon dioxide equivalent during the period of 2021 to 2030 by implementing the updated NDCs. Energy related sub NDC actions in agriculture and livestock sectors have been identified under this NDC submission and implementation of this action plan will give an additional support when reporting the achievements of the above targets.

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION TO THE REPORT

This report has been developed under the Biogas, Biomass and Solar Trilateral Cooperation Project which has been implemented with the objectives of introducing technologies and systems to enhance the Sustainable Energy Use in the Agro-Industry (Agriculture, Fisheries and Livestock industries) in Sri Lanka. This is a 2-year project and the Sri Lanka Sustainable Energy Authority (SLSEA), Ministry of Power and Energy, and the Provincial Councils (Five Provinces-North Western, Southern, Uva, Eastern and Northern) are the project implementing partners whereas UNDP Sri Lanka provides the implementation support through Direct Implementation Modality.

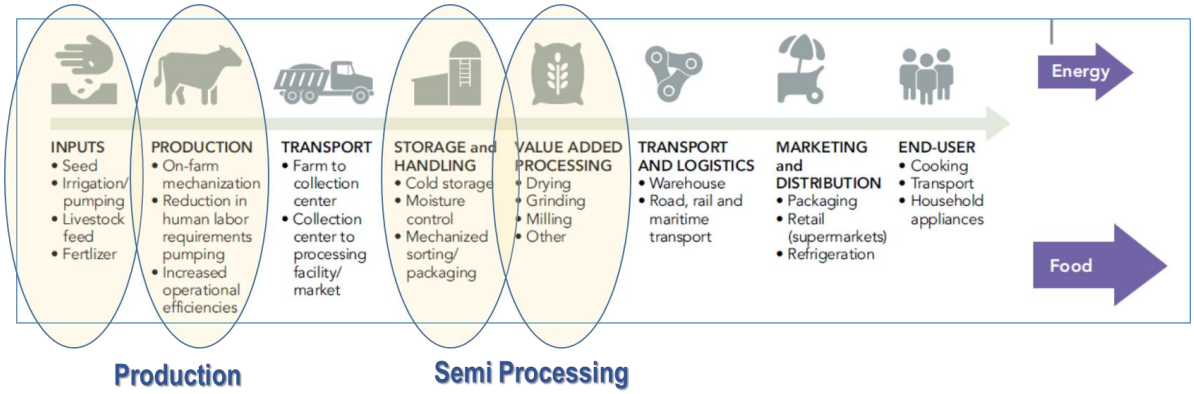


Figure 1.1: Boundary of this analysis report

Agriculture, fisheries and livestock sectors have been considered under this report as the Agro-Industry prevailing in the Uva Province. The production and semi production processes of the above mentioned sectors have been considered as the boundary of this analysis and technically viable renewable energy technologies have been analyzed and included in this action plan.

1.2 BACKGROUND

Energy and agriculture sectors are the largest Green-House Gas (GHG) emitters in Sri Lanka, representing around 59%, and 27% respectively of the total national GHG emissions (SNC, 2011). Thus, implementing energy efficiency measures and renewable energy technologies (RETs) in these sectors can have a significant impact in terms of emission reductions apart from significant socio-economic benefits to the country. However, energy use and energy generation (eg. Biogas) in agriculture, fisheries and livestock practices are not separately accounted in national or provincial level energy balances yet. The main reason may be the practical difficulties of the collection of reliable and accurate data from the fields due to the decentralized and scattered nature of the operation.

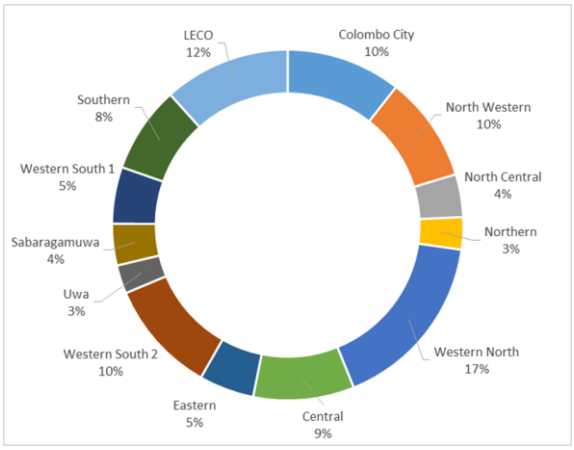


Fig 1.2: Electricity share by province

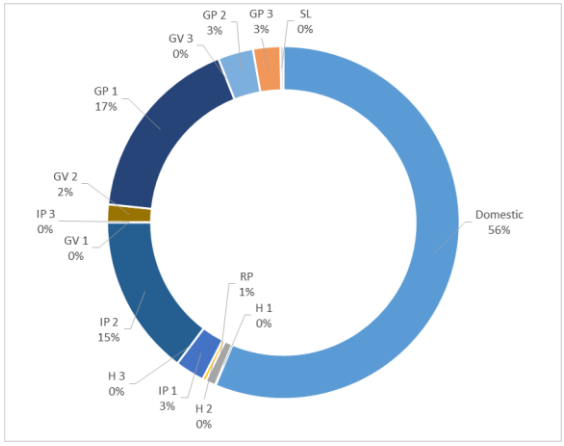


Fig 1.3: Electricity share by different categories in UP

The government of Sri Lanka submitted updated nationally determined contributions (NDCs) in July 2021 and it is expected to achieve a reduction of GHG emissions against the BAU scenario by 7% in the agriculture and livestock sectors (4% unconditionally and 3% conditionally) equivalent to an estimated mitigation level of 2,477,400 MT CO2e unconditionally and 1,858,000 MT CO2e conditionally (total of 4,335,400 MT CO2e) of carbon dioxide equivalent during the period of 2021 to 2030 by implementing the updated NDCs. Adoption of renewable energy technologies in crop farming, livestock applications have been identified as prospective NDCs under this report.

1.3 AGRICULTURE SECTOR – UVA PROVINCE

1.3.1 OVERVIEW

The energy use in crop cultivation and semi processing such as threshing & winnowing has been considered as the boundary of this analysis. There are about 615,000 hectares of agricultural land in Uva Province, and out of this about 87,900 hectares are paddy lands, 77180 ha are vegetable cultivating lands and around 2550 ha are fruit cultivating lands. Balance is for sugar cane and other crops.

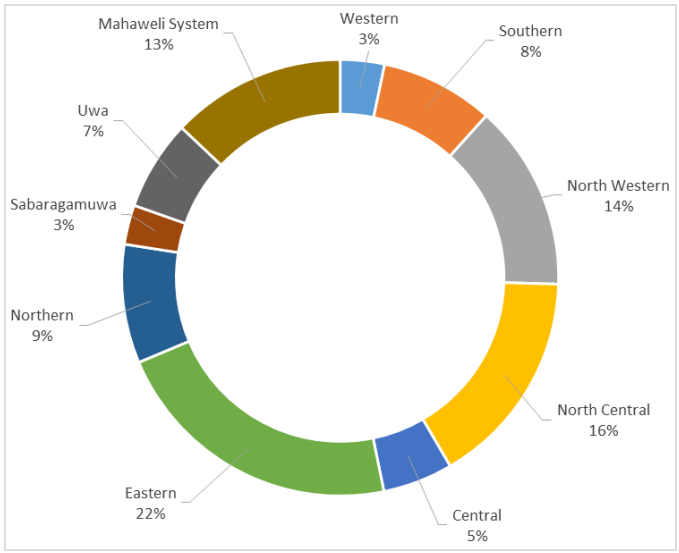


Fig 1.4: Share of paddy cultivation area by province

Geographically both up and low country areas are represented in Uva province. Upcountry vegetables are cultivated in Boralanda, Welimada areas and Monaragala, Wellawaya, Mahiyangana areas are popular for low country agricultural crops such as pumpkin, water melon, maize etc.

Mini tillers are becoming popular in upcountry vegetable farming for land preparation and both 4 wheel and 2 wheel tractors are being used in low country farming. Rain fed crops are cultivated mainly in Uva Province during 'Maha' season from September to March using the North Eastern monsoon. Diesel pumps are used in these areas mainly for lifting water from irrigation channels or agricultural wells and the use of electric pumps are in the range of 20% of the total population.

1.3.2 ENERGY USE

Water pumping is the major energy consumer in both vegetable and fruit cultivation and approximately 80% in terms of energy, and 70% in terms of cost of energy shares are invested in water pumping. Next to water pumping, the energy requirement for land preparation holds the other major share. Energy consuming machineries such as sprayers, mini tillers etc. are used in agriculture industry but the energy or energy cost share is not considerable. The detailed analysis is given in Chapter 4.

1.3.3 IMPLEMENTED AND ONGOING PROGRAMMES

1.3.3.1 Projects Implemented by the Ministry of Agriculture – Uva Province

Ministry of Agriculture in Uva Province is providing agriculture machineries to the farmers at 50% or 100% grant basis annually and the summary of the projects implemented are given in the following table.

Table 1.1: Details of projects implemented in Uva Province

Projects Details (Related to Energy) Uva Province - Agriculture				
Year	**Project**	**No of Beneficiaries**	**Specifications**	**Unit Cost - LKR**
	Need to fill with actual data available at the Ministry of Agriculture – Uva Province			

1.4 LIVESTOCK SECTOR

1.4.1 OVERVIEW

Energy usage in livestock sector productions in Uva Province is comparatively lower than the other Provinces. Few machineries are utilized in this sector. Biogas popularization programmes in different scales have been initiated in Uva Province by different institutions but most of the units are abandoned now due to lack of a proper MRV system in place.

Out of the total national requirement, about 9.6% of cow milk, 8.9% of buffalo milk, 1.6% of beef and 3.2% of mutton is produced in the Uva province.

1.4.2 ENERGY USE

In addition to the energy usage, a substantial amount of energy is generated through biogas for domestic usage from this sector. The use of evaporative cooling technology in broiler chicken industry and use of coolers for preserving milk are the major energy utilizers in livestock sector. In addition to this water is being used in different stages in all the meat and egg production processes and there are not many details recorded on that.

1.5 FISHERIES SECTOR

1.5.1 OVERVIEW

Badulla and Monaragala are the two administrative districts in Uva province and geographically both up country and low country terrains are available in the Badulla district. The mainly inland fishing industry is functioning in low line areas like Mahiyanganaya, Buttala, Monaragala etc. in both districts. Most of the day catches are sold during the same day since marine fish supply to these areas is considerably less. Dry fish is produced if surplus is available but the yield is very small. The average annual tank fish catch in these two districts are 9700 tons and this is 10% of the total annual tank fish requirement in the country.

One ice manufacturing factory is available in Buttala, supplying ice to meet the requirement in Monaragala and Buttala area. Ice requirements for Mahiyanganaya and Rathkinda fishing centers are supplied from Ampara and Batticaloa areas.

Ornamental fishing is also available in moderate level in a few places in Uva province and those productions are mainly supplied to the export market.

1.5.2 ENERGY USE

Mainly non-motorized boats are being used for fish catching and energy usage in this activity is almost zero. Electricity usage in the ice production process is the major energy user in the fisheries sector in the Uva province. In addition to this, electricity or diesel use in aerators and water pumping in ornamental fish farming accounts for a small amount of energy. Battery operated headlamps are used during nighttime fishing charged by domestic electricity but the energy usage is not very significant.

1.5.3 IMPLEMENTED AND ONGOING PROGRAMMES

Since the energy use is not significant compared to the other sectors in the province, there are no energy related projects that have been implemented in the Uva Province during the recent past. However, the Ministry of Fisheries in Uva province is being taken much effort to

enhance the quality and productivity in this sector by implementing number of tailor made programmes.

1.6 ASSISTANCE FOR IMPLEMENTATION OF GREEN ENERGY IN THE UVA PROVINCE

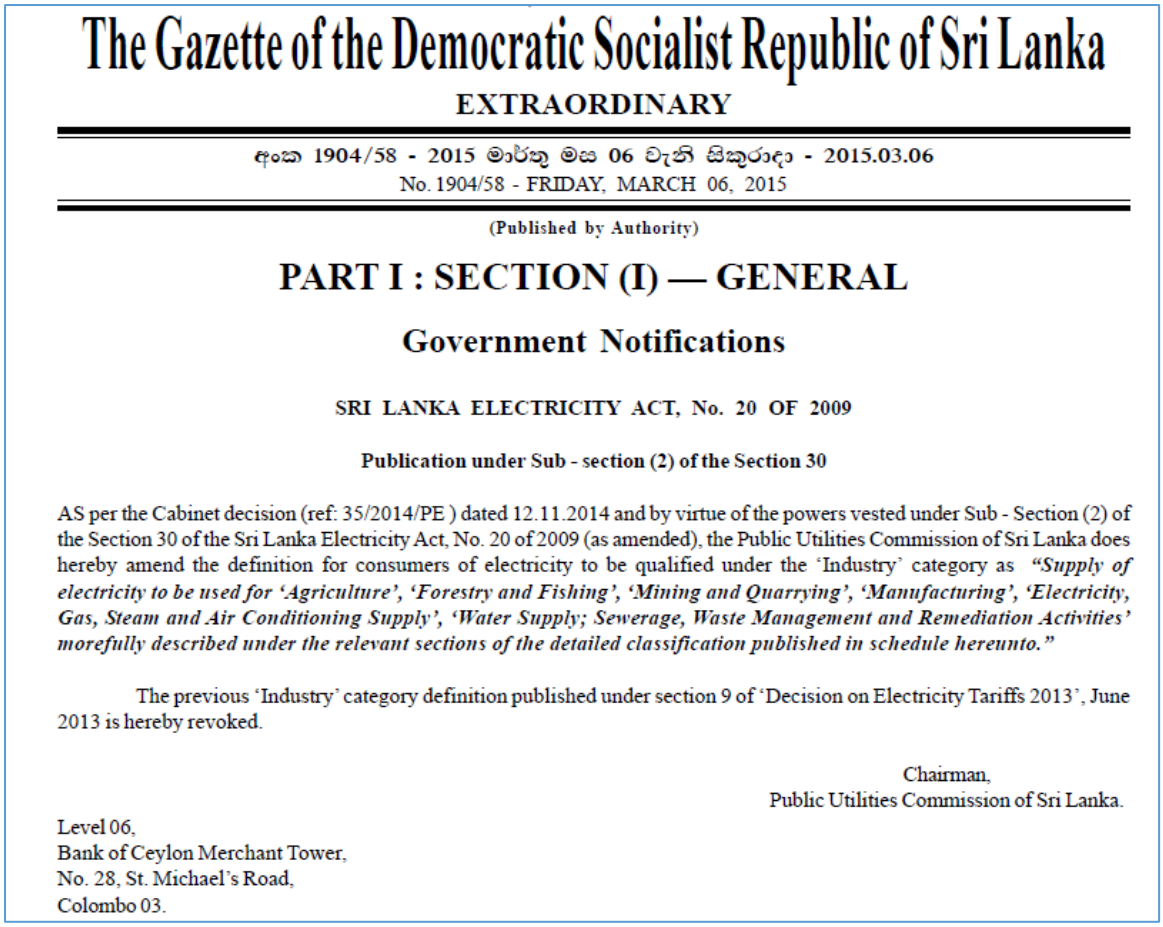
1.6.1 NAMA PROJECT

Nationally Appropriate Mitigation Actions (NAMA) in the Energy Generation and End-use Sectors in Sri Lanka Project was executed by the United Nations Development Programme (UNDP), Sri Lanka Sustainable Energy Authority (SLSEA), and the Climate Change Secretariat of Sri Lanka (CCS) to support appropriate climate change mitigation actions in the energy generation and end-use sectors as part of the initiatives to achieve the voluntary GHG mitigation targets of Sri Lanka and to develop a robust, transparent and functional NAMA framework along with clear inventory and Monitoring, Reporting, and Verification (MRV) system with supporting governance and oversight in Sri Lanka that will systematically quantify Green House Gas (GHG) savings and benefits of the mitigation interventions using a bottom up approach to aggregate from the provincial and sub-sector levels to the national and sectors level.

Under this NAMA project, biogas pilot project was implemented in the Uva Province for testing of MRV system and introduced 65 biogas units in different scales.

1.6.2 ELECTRICITY TARIFF FOR AGRO-INDUSTRY

Agriculture, fisheries, and livestock sectors have been included into industry category under the CEB tariff structure and a separate tariff has been announced by the Government of Sri Lanka on 06th March 2015 but it has been noticed that no one is aware of this initiative. The electricity bill can be brought down with this new tariff structure.



The Gazette of the Democratic Socialist Republic of Sri Lanka

EXTRAORDINARY

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No. 1904/58 - FRIDAY, MARCH 06, 2015

(Published by Authority)

PART I : SECTION (I) — GENERAL

Government Notifications

SRI LANKA ELECTRICITY ACT, No. 20 OF 2009

Publication under Sub - section (2) of the Section 30

AS per the Cabinet decision (ref: 35/2014/PE) dated 12.11.2014 and by virtue of the powers vested under Sub - Section (2) of the Section 30 of the Sri Lanka Electricity Act, No. 20 of 2009 (as amended), the Public Utilities Commission of Sri Lanka does hereby amend the definition for consumers of electricity to be qualified under the 'Industry' category as *"Supply of electricity to be used for 'Agriculture', 'Forestry and Fishing', 'Mining and Quarrying', 'Manufacturing', 'Electricity, Gas, Steam and Air Conditioning Supply', 'Water Supply; Sewerage, Waste Management and Remediation Activities' morefully described under the relevant sections of the detailed classification published in schedule hereunto."*

The previous 'Industry' category definition published under section 9 of 'Decision on Electricity Tariffs 2013', June 2013 is hereby revoked.

Chairman,
Public Utilities Commission of Sri Lanka.

Level 06,
Bank of Ceylon Merchant Tower,
No. 28, St. Michael's Road,
Colombo 03.

1.6.3 AGRICULTURE SECTOR MODERNIZATION PROJECT

Agriculture Sector Modernization Project has been initiated with the assistance of the World Bank and the objective is to support increasing agriculture productivity, improving market access, and enhancing value addition of smallholder farmers and agribusinesses in the project areas. More specifically seeks to promote commercial and export-oriented agriculture; attract and leverage investments from farmer producer organizations and agribusinesses for high value agriculture production and value addition; and provide the enabling environment, incentives, and access to finance for such investments through matching grants, technical assistance support, linkages to the commercial banking sector, and a Partial Credit Guarantee (PCG) facility. Also, the project is aiming enhancement of productivity through supporting smallholder farmers to produce competitive and marketable commodities, improve their ability to respond to market requirements, and move towards increased commercialization.

1.7 BARRIERS TO IMPLEMENTATION

The energy usage in the Agro-industry has not been properly accounted for in national or regional level balance sheets and due to this less attention has been paid to the implementation of energy efficiency or renewable energy projects in these sectors. To overcome this issue a separate chapter is recommended in the national energy balance published by Sri Lanka Sustainable Energy Authority.

Lack of end user awareness, lack of technical capacity among end users and officials in the Agro- industry on renewable energy and energy efficiency technologies are some of the other challenges faced when implementing energy projects. Comprehensive training and capacity

building programmes are essential to overcome this issue. Also, demonstration of new technologies and systems through pilot projects can overcome most of these issues.

Even though the regulatory mechanisms are in place to eliminate the low-quality solar energy powered products coming in to the local market, low-quality products are still available and it is very difficult to recognize the best product by visual inspection. With this situation, the level of confidence about these appliances among the farmer community is decreasing day by day. This situation has been experienced during the questionnaire survey carried out in Uva Province.

Lack of consistent market and price structure for agriculture products is another barrier to developing agriculture sector as expected. Due to weather conditions or seasonal variation, crop prices are varying rapidly in Sri Lanka and it is difficult to predict the market. With this background farmers are reluctant to invest as such for system developments.

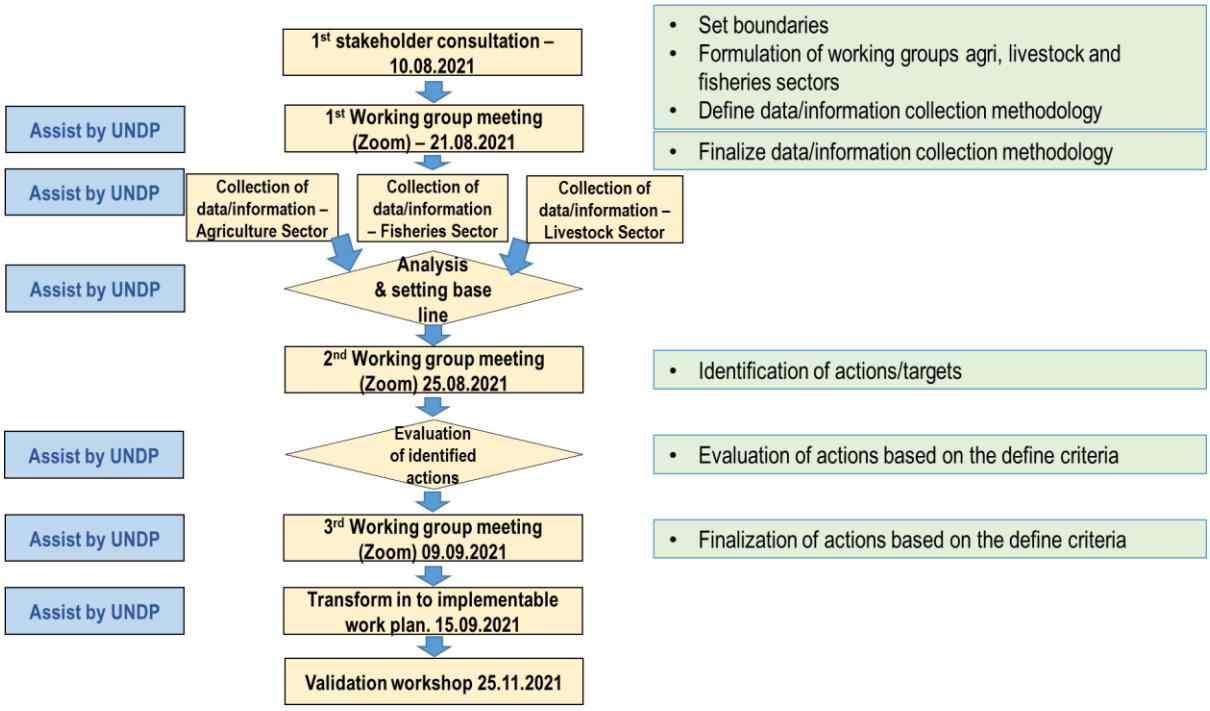
It is obvious that the general public is always trying to move towards convenient lifestyles and they are not paying much attention to complex operations like domestic biogas systems even though it gives a better return on investment (RoI). This is why solar systems are becoming popular even with the high initial cost. Once a solar system is installed on the rooftop, there is not much operation and maintenance involvement except cleaning the panel when required. When introducing a technology or a system, it is needed to take into account these social aspects, otherwise, the entire project will fail.

Agro-industry is one of the major income generating industries in Sri Lanka and with a high return on investment (RoI) in most of the commercially viable technologies. With this background, it seems that financial assistance is not required for the commercialization of these technologies. However, if it is possible to develop and introduce most of the interventions as projects packaging essential elements together (soft financing, technology demonstration, pilot projects, awareness programmes and monitoring) the rate of implementation can be enhanced.

1.8 METHODOLOGY ADOPTED

Since the energy usage details in most of the groundwork operations in the Agro-industry is not readily available, more effort has been given to establish those details. Some of the required details have been taken from the information available in open sources mainly in websites of ministries and departments and other ground information was collected by conducting a questionnaire survey. The reference of websites from which details were taken is given in the reference section and the details of interviewed farmers and other officials are given in the annex.

The steps followed for the development of this action plan are presented in the following diagram and most of the group meetings were conducted online due to prevailing pandemic situations.


1st stakeholder consultation – 10.08.2021
Assist by UNDP
1st Working group meeting (Zoom) – 21.08.2021
Assist by UNDP
Collection of data/information – Agriculture Sector
Collection of data/information – Fisheries Sector
Collection of data/information – Livestock Sector
Assist by UNDP
Analysis & setting base line
2nd Working group meeting (Zoom) 25.08.2021
Assist by UNDP
Evaluation of identified actions
Assist by UNDP
3rd Working group meeting (Zoom) 09.09.2021
Assist by UNDP
Transform in to implementable work plan. 15.09.2021
Validation workshop 25.11.2021
• Set boundaries
• Formulation of working groups agri, livestock and fisheries sectors
• Define data/information collection methodology
• Finalize data/information collection methodology
• Identification of actions/targets
• Evaluation of actions based on the define criteria
• Finalization of actions based on the define criteria

CHAPTER 2:
GOVERNMENT POLICIES, DIRECTIVES AND COMMITMENT

2.1 INTRODUCTION

The energy aspect in the Agro-industry covered by different policies, directives and commitments is discussed in this chapter. These policy directives have been accounted for when developing the prospective actions under this energy plan.

2.2 GOVERNMENT DIRECTIVES

The present Government has given a directive to the agriculture sector to eliminate the use of chemical fertilizer with immediate effect and introduce/promote organic fertilizer to all crops. Under this directive, in-house organic fertilizer manufacturing will be promoted and the machinery and energy requirement will be enhanced.

In addition to the policy directives given in the national energy policy document, the present Government has given a directive to enhance the percentage of renewable energy in the energy generation mix up to 70% by 2030.

2.3 ENERGY POLICY

The latest version of the energy policy has been published on 09th Friday 2019 by the Ministry of Power & Energy. Working through the conflicting demands from the security, equity and sustainability dimensions, known as the energy trilemma, Sri Lanka today is seen to be moving away from the delicate balance of these three forces. The national energy policy is thus founded on ten pillars, rooted in the broad areas impacting the society, economy and the environment, in an effort to counter balance the forces through enhanced equity, security and sustainability, respectively. The strategies directly effecting to the agriculture sector are given in the following table.

Table 2.1: The strategies directly effecting agriculture sector under the energy policy

No.	Pillar	Strategy
01	Providing Access to Energy Services	New productive uses for electricity in agriculture, rural and primary industries will be encouraged with emphasis on empowerment of women and youth
		To encourage prospective small and medium scale industries and businesses, the initial cost of obtaining an electricity connection, which may be considered at present compared with the capital cost of the business, will be reduced by offering a special concessionary package under which the entire cost of the transformer for contract demands up to 100kVA will be waived-off and be socialized through distribution tariffs. This should be fully implemented from January-2021by CEB/LECO, accompanied with an appropriate campaign giving wide publicity through media.
02	Improving Energy Efficiency and Conservation	Expert energy advisory services will be offered through state and private sector service providers to promote energy efficiency, conservation and energy cost reduction across all end use sectors.

2.4 NATIONALLY DETERMINED CONTRIBUTIONS (NDCs)

The government of Sri Lanka submitted updated nationally determined contributions (NDCs) in July 2021 and it is expected to achieve a reduction of GHG emissions against the BAU scenario by 7% in the agriculture and livestock sectors (4% unconditionally and 3% conditionally) equivalent to an estimated mitigation level of 2,477,400 MT CO2e unconditionally and 1,858,000 MT CO2e conditionally (total of 4,335,400 MT CO2e) of carbon dioxide equivalent during the period of 2021 to 2030 by implementing the updated NDCs. The energy related NDCs identified in this document is given following table.

Table 2.2: The NDCs directly effecting to the agriculture sector

NDC No.	NDC and Action
NDC 03	**Improve adoption of renewable energy for crop farming/value addition**
	3.1 Application of solar PV and wind energy (or hybrid) for agriculture practices
	3.2 Promote grid electricity use in place of fossil fuel driven engine powered pumps
	3.3 Renewable energy powered mini grid for clustered agriculture farming in vulnerable areas (as a pilot)
	3.4 Explore and develop small hydro power potential in irrigation water canals for agriculture purpose
NDC 06	**Adopt renewable energy for livestock applications** E.g. small-scale solar-powered refrigeration to increase the milk storage facilities, solar-powered can-coolers for milk producers, solar energy for milk collection, chilling centres, farm operation and processing; and introducing biogas digesters for large scale livestock & poultry, dairy processing and abattoirs

2.5 AGRICULTURE POLICY

The Government has unveiled the drafted National Agriculture Policy towards achieving the vision of "sustainable food security to achieve national prosperity. The policy is primarily focused on food and feed crops, and sustainable food security with improved food quality and has set multiple goals to be achieved by 2030. The drafted policy has identified fifteen policy statements under ten thematic areas and 144 policy actions. Out of these the energy related policy actions are given in the following table.

Table 2.3: Energy related policy actions in the National Agriculture Policy

No.	Thematic Area	Policy Statement	Policy Action
01	Eco-friendly Operations	Support sustainability in agriculture development through conservation and utilization of natural resources while safeguarding ecosystem services	Take appropriate measures to **increase the use of renewable energy in agriculture** – e.g. financial incentives to access solar-energy and wind powered technology/ battery-powered technology for irrigation, cold-storage systems and use of biogas
02			Introduce and adopt eco-friendly agricultural practices across agro-ecosystems to support environmental conservation
03	Input Management	Strengthen delivery and management	Establish a mechanism to **certify machinery** and other agricultural inputs to be used in Sri

		operations of physical inputs for their judicious use	Lanka (e.g. a central regulatory entity for auricular inputs)
04		Enhance rational use of irrigation water through participatory management to improve the irrigation water use efficiency	Take appropriate regulatory measures to avoid excessive use of ground water
05		Encourage development and adoption of appropriate innovations and technologies during pre- and post-harvest management for sustainable agricultural production	Provide financial and institutional support to develop cost-effective technology using locally-available resources
06			Promote adoption of technologies targeting value addition for perishables
07			Strengthen technology transfer mechanisms
08			Revisit and restructure existing authoritative body responsible for agriculture research to focus on establishing an Agriculture Research and Development/Extension Council
09			Introduction of proven and appropriate technology into the sector through field validation
10	Agri-Entrepreneurship and Markets	Streamline and explore the domestic and international market systems with appropriate logistic services in compliance with national and international standards	Adopt warehouse receipting system for durables (e.g. grain crops) by encouraging PPP, establishment of databases, etc.
11			Establish cold storage and cold chain facilities for perishables through PPP
12	Knowledge Management and Agricultural Extension	Constitute a centrally-controlled information development and dissemination system to manage research, development and extension systems, and recruitment related to the agriculture sector	Provide appropriate incentives (financial & physical) to promote R&D for technology development

CHAPTER 3:
DATA AND INFORMATION

3.1 INTRODUCTION

Data and information related to energy and machinery use in the Agro-industry in Sri Lanka is not readily available in open sources. The national energy balance is published by Sri Lanka Sustainable Energy Authority every year but the energy use in agriculture sector is not separately represented and it is accounted under domestic sector. Some information about the cost of machinery used in the cultivation of vegetable and fruits are available in the booklet "Cost of cultivation of agriculture crops" an annual publication by the Socio Economic and Planning Center, Department of Agriculture, Peradeniya and production details of paddy, vegetables, fruits and other crops are available in both Ministry of Agriculture and Department of Agriculture web sites. Also, production statistics in the fisheries sector and livestock sector are available in statistics reports published by the Ministry of Fisheries and Department of Animal Production and Health, Peradeniya.

Due to the absence of energy consumption data in cultivation, growing and semi processing, a sample survey has been carried out both in Badulla and Monaragala Districts and the summary of those data are presented in this chapter. Considering the prevailing COVID-19 situation, this survey has been carried out online.

The specific energy consumption for each operation has been established based on the details taken from the questionnaire survey and the results are given in the following tables.

3.2 DATA AVAILABLE IN OPEN SOURCES

3.2.1 AGRICULTURE SECTOR

Table 3.1: Land use in hectares in vegetable and other crop cultivation in Uva Province

	Tomato	Bean	Capsicum	Carrot	Cabbage	Pumpkin	Brinjal	Potato	Ground Nut	Red Onion	Big Onion	Chilli	Green Gram	Cowpea	Black Gram	Soy Bean	Maize	Beet root	Raddish	Leaks	Knokhol	Long Bean	Bushitavo	Okra	Luffa	Snake Gourd	Leaf Vegetable	Bitter Guard	Cucumber	Winged Bean	Ash Plantan	Sweet Potato	Kurakkan	Gingelly	Murunga	Manioc	Ind.Tuber & Roots
Badulla	1629	4869	706	894	1114	310	874	3845	277	43	41	728	398	385	50	145	11915	274	558	529	341	65	6	80	73	54	136	130	29	40	64	83	303	276	60	515	99
Monaragala	275	64	337	0	9	5336	926	0	2794	340	53	1225	2015	2289	404	770	20527	0	69	0	0	546	138	598	341	241	127	351	486	104	537	213	839	1694		1434	160

Source: https://www.doa.gov.lk/SEPC/images/cost_of_cultivation/cost_of_cultivation_19.pdf

Table 3.2: Land use in hectares in fruit cultivation in Uva Province

	Banana	Pineapple	Mango	Passion Fruit	Papaw	Rambutan	Lemon	Orange	Avacado	Guava	Mandarin	Pomegranate	Watermelon
Badulla	930	88	452	14	99	74	230	373	162	30	22	52	27
Monaragala	8250	272	1841	96	458	379	50	295	0	0	0	55	930

Source: https://www.doa.gov.lk/SEPC/images/cost_of_cultivation/cost_of_cultivation_19.pdf

3.2.2 FISHERIES SECTOR

Table 3.3: Key statistics of the fisheries sector in the Uva Province

Description	Badulla	Monaragala
No of permanent tanks	12	52
Seasonal tanks	47	60
Fisheries societies	27	52
Fishing crafts	390	415
Average annual production - tons	2100	7550
Percentage from the national production	2.3	8.3
Ice plant capacity	-	2 tons/day

3.2.3 LIVESTOCK SECTOR

Table 3.4: Key statistics of the livestock sector in the Uva Province

No.	District	No of Chilling Centers	Chilling Capacity (Liters)	Milk Collection (Liters)
01	Badulla	13	37,000	15,431,932
02	Monaragala	09	18,160	4,658,227

Table 3.5: Number of Livestock Farmers - 2020

District	Cattle and/or Buffalo (Local)	Cattle and/or Buffalo (Improved)	Goat	Swine	Poultry					
					Local Poultry	Broiler Farmers		Egg Producing Farmers		Total
						No. of Chicken Below 1000	No. of Chicken Over 1000	No. of Chicken Below 1000	No. of Chicken Over 1000	
Badulla	5,943	4,538	1,508	7	3,980	617	27	1,288	15	5,927
Monaragala	4,632	1,199	460	9	2,883	194	46	1,090	23	4,236

Source: http://www.statistics.gov.lk/Agriculture/StaticalInformation/rubb7

3.3 DATA COLLECTION THROUGH A QUESTIONNAIRE SURVEY

3.3.1 AGRICULTURE SECTOR

Table 3.6: Machinery usage in cultivation

No.	Crop	Machine	Work	Time Spend	Fuel Usage	No of seasons
Land Preparation						
01	Vegetables cultivation in Monaragala District	4 Wheel tractor with rotor vane	1st and 2nd plough per season	3 hrs per acre per plough	4 liters per hour	4 seasons, Average 2 months per season
02	Vegetable cultivation in Welimada, Boralanda in Badulla District	Mini Tillers	Loosening the soil and bed preparation	4 hrs per acre	1.5 liters per hour	4 seasons, Average 2 months per season
03	Chili, Maze, Pumpking in Monaragala District	4 Wheel tractor with rotor vane	1st and 2nd plough per season	3.0 hrs per acre per plough	4.0 liters per hour	2 seasons, Average 4 months per season
04	Paddy	4 Wheel tractor	1st and2nd plough per season	3 hrs per acre	5 liters per hour	2 seasons
05	Fruits (Yearly crops eg, Banana, papaya, water melon)	4 Wheel tractor	One plough per year	3 hrs per acre per plough	4.0 liters per hour	One season
06	Fruits (Mango, guava, Rambutan etc.)	Grass cutter	Grass cutting	0.5 acre per day	3 liters per 0.5 acre	-
Weeding and Soil turning/softening						
07	Vegetable like Okra, chili having 2 feet space	Mini tiller	Weeding	3 hrs/Acer and two time per season	Petrol 4 liters per acre	4 seasons for vegetables and 2 seasons for chili
Water Pumping						
08	Vegetables, Chili etc.	2 inch electric pump. One pump per acre	Water pumping	8 ~ 10 hrs per day	10 kWh per day per acre	4 seasons for vegetables, Average 2 months per season. 2 seasons for chili, Average 4 months per season
09		2 inch solar pump. One pump per acre		6 hrs per day	Very few pumps are operating in Monaragala District	
10		4 inch pump. One pump per 2 acre		5 hrs per day	3 liters/day	
11	Banana	Water is taken from irrigation channels for around 75% of total banana cultivation and no water lifting.				
Spraying						

12	Vegetables, fruits	Petrol engine driven sprayer	Spraying	3.5 hrs per acre	1.5 liters/acre	One or two times per week
13	Paddy	Petrol engine driven sprayer	Spraying	1.0 hrs per acre	2.5 liters/acre	Five times per season
Harvesting						
14	Paddy	Combine harvester (Bhuthaya)	Harvesting	1.5 hrs per acre	13.5 liters per hour	2 seasons
15	Maize	Harvester		20 minutes	1 liter per acre	2 Seasons

3.3.2 FISHERIES SECTOR

Table 3.7: Energy and production data in the fisheries sector

No.	Description	Results
Tank Fish industry		
01	Amount of ice used in Rathkinda fishing center	500 kg/day
02	Amount of ice produced in Buttala	2 tons/day
02	No of fish catching days per year	300
Ornamental fish industry		
03	Power of the aerator blower in ornamental fish farming	250 W
04	No. of ornamental fish farms	25
05	Water pumping in Badulla District	Very less. Most of the places water is taken by gravity.
06	Electricity usages in ornamental fish farming	Monthly bill is around Rs. 4000.00 in one center

3.3.3 LIVESTOCK SECTOR

Table 3.8: Details of milk chilling centers

No.	Description	Details
01	No of milk can coolers with 500 liters capacity	13
03	Potential for mini milk can coolers – 50 liters	1,000
04	Power requirement in can coolers Small Can cooler (50 liters) Mini cooler (200 liters) Mini cooler (300 liters) Mini cooler (500 liters)	 0.5 kW 1.2 kW 1.5 kW 3.5 kW

Table 3.9: Details of biogas units

No.	Description	Details	Cumulative Capacity – m^3
01	No of potential biogas unit Large scale Small scale	 01 (Badulla) 64 (Badulla 47 Monaragala 17)	 300.0 830.0

Milk industry is popular in Uva Province and there are five mjor milk collectors in Uva province. The details of such collectors are given bellow.

- Milco regional office, Bandaranayake Mawatha, Badulla
- New Heritage farm development society, Himbiliyagahamadiththa, Hewana Kumbura, Keppetipola.
- Ruvansiri Dairies, Divithotawela, Welimada.
- Pelwatta dairies and
- Lucky yorghurt

Table 3.10:Milk collecting centers in Uva Province

Description	Milco Industries	New Heritage farm development society	Ruvansiri Dairies	Pelwaththa Dairies	Lucky Yorghurt
Badulla District					
Milk chilling centers >2000 l	8	1	1	5	2
Milk chilling centers – 500 l			1	5	
Milk collecting centers	200	2			
Monaragala District					
Milk chilling centers >2000 l	4	2			
Milk chilling centers – 500 l				5	
Milk collecting centers	140	2			

CHAPTER 4:
BASELINE ANALYSIS

4.1 INTRODUCTION

As indicated above, analysis of baseline of energy use in the Agro-industry is a difficult task due to absence of readily available data. However, an attempt has been taken to establish a few baselines taking the data and information presented in chapter 2 and making several assumptions, and the results are presented in this chapter.

Most of the vegetables are harvested within 45 to 55 days. Considering this the farmers in some areas are practicing 4 to 5 cultivation seasons for these vegetables. Walimada, Boralanda areas are good example for this and the farmers in this area are cultivating 4 to 6 seasons depending on the variety. These seasonal variations, mainly the rainfall have been accounted when establishing baseline details below.

Multiplied the specific energy use (eg. Diesel consumption for plough per acre) with the total volume (eg. Total land area) and thereby the total energy consumption has been established in each operation.

4.2 LIMITATION OF THIS ANALYSIS

The accuracy of these analyses is depending on the accuracy of the data and information. The data taken for this analysis have been taken from open sources and a questionnaire survey. The data gathered from the questionnaire survey is accurate but the operating frequency of the machineries (Land preparation, water pumping, spraying etc.) are varying from area to area. Taking in to consideration all the variables, average figures have been established and presented in this chapter.

Recommendation for enhancing the accuracy of data

It is recommended to carry out the data collection survey in detail enhancing the survey population every year and establishing more accurate specific indicators.

4.3 FORECASTING

Forecasting in the agriculture sector is a regular exercise and it is being done in provincial and national levels in two scenarios. One is immediate forecasting for next season and the other one is five-year forecasting development of programmes accordingly. However, with the present Government's new directives of achieving 100% organic fertilizer, it is required to re-visit these plans and amend accordingly. The recommendations made in this document will be useful when amending these plans.

Forecasting in the fisheries sector is conducted with different models developed (eg. Auto Regressive Integrated Moving Average model) mainly for enhancing the fish catch. With these new technologies the travelling time can be minimized and thereby the overall energy usage can be optimized.

4.4 AGRICULTURE SECTOR

4.4.1 AVERAGE VALUES TAKEN FOR ESTABLISHING THE ENERGY USE

Following average values have been taken from the data presented in chapter 3 when estimating the energy use in the agriculture industry

- Diesel consumption in 4 wheel tractor - 10.8 liters /acre
- Diesel consumption in 2 wheel tractor - 10.0 liters /acre
- Diesel consumption in combine harvester - 13.5 liters/acre
- Availability of electricity or solar powered pumps - 20% of total land area
- Availability of diesel or kerosene pumps - 80% of total land area
- Loading factor of a pump -73% (due to the availability of rain, supplying water is not necessary at all the time period)

4.4.2 RESULTS

Table 4.1: Energy use in paddy cultivation

Description	Results
Specific energy requirement per acre per year (for Yala and Maha seasons)	42.75 liters diesel and 12.5 liters of petrol
Total land area for both seasons	439,900 Acres
Total energy requirement per year	
Land preparation	9,898,000 Liters of diesel
Harvesting	8,900,000 liters diesel
Spraying	5,499,000 Liters of petrol

Table 4.2: Energy use in vegetable cultivation – 4 seasons per year

Description	Results
Specific diesel/kerosene requirement per acre per season for land preparation	24 liters diesel
Specific electricity requirement per acre per season for water pumping	70 kWh
Specific diesel requirement per acre per season for water pumping	84 Liters of diesel
Specific electricity generation per acre per season for water pumping in solar pumps	5.6 kWh
Specific energy requirement per acre per season for spraying	18.0 liters
Total land area per seasons	15750 Acres
Total energy use in land preparation	1,512,360 liters
Total energy use in water pumping Electricity Diesel/kerosene Electricity saving use of solar pumps	 4,411.000 kWh 5,293,250 liters Not significant
Total energy use in spraying	1,134,270 liters

Table 4.3: Energy use in vegetable cultivation – 2 seasons per year

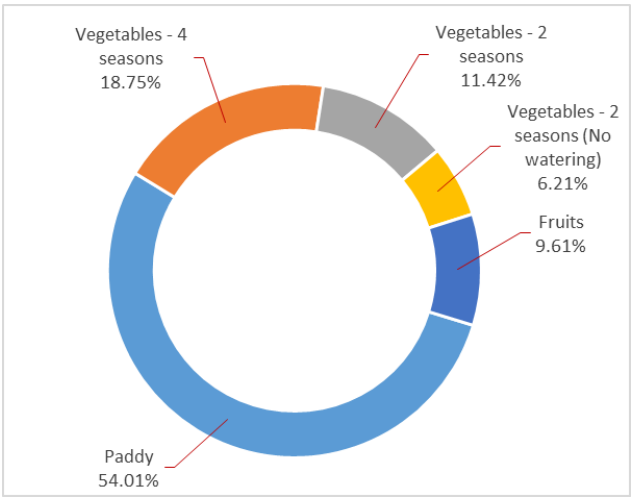
Description	Results
Specific diesel/kerosene requirement per acre per season for land preparation	24 liters diesel
Specific electricity requirement per acre per season for water pumping	120 kWh
Specific diesel requirement per acre per season for water pumping	144 Liters of diesel
Specific electricity generation per acre per season for water pumping in solar pumps	9.6 kWh
Specific petrol requirement per acre per season for spraying	0 (only hand operated sprayers)
Total land area per seasons – watering crops	14,000 Acres
Total land area per seasons – non watering crops	57,100 Acres
Total energy use in land preparation	3,413,820 liters
Total energy use in water pumping Electricity Diesel/kerosene Electricity saving use of solar pumps	 3,364,500 kWh 4,037,400 liters Not significant
Total energy use in spraying	0 (only hand operated sprayers)

Table 4.4: Energy use in fruits cultivation

Description	Results
Specific diesel/kerosene requirement per acre per season for land preparation	24 liters diesel
Specific electricity requirement per acre per season for water pumping	240 kWh
Specific diesel requirement per acre per season for water pumping	288 Liters of diesel
Specific electricity generation per acre per season for water pumping in solar pumps	19.2 kWh
Specific petrol requirement per acre per season for spraying	12.5 liters
Specific petrol requirement per acre per season for grass cutting	18.0 liters
Total annual fruits (banana, papaw etc.) cultivation area	27635 Acres
Total permanent fruits (mango, orange etc.) available area	9850 Acers
Total water pumping required area	10420 Acres
Total energy use in land preparation	663,240 liters
Total energy use in water pumping Electricity Diesel/kerosene Electricity saving use of solar pumps	 2,501,400 kWh 3,001,680liters 468,300 kWh
Total energy use in spraying	187,450 Liters petrol
Total energy use in grass cutting	177,350 Liters petrol

4.5 ENERGY BALANCE – EMBEDDED ENERGY

4.5.1 SHARE OF ENERGY IN AGRICULTURE SECTOR



The total energy balance by crops in agriculture sector is given in the figure 4.1. The energy consumption in paddy cultivation is the highest in Uva Province and rest of the energy is sharing equally among vegetable and fruits cultivation

Figure 4.1: Share of energy by crop

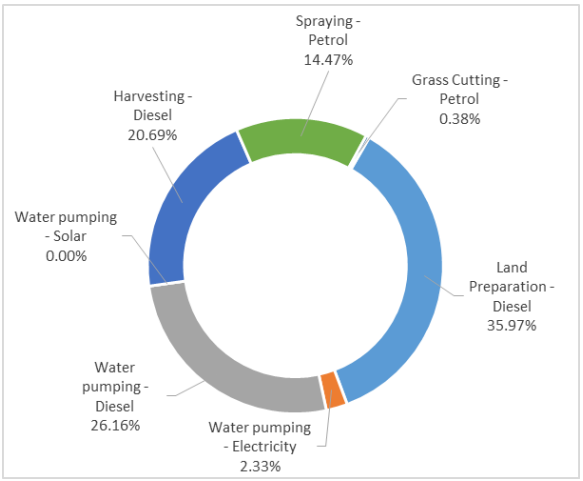


Figure 4.2: Share of energy by process

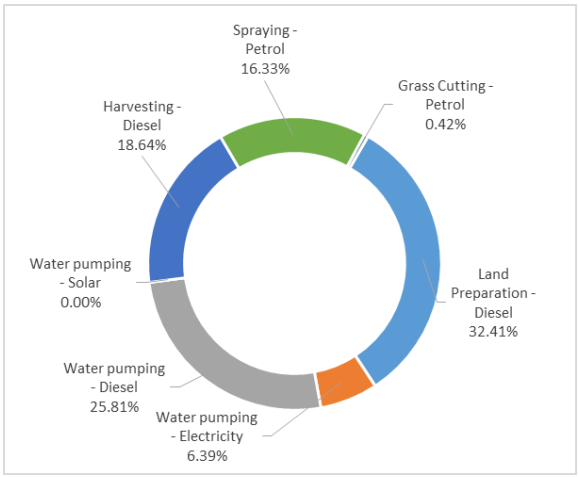


Figure 4.3: Share of energy cost by process

Out of the total energy consumption in the agriculture sector (cultivation) land preparation and harvesting consume 65% and 25% respectively. Water pumping is the next and it shares around 7% of the total energy.

4.5.2 SHARE OF ENERGY IN PADDY PRODUCTION

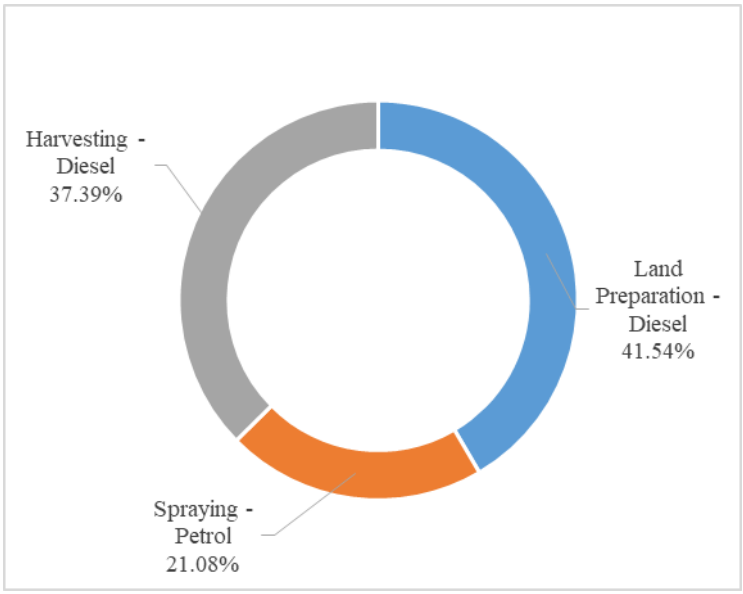


Figure 4.4: Energy usage pattern in paddy production

4.5.3 SHARE OF ENERGY AND ENERGY COST IN VEGETABLE (4 SEASONS PER YEAR) CULTIVATION

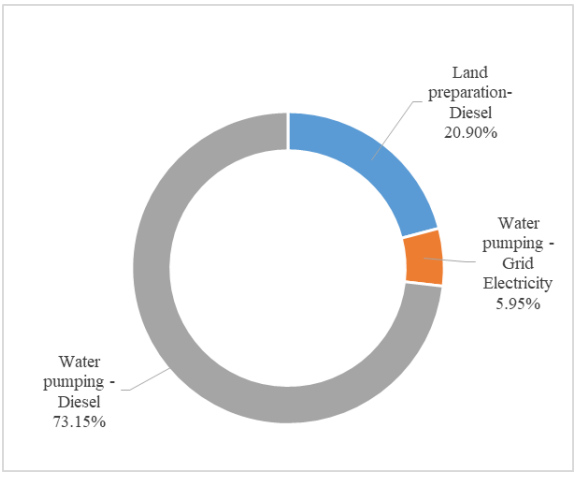


Figure 4.5: Energy share by process

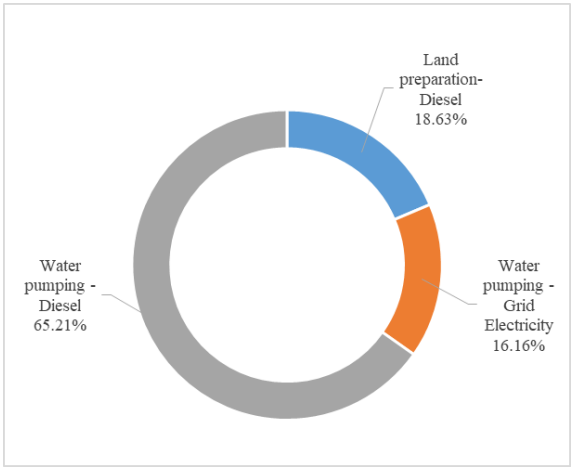


Figure 4.6: Energy cost share by process

The energy consumption and energy cost variation pattern in short rotation vegetable crops are given in the above figures. More than 50% of total energy consumption shares water pumping and approximately 38% for land preparation. As per the details presented in chapters 4.5.2 and 4.5.3, the energy consumption pattern in paddy cultivation is completely different from vegetable cultivation.

4.5.4 SHARE OF ENERGY AND ENERGY COST IN VEGETABLE (2 SEASONS PER YEAR) CULTIVATION

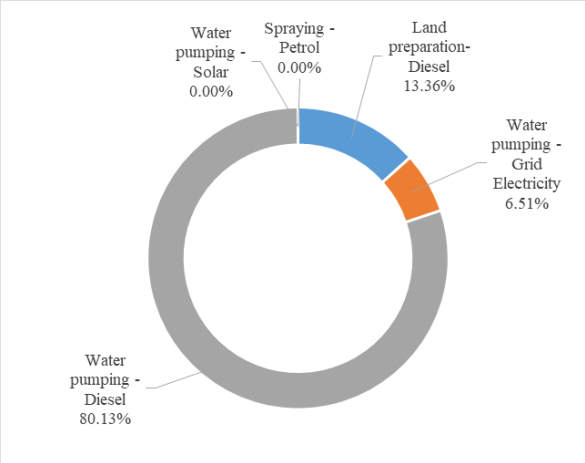


Figure 4.7: Energy share by process

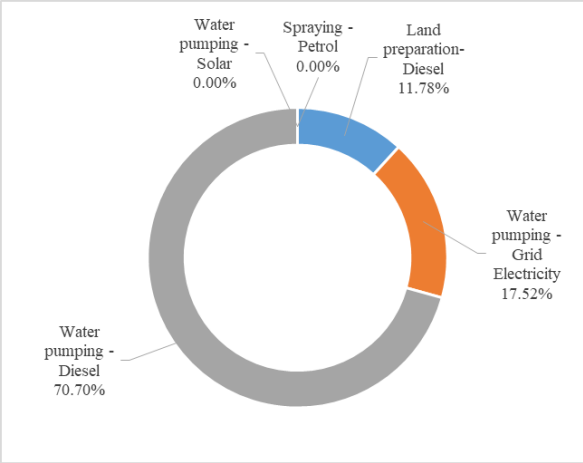


Figure 4.8: Energy cost share by process

The energy consumption and energy cost variation of vegetables which are cultivated two seasons per year are given in the above figures. Similar to short rotation vegetable cultivation, this also follows a similar variation pattern.

4.5.5 SHARE OF ENERGY AND ENERGY COST IN FRUITS CULTIVATION

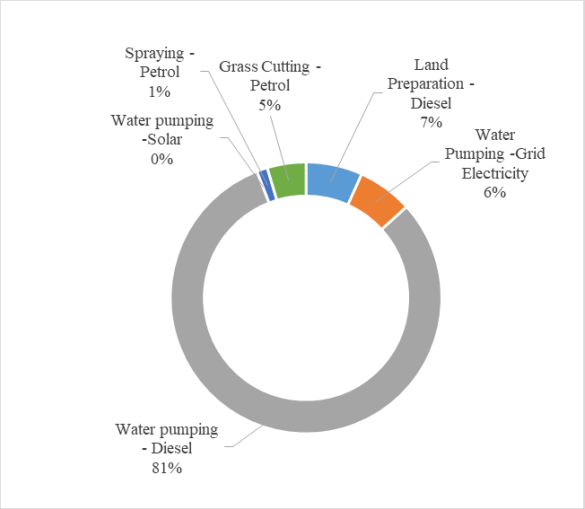


Figure 4.9: Energy share by process

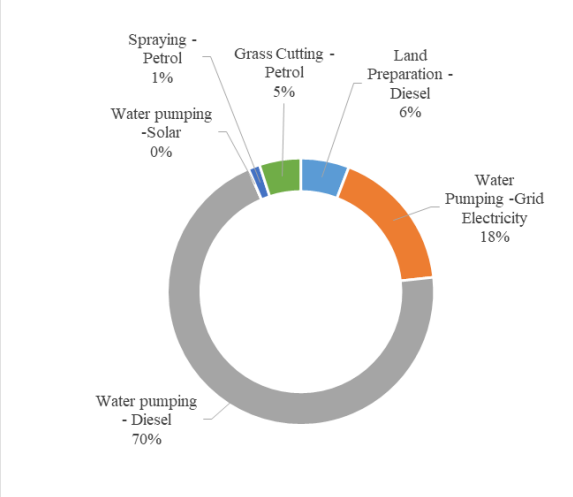


Figure 4.10: Energy cost share by process

The analysis of embedded energy or the energy required to produce one kg of paddy, vegetable or fruit is given in the following table. The average embedded energy in paddy production is 16.7% and it is very much lower in vegetable and fruit cultivation.

Table 4.5: Embedded energy in cultivation

Crop	Embedded Energy (Emergy) - kJ/kg of product	Total Energy in Food - kJ/kg	%
Paddy	2707	11524	23.49
Vegetables - 4 seasons	1029	16500	6.24
Vegetables - 2 seasons	1491	16500	9.04
Vegetables - 2 seasons (No watering)	722	16700	4.32
Fruits	1360	15100	9.01

4.6 FISHERIES SECTOR

4.6.1 ASSUMPTIONS MADE FOR ESTABLISHING THE ENERGY USE

Table 4.6: Assumptions made for establishing the energy use in the fisheries sector

No.	Description	Results
01	Specific energy use in ice production	120 kWh/ton
02	Average fishing days per year per boat	300

4.6.2 RESULTS

Table 4.7: Energy usage in the fisheries sector

No.	Description	Results
01	Total annual electricity usage in ice production	90,000 kWh
02	Total annual electricity usage in the ornamental fish industry	300,000 kWh

4.7 LIVESTOCK SECTOR

4.7.1 RESULTS

Table 4.8: Energy use in the livestock sector

	Description	Results
01	Electricity consumption in livestock industries (egg production, broiler chicken, cattle farming, etc.)	Not significant

Table 4.9: Energy generation in the livestock sector

No.	Description	Results
01	Energy generation in biogas units	330 m^3

CHAPTER 5:
ANALYSIS ON GREEN ENERGY POTENTIAL IN AGRO-INDUSTRY

5.1 INTRODUCTION

This analysis has been done based on the results of the baseline analysis presented in chapter 04. Further, this analysis has been limited to energy consumption in production (growing, farming and fishing) and semi processing activities. Commercially and technically proven technologies have been considered under this section. Also, the up-scaling potential and operating performance under the local climatic condition have been considered when analyzing green energy potential in Agro-industry.

5.1.1 OFF-GRID SOLAR APPLICATION

5.1.1.1 Solar Water Pumping

It has been estimated approximately 10,000 diesel water pumps are being operated for vegetable cultivation in the Uva Province. These pumps are operating in electricity non-accessible areas/places. On average 3 to 5 liters of diesel is consumed per acre per day in vegetable farming and one diesel pump is serving for two acres. This operation can be partially replaced with a 2-inch solar powered pump in the day time. In the early stages of vegetable cultivation, water is supplied in the early mornings and evenings and direct solar pumps are not suitable for this operation unless high head (approximately 60 foot) storage is available and only the daytime diesel pumps usage can be eliminated.

The cost of the solar water pumps is not uniform in the Sri Lankan market, however the cost of a standardized solar pump is in the range of Rs. 500,000.00 to Rs. 800,000.00. The approximate diesel saving would be around 130 liters per month per pump and the simple payback period of this replacement would be around 2.6 years to 4.2 years.

5.1.1.2 Other Solar Applications

Solar insect traps are available in the international market with 12V battery and solar charging system and can be used as an off-grid system. These traps are generally used for night time flying insects and need to select the appropriate system before using. The energy usages in these units are not significant and equivalent CO_2 savings are negligible, but practically it has an impact on increasing productivity in the agriculture sector. The use of solar energy in ***elephant fences*** are recommended since most of those operations are in remote areas where grid electricity supply is not available. The electricity usage in these units is considerably small and the technology has been developed with battery storage for easy operations and those systems are available at attractive prices in the open market now. ***Solar home standalone systems*** are available in the open market similar to the elephant fencing technology and can be used in both huts, shelters in agricultural lands and in night time inland and lagoon fishing. With this intervention, the existing kerosene usage can be minimized.

5.1.1.3 Biomass Applications

The use of high-quality energy sources like electricity is not encouraged for low temperature (low quality) applications as per the principles of thermodynamics. There is plenty of low

temperature drying and low temperature hot water applications available in Agro-industry mainly for drying crops and washing, cleaning and cooking in institutions like training centers. Locally fabricated low temperature dryers and low temperature hot water generators fueled by biomass are available in the open market now with attractive prices. Potential is there to eliminate the existing electricity, kerosene or LPG usage in Agro-industry by introducing these systems and thereby reducing of the carbon footprint.

5.1.1.4 Biogas for thermal applications

The use of biogas in the thermal application is not a new intervention but the issues existing in this sector have not been properly addressed. Most of the individual small scale biogas units have been abandoned in the Uva Province mainly due to social aspects. Therefore, it is better to carry out a situation analysis on use of biogas and establish proper criteria on suitability of use of biogas. There are 16,312 cattle farms in the Uva Province and theoretically, establishment of biogas units in all these places is possible.

5.1.2 ON-GRID RENEWABLE ENERGY APPLICATIONS

5.1.1.1 Solar rooftop systems

Solar rooftop systems are encouraged by the Government of Sri Lanka under three systems viz. solar net metering, solar net accounting and solar net plus scheme. The national grid is acting as an energy bank and the generated electricity during daytime either can be utilized at the site or excess can be fed into the grid. Electricity generation and consumption are metered in separate meters and the electricity bill is calculated at end of the month accordingly. More details about solar rooftop are available at the Ceylon Electricity Board, Sri Lanka Sustainable Energy Authority and Public Utilities Commission of Sri Lanka websites.

The electricity consumption can be offset with the net metering scheme and a sample analysis of the solar rooftop system is given in the following table. In general maximum 5 kW solar system is recommended by CEB for a house with single phase electricity supply. If someone needs to enhance the solar capacity further, three phase supply is required and the solar rooftop system capacity can be enhanced up to 15kW.

Table 5.1: Investment and payback period for solar rooftop systems

No.	Land area - hectares	Average monthly electricity use including house load - kWh	Monthly electricity bill – Rs.	Equivalent solar roof top system - kW	Simple payback period - Years
01	1	226	6133.50	2	4
02	2	352	11803.50	4	4
03	3	550	20713.50	5	3

Since the electricity supply is available island wide, electrically driven Agro machineries such as water pumps, milk can coolers, sprayers, threshers, dryers etc. are favourably utilizing the CEB national grid in many areas rather than introducing solar standalone systems. The overall energy efficiency in the solar standalone water pumping system is comparatively lower than the solar rooftop system. This is due to storing electricity in batteries and conversion from DC to AC. The required electricity can be offset through solar rooftop system. Since the electricity network has reached 100% of households and installation of solar rooftop systems are possible in most of the areas, it will be a more practical reliable solution since the solar

rooftop systems are regulated through Sri Lankan Standards SLS 1552, SLS 1542 to SLS 1547, SLS 1553 and SLS 1554.

5.1.3 BIOMASS APPLICATIONS- SMALL SCALE POWER GENERATION

A feasibility study has been carried out by UNDP Sri Lanka office to ascertain the viability of establishing small scale biomass power plants in Sri Lanka. As per the results of this study, the most viable technology for small scale biomass power plants is steam turbine-based power generation system. According to the analysis done under this study, seven strategic locations have been identified in the Uva Province with total potential capacity of 6MW and annual biomass requirement to run these systems would be around 111690 tons. Agriculture waste has been considered as the prospective source of biomass under this study and if these proposals were implemented, potential market will be there to supply biomass at a reasonable cost.

5.1.4 BIOGAS APPLICATIONS- POWER GENERATION

Power generation with biogas driven engine is not a new application to Sri Lanka. There is a grid connected power plant in Attanagalla with 80kW generating capacity driven by biogas and biogas is generated using poultry waste.

5.1.5 ENHANCEMENT OF ENERGY UTILIZATION EFFICIENCY

Energy consumption in paddy cultivation is substantially higher than the energy consumption in other crops and this is mainly for land preparation and harvesting. Four-wheel tractors, two-wheel tractors and combined harvesters are being utilized in many places for this purpose and introduction of productive machineries (having a higher output and less down time) in these categories are very much encouraging and thereby potential saving of diesel is substantial.

CHAPTER 6: RECOMMENDATIONS

6.1 INTRODUCTION

The results of the questionnaire survey and the results of the analysis done in chapter 5 have been considered when developing these recommendations.

6.2 RECOMMENDATIONS - AGRICULTURE SECTOR

6.2.1 INTRODUCTION OF NEW TECHNOLOGIES

The importance of use of machineries for cultivation and semi processing activities has been emphasized in many occasions when carrying out the field data survey for collection of energy consumption details in cultivation and semi processing. The main objective of this initiative is to reduce the manpower involvement in this sector. Farmers highlighted two major issues. Moving away of the young generation from agriculture activities is the first issue and gradual reduction of human power is the second issue. One of the direct solutions to overcome the negative impact of the above mentioned issues is introduction and enhancement of use of machineries and systems in the agriculture sector. Use of mini tillers, use of sprinkler and drip irrigation systems are some of the examples and they are expecting advanced technologies for other activities such as planting seeds and plants, weeding, applying fertilizer etc.

6.2.2 ENHANCEMENT OF KNOWLEDGE ON RENEWABLE ENERGY & ENERGY EFFICIENCY

One of the major reasons for RE and EE applications to backfire is the lack of knowledge and awareness among the farmer communities. It is very important to educate the farmers and other sector related persons including government officials, service providers, and technology suppliers. It should be emphasized that the government is encouraging 100% organic farming, and use of clean energy sources combined with energy efficiency measures have a number of benefits including creating environmental sustainability, reducing energy cost, and increasing income margins.

6.2.3 INFORMATION SHARING

With the technological developments in the agriculture field, the need for a reliable and accessible information network has become prominent. As a promising solution the Food and Agriculture Organization (FAO) and International Telecommunication Union (ITU) have introduced the concept of e-agriculture, developing the 'Sri Lanka E-Agriculture Strategy' and 'E-Agriculture Action Plan 2016-2020). This discusses the methods of integrating agricultural technology with ICT introducing recommended actions for practical implementation. Recommended actions include increasing the availability and accuracy of agricultural information by creating, updating, analyzing and linking critical databases, developing accessible, affordable, and secure ICT platforms, networks, and devices, and improving the financing, investing and banking outreach to agriculture sector leveraging on electronic and mobile technologies. Unlike in the old days, the younger generation is more familiar with digital interfaces and smart applications creating a high probability of success for this e-agriculture concept.

6.2.4 DEMONSTRATION SITES

Demonstration sites are proved to be effective extension tools used in the Agro-Industry. They provide an opportunity for the farmers to observe and study new technologies under similar environmental and practical conditions they are familiar with. This approach is quite welcome in the farmer communities as it enables them to reach out for better technological options without any investment risk. With the hands-on experience gained through training at demonstration sites, they are capable of making educated choices with more confidence.

Existing sites with sufficient facilities (i.e: land extension, accessibility) can be developed in to demonstration sites to practice sustainable energy solutions including EE measures and RE technologies with predicted beneficial outcomes. How the site is to be funded needs to be clear and guaranteed for the proposed life of the demonstration site. Standard practices and conditions that need to be maintained should be clearly defined and a reliable recording system and an effective communication plan need to be developed.

6.2.5 EFFICIENCY ENHANCEMENT IN AGRICULTURE MACHINERIES

The future of Agriculture field is largely relying on machineries and tools with the technological developments in the sector. Use of machineries for cultivation and semi processing activities has enabled covering up for the decrease in man-power and has enhanced the productivity. Continuous research and field trials are needed for the improvement of the machinery as well as to enhance the efficiency.

6.3 RECOMMENDATIONS - LIVESTOCK SECTOR

6.3.1 STUDY ON UTILIZATION OF BIOGAS UNITS

Biogas technology has been in existence since early 1970's in Sri Lanka, but has not become popular compared to other RE technologies such as solar energy. Even though large scale biogas units are a highly preferred solution for the Agro-Industry considering the clean energy production, environmental friendly organic waste management, and generation of bio fertilizer, its application is seen mostly limited to lighting, cooking and heating in domestic level and small-scale production of bio fertilizer in the agro-industry. Several studies including the UNDP Energy NAMA project have been performed over time to identify the issues related to backfiring of biogas application. These studies have conveyed that the biodegradation process itself and the routine maintenance practices required to function the system smoothly have been largely disregarded when promoting the technology within farmer communities. Further studies should be conducted with practical intervention and trial studies to assess the compatibility of the biogas technology with existing Agro-Industrial practices.

6.3.1 PRESERVING THE EVENING MILK

Preserving of evening milk is an issue mainly in the small scale cattle farming category and due to this the farmers are reluctant to harvest the evening milk so that this is badly effecting to the to the total milk yield in the country. Mini can coolers are being developed by MILCO industries and the trial has been successfully completed and this is an ideal solution for preserving the evening milk.

6.4 RECOMMENDATIONS - FISHERIES SECTOR

Since renewable energy and energy efficiency interventions are still at the preliminary phase in the fisheries sector, it is recommended to conduct introduce new technologies through research & trial, pilot studies, and practical demonstrations.

CHAPTER 7:
ACTIVITY PLAN

7.1 INTRODUCTION

The results based action plan is considered for implementation of green energy technologies and systems in the Agro-industry in Uva Province. The priority has been given to easily implementable and high impact actions and new technologies considered separately under R&D section since these have not been proven as commercially and technically viable technologies.

7.2 ACTIVITIES

Table 7.1: Recommended activities for the action plan

No.	Intervention	Action
1	Training And Capacity Building on RE And EE technologies/systems	Training Agriculture Inspectors
		Training programs for farmer producer organizations
2	Popularization of commercially viable technologies- agriculture sector	Solar water pumps supportive programme
		Introduction of battery operated sprayers
		Temperature and RH controlled food storage system
		Chipping machines for green matters – making compost fertilizer (pruning material, grasses, branches etc.)
		Biomass fired food dehydrators – fruits, vegetables
3	Popularization of commercially viable technologies- livestock sector	Small scale milk can coolers
		Biogas systems – large units
4	Popularization of commercially viable technologies- fisheries sector	Introduction of RE based ice making facility to Rathkinda fishing center
5	Renewable energy for all sectors	Introduction of solar roof top systems
		Solar home systems for sheds, huts, farms
		Establish demonstration sites
6	Financial assistance through commercial/regional banks	Introduction of soft loan facilities
7	Application research on new technologies	Solar powered battery-operated insects control system
		Testing of new machineries for land preparation, digging holes, planting, fertigation, weeding, etc.
8	Upgrading energy consumption and production data in Agro-industry	

AG -01 Training and Capacity Building on RE & EE Technologies

Background: One of the main barriers in promoting sustainable energy technologies in the Agro-Industry is lack of knowledge and awareness among the sector community. It is very rarely that the energy and agricultural sectors collaborate to make sustainable development plans, or foster an effective approach for smooth technology transfer. This results in isolated energy systems that are non-productive and non-progressive. Knowingly, the very few energy related projects considering the Agro-Industry in Sri Lanka have not been sustained well in the industry. This failure is largely owing to the fact that there is no accessible and reliable knowledge regarding the adopted energy systems, and technology support is not readily available.

It is a priority requirement to create awareness and provide training and capacity building on sector related energy aspects and the RE & EE Technologies among different levels in the Agro-Industry, including government officials, service providers, technology suppliers, and farmer communities.

Objective: Creating awareness and capacity building on sector related energy aspects and the RE & EE technologies among different levels in the Agro-Industry

Main Targets: To be set by the executing party

Recommended Actions

It is recommended to build actions to deliver targets based on the following strategy/ies.

1. Training of trainers – i.e. Training of Agriculture Inspectors and using them as focal points
2. Reaching out for Energy Services Companies (ESCOs) such as the Industrial Services Bureau (ISB)
3. Assistance from relevant authorities such as SLSEA

Stakeholders

As identified by the executing party

Responsibility

To be assigned

Estimated Budget – LKRM

To be assigned

AG -02 Solar water pumps supportive programme

Background: Water pumping is one of the major energy consuming process in agriculture sector. Electricity, fossil fuel (diesel/kerosene) or solar powered pumps are being used for this purpose and out of these about xx% of pumps are operating with fossil fuel.

Solar powered water pump is not a new technology for Uva Province. The first solar pump project has been implemented in 2006. However, lifetime of most of the pumps introduced during last 16 years period were not more than 2 years. This is mainly due to selection of low-quality technologies and absence of proper after sales services. In this situation, farmers are very reluctant to use solar powered water pumps as an alternative source to the kerosene pumps. Some of the pumps are being successfully operated during last five to seven years period with proper maintenance and most of these pumps are produced under European standard.

Compared with the kerosene or diesel engine driven pumps, solar powered water pumps are economical and the simple payback period would be around 2.5 to 3.0 years. The major issue in solar powered water pumps are intermittent operation (Fluctuation of the output with respect to the variation of solar irradiation) and to eliminate this issue, water storage at a higher elevation is required.

It is expected to provide technical guidance for existing users in operation and maintenance and potential users in selecting and purchasing the pumps through this supportive system.

Objective: Introduction of technology sound solar powered water pumping system as an alternative to the diesel/kerosene pumps with proper after sales services and affordable cost.

Main Targets: To be set by the executing party

Recommended Actions

1. Conduct a comprehensive study on the performance of solar powered water pumps in agriculture sector and identify failures and success stories and identify suitable technologies (eg. AC power pumps with inverters, DC power pumps, pumps with oil cooled motor and electronically controlled, pumps with water cooled motors etc.)
2. Develop few demonstration sites with best technologies covering major agriculture areas
3. Education and training programmes on solar pumping and solar technologies
4. Implement star rating system for solar water pumps and discourage use of low performance pumps
5. Introduce lifecycle-based procurement system

Stakeholders

As identified by the executing party

Responsibility	**Estimated Budget – LKRM**
To be assigned	To be assigned

AG -03 Introduction of battery-operated sprayers

Background: Sprayers are widely used in agriculture to apply pesticides, herbicides, and fertilizers to the field. Currently there are two types of sprayers used in Sri Lanka, the conventional hand operated sprayers and the petrol engine driven sprayers. Hand operated sprayers work through an air pump that compresses air and release the liquid with a pressure. The applicator must pump the air with a handle lever before spraying. This is suitable for small plantations, but is not feasible for large scale plantations spreading over several acres.

Petrol engine driven sprayers use the technology of a DC motor pump powered by a rechargeable battery. They require much less man power, are less heavy, and are more convenient to use compared to the hand operated sprayers. Both the grid electricity and solar charging can be used to recharge the batteries, and once charged it can spray up to 20 tanks making it very convenient to use. Some models come with the pump control feature including a speed regulator so as to control the speed of the pump output that suits your spraying needs. Many long-term benefits are associated with the petrol engine driven sprayers including cost and time efficiency. These are low maintenance devices and spare parts are readily available in the market.

Objective: Applying RE based technologies for creating user-friendly, easily operated and reliable technological advancements and attending to gender responsive technology needs

Main Targets: To be set by the executing party

Recommended Actions

It is recommended to build actions to deliver targets through the following strategies.

1. Introducing suitable financial assistance model (i.e. 50% government fund and 50% owner's fund)
2. Introducing easy payment modes
3. Introducing soft loan schemes through development banks

Stakeholders

As identified by the executing party

Responsibility

To be assigned

Estimated Budget – LKRM

To be assigned

AG -04 Temperature and RH controlled food storage system

Background: Food products are easily perishable under ambient temperatures, and therefore it is very important to maintain controlled environment in storage spaces to increase the shelf life of stored food preserving their nutritional qualities. The study is focused on short term storage of agricultural crops on site during the transfer period from farmers to transporters. Amongst the existing technologies, thermally driven air conditioner and relative humidity control systems are favoured currently. Optimum conditions are maintained at 25-35 C temperature and 60-65 % RH for most of the food products including potatoes, ginger, turmeric, black pepper and other spices. This storage system has been effectively adapted in Dambulla and Jaffna for the storage of enasal (cardamom) and onions respectively. Storage capacity for a substantial storage of 100*30 ft is approximately 600 – 700 K kilograms of onion which requires a 1.5 kW machine to run the system maintaining optimum conditions. Energy use is negligible compared to the output and the payback period for the investment in building the system is usually less than one year depending on the market parameters.

Objective: Introduce RE based advanced technologies to minimize wastage of food and ensure constant market supply

Main Targets: To be set by the executing party

Recommended Actions

It is recommended to build actions to deliver targets through the following strategies.

1. Awareness through demonstration sites
2. Financial support systems (grants /soft loan facilities)

Stakeholders

As identified by the executing party

Responsibility

To be assigned

Estimated Budget – LKRM

To be assigned

AG -05

Chipping machines for green matters (pruning material, grasses, branches etc.)

Background: Discarding agricultural waste is a problem faced by many small-scale farmers. Cutting, drying, and processing bio waste is strenuous and time consuming, and first-hand burning is harmful for the environment. As a solution for this, small-scale chipping machines/ agricultural shredders can be used for chopping agricultural waste, farm waste and garden waste and convert them to compost manure. Government is encouraging 100% organic farming, and the use of these shredders to produce natural compost manure with bio waste would be both economically advantageous and promoting sustainable agriculture technology. Additionally when plant waste is directly used in composting process, some parts will remain undigested which have to be separated from the manure. Chipping will eliminate this need enhancing the productivity of composting process. A range of bio waste products such as pruning material, dry and wet coconut fronds/husks, harvested banana trees can be processed in these chipping machines. Different models are available such as Tractor PTO agriculture shredders (prevalent in Sri Lankan market), Mini Tractor operated shredder machine, Electric shredder machine, Coconut Shredder Machine, and Garden Shredder Machine, etc.

Objective: Applying RE based technologies for introducing user-friendly, easily operated and reliable technological advancements and attending to gender responsive technology needs

Main Targets: To be set by the executing party

Recommended Actions

It is recommended to build actions to deliver targets through the following strategies.

1. Awareness through demonstration sites
2. Financial support systems (grants /soft loan facilities)

Stakeholders

As identified by the executing party

Responsibility

To be assigned

Estimated Budget – LKRM

To be assigned

AG -06 Biomass fired food dehydrators

Background: Drying/ dehydration is a critical step in post-harvest treatment procedure, which is necessary to avoid spoilage/molding of crops due to moisture and increase shelf life during storage. Food products with low-medium moisture content (<30% wet basis) such as paddy, maize, sesame seeds, legumes, etc. are dried and food products with high moisture content (>50%) such as fruits, vegetables, fish, meat, etc. are dehydrated in the process. Traditionally drying involved capturing direct heat from the sun, but with the technological advancements in the Agro-Industry mass harvesting is more common making it difficult to use sun drying effectively. Using biomass fired food dehydrators is a more efficient and convenient option for the drying process. They are designed optimizing parameters like the moisture removal rate, drying rate, thermal efficiency, and heat transfer efficiency to obtain optimum results while preserving the physical and nutritional qualities of the food products. Biomass pellets, saw dust, wood pellets can be used as the heat source in these dehydrators and the capacity can be as high as 500 kg/hr.

Objective: Establishing Micro industries in rural level and value addition of agricultural products

Main Targets: To be set by the executing party

Recommended Actions

It is recommended to build actions to deliver targets through the following strategies.

1. Awareness through demonstration sites
2. Financial support systems (grants /soft loan facilities)

Stakeholders

As identified by the executing party

Responsibility

To be assigned

Estimated Budget – LKRM

To be assigned

AG -07 **Small scale milk can coolers**

Background: Small scale dairy farming is a common livelihood among the farmer community in the Uva Province of Sri Lanka, housing 16,300 cattle farmers. The milk produced is transported to collecting centres without any form of cooling. The hygiene and quality of the milk largely depends on how fast the collecting and transporting process is, because fresh milk tends to exceed the maximum bacterial count decided by food safety laws in about 2-5 hours when left in the open under the warm climatic conditions of Sri Lanka. A cow produces around 10 litres of milk in the morning, and 6 litres in the evening. Due to lack of facilities farmers have stopped collecting the evening milk causing additional on-farm losses.

Small scale on-farm milk cooling systems with insulated milk cans are being used worldwide as an immediate solution to these issues. They are designed with a commercially available DC refrigerator and an ice maker with insulated cylindrical cans to store milk. Local manufacturing is done by Milco Sri Lanka making it possible to purchase at affordable prices. The cooling systems can also be coupled with independent solar units, but in long term aspects a grid connected system will be more convenient to use, while using a solar roof top system to compensate the energy use.

Objective: Optimizing the yield and encouraging maximum milk production locally

Main Targets: To be set by the executing party

Recommended Actions

It is recommended to build actions to deliver targets through the following strategies.

1. Enhancing technology availability in the market
2. Introducing suitable financial assistance model/ easy payment modes

Stakeholders

As identified by the executing party

Responsibility

To be assigned

Estimated Budget – LKRM

To be assigned

AG -08 Biogas Systems- Large Units

Background: Biogas technology has been in existence since early 1970's in Sri Lanka, but has not become popular compared to other RE technologies such as solar energy. Biogas application is seen mostly limited to lighting, cooking and heating in domestic level and small-scale production of bio fertilizer in the agro-industry. Several studies including the UNDP Energy NAMA project have been performed over time to identify the issues related to backfiring of biogas application. These studies have conveyed that the bio degradation process itself and the routine maintenance practices required to function the system smoothly have been largely disregarded when promoting the technology within farmer communities. Hence lack of knowledge and preparedness causes efficiency drop in the biogas systems and raise dissatisfaction among its users. There are no proper regulations or policies related to biogas promotion and application in Sri Lanka, except for some environmental standards imposed on solid waste management and waste water treatment in swine farming. If these issues are addressed properly, large scale biogas units are a highly preferred solution for the Agro-Industry considering the clean energy production, environmental friendly organic waste management, and generation of bio fertilizer.

Objective: Popularization of commercially viable technologies through establishment of demonstration sites

Main Targets: To be set by the executing party

Recommended Actions

It is recommended to build actions to deliver targets through the following strategies.

1. Identifying potential implementation sites
2. Providing site specific solutions to overcome implementation barriers
3. Awareness through demonstration sites
4. Financial support systems (grants /soft loan facilities)

Stakeholders

As identified by the executing party

Responsibility

To be assigned

Estimated Budget – LKRM

To be assigned

AG -09 **Introduction of RE based ice making facility**

Background: There is a high potential in developing freshwater fish production in reservoirs in the Uva Province, one of the major fish catchment areas being at the Rathkinda Reservoir. There is also an active fisheries society creating an upfront market for daily catchment. However, the daily requirement for ice which is around 500 kg/day is currently met with ice transported from the Batticaloa and Ampara area. The government and the fisheries society have proposed the establishment of an ice generating facility at the Rathkinda reservoir as an essential step in expanding the production.

It is technically viable and both economically and environmentally beneficial to use RE based technology for generating ice at the centre. The project will need financial assistance to be executed.

Objective: Popularization of commercially viable technologies

Main Targets: To be set by the executing party

Recommended Actions

It is recommended to build actions to deliver targets through the following strategies.

1. Providing financial assistance
2. Creating technology awareness

Stakeholders

As identified by the executing party

Responsibility

To be assigned

Estimated Budget – LKRM

To be assigned

AG -10 | **Introduction of solar roof top system (Domestic level)**

Background: "Sooryabala Sangraamaya" Battle of Solar Energy is a government program to power up the country with renewable energy up to a 50%, by year 2025, reaching for the target of 100% renewables by 2050. Under this program, domestic level consumers are encouraged to install solar roof top systems up to 5kW under one of the three connectivity plans; net-metering, net-accounting, and net plus schemes. Soft loan facilities are available with most of the prominent banks at interest rates as low as 4%. Even though the solar power generation is popular among industrial and commercial sectors, the knowledge is lacking in the domestic levels. Stand-alone off-grid solar applications are used to some extent, but the grid connected systems are more reliable and useful compared to these. It is important that the function of these systems, their benefits and economic advantages are clearly transmitted to agricultural communities through awareness programs, and the systems should be promoted through introducing affordable technical and financial aid.

Objective: Popularization of commercially viable technologies

Main Targets: To be set by the executing party

Recommended Actions

It is recommended to build actions to deliver targets through the following strategies.

1. Introducing and popularizing ongoing schemes
2. Creating links to the available financial tools

Stakeholders

As identified by the executing party

Responsibility

To be assigned

Estimated Budget – LKRM

To be assigned

AG -11 Solar home systems for sheds, huts, farms

Background: Despite the technological advancements in the Agro-Industry some traditional farming practices are continued up to date in the rural areas. For example, to protect the crops from wild animals, farmers keep watch during the night in small tree houses built in the field. Some stages of harvesting and post-harvest handling including threshing requires overnight field work. Usually kerosene lamps are used to light up the sheds, huts, and farms during the night.

Solar home systems are battery operated solar powered lighting systems with a simple plug and play technique, that can be used to replace the kerosene lamps. They are compact, portable, and durable devices that can light up to 3 LED bulbs. They usually come with a USB output that can be used to charge a simple device such as a mobile phone. It is an easy to use and environmental friendly alternative to the harmful kerosene lamps.

Objective: Popularization of commercially viable technologies through establishment of demonstration sites

Main Targets: To be set by the executing party

Recommended Actions

It is recommended to build actions to deliver targets through the following strategies.

1. Enhancing technology availability in the market
2. Awareness through demonstration sites

Stakeholders

As identified by the executing party

Responsibility

To be assigned

Estimated Budget – LKRM

To be assigned

AG -12 Establishment of Training and Demonstration Sites

Background: Demonstration sites are proved to be effective extension tools used in the Agro-Industry. They provide an opportunity for the farmers to observe and study new technologies under similar environmental and practical conditions they are familiar with. This approach is quite welcome in the farmer communities as it enables them to reach out for better technological options without any investment risk. With the hands-on experience gained through training at demonstration sites, they are capable of making educated choices with more confidence.

Existing sites with sufficient facilities (i.e: land extension, accessibility) can be developed in to demonstration sites to practice sustainable energy solutions including EE measures and RE technologies with predicted beneficial outcomes. How the site is to be funded needs to be clear and guaranteed for the proposed life of the demonstration site. Standard practices and conditions that need to be maintained should be clearly defined and a reliable recording system and an effective communication plan needs to be developed.

Objective: Popularization of commercially viable technologies through establishment of demonstration sites

Main Targets: To be set by the executing party

Recommended Actions

It is recommended to build actions to deliver targets through the following strategies.

1. Identifying potential demonstration sites
2. Introducing funding and maintenance systems for the sites

Stakeholders

As identified by the executing party

Responsibility

To be assigned

Estimated Budget – LKRM

To be assigned

AG -13 Soft loan schemes through regional banks

Background: One of the major difficulties faced in promoting and implementing RE applications in the Agro-Industry is lack of financial capability and the investment load. Many of the RE technology applications require a very high initial cost, which creates a wide gap in the technology requirement and actual application. Therefore, it is essential to incorporate financial assistance models when introducing these technologies to the market.

There is a substantial number of soft loan schemes available through both public and private banks in Sri Lanka, but awareness level is very low within the farmer communities. The information should be effectively communicated to the farmers and the loan facilities should be easily accessible.

Objective: Popularize RE based advanced technologies through financial support models

Main Targets: To be set by the executing party

Recommended Actions

It is recommended to build actions to deliver targets through the following strategies.

1. Increase awareness on available financial support systems
2. Establishing a communication network for information sharing and coordinating the facilities

Stakeholders

As identified by the executing party

Responsibility

To be assigned

Estimated Budget – LKRM

To be assigned

AG -14 **Solar powered battery-operated insect control system**

Background: Pest control is an important requirement in farming, and chemical pesticides are still used as the fastest and most effective method for this purpose. However, chemical pesticides are health hazards and environmental pollutants, and with the government encouraging 100% organic farming practices, it has become a concern of the farmers to look for pest control methods other than the use of pesticides. Traditional methods of pest control such as crop rotation, intercropping, and growing insect repellent weeds are usually effective but the knowledge and practical experience on how to apply these methods properly have not been passed through generations. The solar powered insect traps are a very attractive effective alternative developed with the advancements in agricultural technology. They are simple devices that include a rechargeable battery powered by solar energy, which is used to light a LED bulb that lure and trap the insect pests. The bulb can automatically light up when there is no sun, and stay up to 4 hours after sunset.

Objective: Popularization of commercially viable technologies through establishment of demonstration sites

Main Targets: To be set by the executing party

Recommended Actions

It is recommended to build actions to deliver targets through the following strategies.

1. Enhancing technology availability in the market
2. Awareness through demonstration sites

Stakeholders

As identified by the executing party

Responsibility

To be assigned

Estimated Budget – LKRM

To be assigned

AG -15

Testing of new machineries for land preparation, digging holes, planting, fertigation, weeding, etc.

Background: The agriculture sectors in all the leading countries with an agriculture-based economy such as China, India, and Bangkok have been developed with research and experiment. It is essential that new machineries are tested and developed regularly for introducing to the field, as the man power in agriculture sector is visibly decreasing. Many people from the younger generation are shifting to livelihood methods other than farming, and the fitness and strength of people have also become less, reducing the capacity to engage in field work.

Objective: To enhance overall productivity of the Agro-Industry

Main Targets: To be set by the executing party

Recommended Actions

It is recommended to build actions to deliver targets through the following strategies.

1. Continuous updating of technology database
2. Conducting trial studies through research and development

Stakeholders

As identified by the executing party

Responsibility

To be assigned

Estimated Budget – LKRM

To be assigned

No	Action	Targets	Strategy	Responsibility	Supportive agencies	Budget - MLKR	KPIs					Funding Sources					MRV
							2022	2023	2024	2025	2026	Self Funded	Consolidated Fund	Donor Funds	CSR Funds	Sponsorships	
1	**Solar water pumps supportive programme**	Introduction of 250 solar water pumps	Financial assistance maximum up to 25% of the total cost	Ministry of Agriculture Uva Province													
			Coordinate with local banks and arrange soft loans														
			Training programs on effective use of solar pumps		SLSEA												
2		Introduction of 250 electrically driven water pumps															
3		Introduction of 500 solar roof top systems															
4		Introduction of 200 solar home systems for inland fishing boats															

CHAPTER 8:
IMPACT ASSESMENT OF PROPOSED ACTIONS

Nos.	Technology	Capacity of the proposed intervention	Minimum land area required for introduction of new technology- Acres	Cost of a unit - LKR	Base case	Existing Energy Use	Units	RE technology	Specific base case energy cost - LKR/kWh, Liter	Simple pay back period - years	Potential sites for new intervention	Emision factors kg of CO_2/kg of fuel	CO_2 saving potential - tons/year
1	Electricity driven water pumps + solar rooftop system (5kW)	5kW	5	1,150,000.00	Electricity	6,600	kWh/year		35.00	5.0	100,000	0.722	476,520
2	Solar water pumps	2kW	2	500,000.00	Diesel	840	lires/year	Sola pumps	111.00	5.4	3,000	3.17	8,000
3	Sprayer		2	12,500.00	Petrol	48	lires/year	electricity	127.00	2.00	100,000	3.13	15,000
4	Solar home system	3 lamps	any	20,000.00	Kerosene	150	lires/year	Solar home system	80.00	1.7	2,000	3.15	950
5	Solar energy based ice making system	500 kg/day	-	3,000,000.00	Electricity	18,000	kWh/year	Solar System	25000 for purchasing daily ice	1.0	-	0.722	25 (Including transport savings)
6	Temperature and RH controlled food storage systems	These technologies are being proposed for valuve addition to the agriculture, fisheries and livestock sector outputs. Since there is not a base case for these technologies, potential reduction of CO_2 emision is not arrised.											
7	Biomass fired food dehydrators												
8	Small scale milk can coolers												
9	Solar thermal powerd fish dryers												
10	Solar powerd battery operated insects contorl systems												

CHAPTER 9:
IMPLEMENTATION ARRANGEMENT OF THE ACTION PLAN

The Ministry of Agriculture, Fisheries, Animal Production and Irrigation, Department of Agriculture and Department of Animal Production will be implementing this green energy action plan individually and the Ministry of Energy will be executing it. A results based action plan is proposed under this analysis report and based on the availability of resources and the budget, the annual targets need to be finalised. A common template is proposed in chapter 07 and it will help to monitor the implementations of proposed actions precisely.

9.1 IMPLEMENTATION ARRANGEMENT OF THE GREEN ENERGY ACTION PLAN

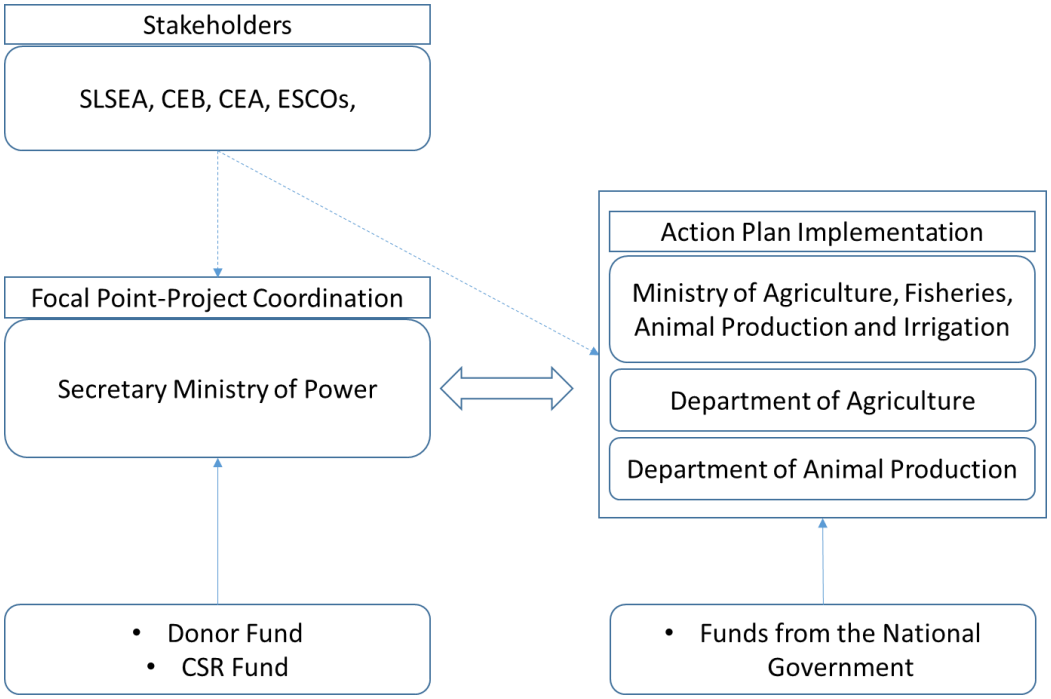


Fig 9.1: Implementation arrangement of the action plan

9.1.1 GOVERNING FRAMEWORK

Coordination, monitoring and implementation assistance will be provided by the focal point-project coordination established in the Mnistry of Power & Energy, Uva Province and the implemetation of the action plan will be done individually by the relevent Ministries and the departments.

Focal Point- Project Coordination will be specifically responsible for:

Liaising with the donor agencies, CSR funding sources and channeling the fund for implementing partners.

Coordination with relevant institutions for obtaining technical assistance in implementation of the action plan.

Monitoring the progress and ensuring smooth operation.

Implementing partners will be specifically responsible for:

Liaising with the Financial Commission, and line Ministries for budgeting requirement.

Development of annual action plan based on the available resources and Government directives.

Implementation of the action plan and reporting the progress.

9.1.2 STEERING COMMITTEE FOR IMPLEMENTATION OF THE ACTION PLAN (SC)

Chairman	Chief Secretary, Uva Province
Secretary	Secratery or nominee
Responsibility	Guidance & direction for enhancing the overall productivity
Meetings	Once in 4 months

A Steering Committee (SC) for implementation of the green energy action plan will be officially appointed by the chief secretary. The SC will include members representing the Agriculture, Fisheries and Livestock sector relevant institutions. The heads of participating public sector institutions will be invited to SC meetings as necessary. The Secratery of the Ministry of Power & Energy or his/her nominee will act as the Secretary and convener of the SC. The SC will meet as often as required, but will meet at least once in every 4 months.

9.1.3 FINANCIAL MANAGEMENT

Finances available at donors and CSR funds will be channeled through the Focal Point- Project Coordination and the implementation progress will be monitored. Government funds will be directly channeled to the relevent implementation institutions following the existing prevaling mechanisms.

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- http://www.energy.gov.lk/images/energy-balance/energy-balance-2019-lq.pdf

ANNEXURES

ANNEX 1: CONTACT DETAILS OF WORKING COMMITTEE- FOCAL POINTS (UVA PROVINCE)

Formulation of provincial energy plans for the agriculture, livestock and fisheries sector

No	Name	Designation	Ministry /Department	Contact No	E mail
01	Mr. K. M. W. R. Bandara	Deputy Director-Planning	Ministry of Agriculture	0710463639	ministryofagri@gmail.com wasantha7112@gmail.com
02	Mr. Ananda Vijitha Kumara	Deputy Chief Secretary-Planning	Deputy Chief Secretary Planning Office	0718162697	
03	Mrs. Ayesha Gunawardana	Provincial Director of Agriculture	Provincial Department of Agriculture	0718220632	agriuva@gmail.com
04	Dr. S. K. Weerasundara	Provincial Director	Department of Animal Production and Health	0773775206	daphuva@gmail.com
05	Mr. D. M. Samarasekera	Director Planning	Ministry of Power & Energy	0714420149	samarasekera@gmail.com
Other Contacts					
District	**Name**	**Designation**	**Institute**	**Mobile number**	**E- Mail**
Badulla	Mr. G.A.A. Gurusinghe	Assistant director of Agriculture - Badulla	Department of Agriculture - Uva province	0702562256	guruwelimada@gmail.com
	Ms. L.A. Thushani Munasinghe	Assistant director of Agriculture - Bandarawela		0718177053	tushani.munasingha@gmail.com
	Ms. H.M.H. Udayangani	Assistant director of Agriculture - Welimada		0716525227	udayanganihasantha@gmail.com
	Mr. R.M.Nilantha sarath kumara	Assistant director of Agriculture - Mahiyanganaya		0715343107	kumara.rmns@yahoo.com
	Mr. D.M.T.D. Dissanayaka	Subject matter Officer (AI)		0718110108	thushanthadmtd@gmail.com
Monaragala	Ms. S.M.S. Udayangani	Assistant director of Agriculture		0712068228	smsudayangani e@gmail.com

		(Hq)- wellawaya (Act.)			
	Ms. S.C. Sellahewa	Assistant director of Agriculture - Monaragala		0714422732	admonaragala@gmail.com
	Ms.R.W.P. prasangi	Assistant director of Agriculture - Monaragala		0703709560	prasangi.rpw@gmail.com
	Mr. Suranga sampath Jayasundara	Subject matter Officer (AI)		0718185025	suranga1982v@gmail.com
	Mr. Kapila	District Officer	NAQDA - Monaragala	0718034698	
	Mr. Malith	District Officer	NAQDA - Badulla	0760985015	
	Mrs. Achini	Development Officer	Ministry of Fisheries- Sevanagala AG Office	0713707083	
	Mr. Siriwardana	Extension Officer	NAQDA - Mahiyangana ya	0713167180	
	Mr. Jayantha	Secretary	Rathkida Wawa - Mahiyangana ya	0767896467	
	Mr. Sumathi	Chairman	Sorabora Wawa - Mahiyangana ya	0770423780	
	Mr. Rupasinghe	Secretary	Ulhitiya Wawa - Mahiyangana ya	0703117860	
	Mr. Thissa	Chairman	Urusita Wawa - Sevanagala	0712865470	
	Mr. Wasantha	Treasurer	Kiriibban Wawa - Sevanagala	0771993384	
	Mr. Ranga	Treasurer	Muthukandiya Wawa - Muthukandiya, SiyabalandUva	0770234790	
	Mr. Ananda	Chairman	Athimale Wawa - Athimale, SiyabalandUva	0740261287	

ANNEX 2: CONTACT DETAILS OF SURVEY RESPONDANTS- FARMERS

District	Name of the Farmer	Telephone Number
Mahiyanganaya	A D S Jayasumana	767963200
Bibile	Noyel Weerasinghe	769721651
Bibile	Chandana Sisirakumara	712454595
Bibile	R M Ramsi	773352755
Bibile	Ajith	701337004
Bibile	Siripala	702633732
Bibile	Sumanapala	711301544
Walimada	Shantha Kumara	713741443
Walimada	Somapala	710883062
Walimada	Bandara	711969923
Walimada	Wasantha kumara	772881981
Walimada	Pathmasiri	713119244
Walimada	Kapila Bandara	712760033