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# Training Manual for Orientation to Potential Entrepreneurs/Farmers engaged in Ginger, Large Cardamom, Dairy and Orthodox Tea Commodities in Nepal



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This training manual is designed for imparting training to entrepreneurs and farmers engaged in Ginger, Large Cardamom, Dairy and Orthodox Tea commodities, who aspire to adopt modern energy powered technologies into their crops and enterprises.

It is advised that the trainers make available relevant materials to the participants at least one week prior to the commencement of the actual training programme.



## SECTION I: INTRODUCTION

### A. Who should use this Training Manual?

This manual is primarily intended for trainers and organizations currently working with, or planning to work with farmers/entrepreneurs to build their capacity and for value chain development of Ginger, Large Cardamom, Dairy and Orthodox Tea commodities using modern energy powered technologies.

### B. What is it - Essence of the Training Manual?

This manual provides background information to prepare for and conduct a one day<sup>1</sup> orientation programme to Ginger, Large Cardamom, Dairy and Orthodox Tea commodities' entrepreneurs/farmers. The manual contains information on value chain concept, introduction to proposed potential modern energy powered technologies in the respective agro value chains and their corresponding financial analysis. In order to successfully implement this training; proper planning and preparation by organisers is required, including assessing needs and demands of the participants. This document should be taken as a dynamic document which needs to be updated as required.

### C. How to use the Training Manual?

This document consists of parts including training planning, delivery and setting actions plans. The content and training design are suggestive and needs to be customized according to the participants' needs and interests as well as resources available. The required content and elaboration to prepare presentation materials can also be derived from section III of this manual.

The training can be designed to include all four value chain entrepreneurs/farmers in a single training or four separate training for respective value chains, as deemed appropriate.

### D. Expected Outcomes from the usage of the Training Manual

It is expected that use of this manual will serve as the necessary reference material for the organizers, trainers and (possibly) the participants to become conversant in recommended potential modern energy powered technologies to be introduced in the Ginger, Large Cardamom, Dairy and Orthodox Tea commodities in production and/or value addition of their products.

Combined with the training delivery, the participants will evaluate the significance of such technologies for increasing their profitability and become aware of viable financial implications and options for upfront investments.

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1 Depending on the need and context, the duration of the training can be changed.

## **E. Limitations of the Training Manual**

The information provided and the analysis carried out is as of the time when this manual was prepared. To ensure relevance of the information contained herein, there needs to be continuous updating and validation.

One-day orientation alone may not be sufficient to convince the participants to adopt and/or utilize modern energy powered technologies suggested in this document. Continuous support and sometimes hand-holding support may also be required, in favour to adapt the technologies as per their needs and requirements. This manual can indicate but does not cover post-training support required for proper and effective adoption of technologies.

## **F. Desired Qualification of Trainers and Eligibility of Participants**

The trainers should be well versed with adult learning principles and experienced in carrying out similar training. They need to have high level of facilitation skills and should be adaptive to the situation to make the training more effective.

The participants of the training are expected to be existing or potential entrepreneurs and/or farmers with sufficient financial base who are willing to upgrade from traditional energy sources to technologies using clean energy.

## SECTION II: PLANNING

It is recommended that the trainers establish a clear understanding on the following aspects to ensure, to prepare for and to customise the training using Human-Centered Design (HCD) principles:

### i. Application of Human-Centered Design (HCD) Plan

#### A. (H) HEAR

- Who are the participants?
- What can be the value proposition - training needs/demands of the participants?
- Explore possible options to meet the value propositions.
- Brainstorm on effective training methods - presentations, games, group works/activities.

#### B. (D) DELIVER

- What are the best processes for implementation of the training considering adult learning principles and approaches?
- Brainstorm on potential challenges and best options.
- Develop a monitoring approach on how the sessions are going and if needed adapt.
- Evaluate your own skills as a trainer.
- Have a support system of mentors/peer support groups or peer buddies.

#### C. (C) CREATE

- Define training activities based on the outcome of (H) and (D).
- Envision "Success". Brainstorm: What does "Success" look like not only for the training but the resulting outcome of the training?

### iii. Participant Packet

The trainers may want to distribute reference and presentation materials before, during or at the end of the training according to the delivery design of the training. However, it is essential that prior to the training a relevant participant packet is made ready.

## Section III: TRAINING ACTIVITIES

### Part A – Outline of One-day Orientation to Potential Entrepreneurs/Farmers<sup>2</sup>

Purpose of the training: to orient the entrepreneurs/farmers on various technology options recommended for consideration in various stages of the respective agro value chain development.

Training component(s)	Training method(s)	Expected outcome(s)
1. <b>Introduction to the value chain(s)</b>	Brief power point presentation <sup>3</sup> on value chain(s) <sup>4</sup> . Printed poster of value chain(s). Materials required: LCD Projector, computer, posters. Duration: 1 hour.	Participants (Potential entrepreneurs/farmers) learn: <ul style="list-style-type: none"> <li>- Key parts of the value chain and value chain development concept</li> <li>- Possible modern energy powered technologies.</li> </ul>
2. <b>Proposed modern energy powered technologies and their applications</b>	Presentation on the proposed technologies. Parallel sessions: formation of groups based on value chains. Group task: Participants discuss on <ul style="list-style-type: none"> <li>- Proposed technologies.</li> <li>- Prerequisite criteria for successful adoption of the technologies.</li> </ul> Mode: Presentation and discussion. Materials required: Desk study report – technology description document, chart papers, stick papers, markers. Duration: 2 hours	Participants get better understanding on the selected technologies.  Participants discuss on opportunities and barriers to adopting proposed technologies.

2 The training can be designed to include all four value chain entrepreneurs/farmers in a single training or four separate trainings for respective value chains, as appropriate.

3 To save time, the participants can be distributed value chain maps of all the commodities and presentation of one value chain can be done.

4 Depending on the nature of participants attending, the presentation of the relevant commodity (ies) from Ginger/ Large cardamom /Dairy/ Orthodox tea can be done.

Training component(s)	Training method(s)	Expected outcome(s)
3. <b>Financial feasibility analysis/ Business model of selected technologies</b>	<p>Power point presentation on financial feasibility analysis of 2 or 3 technologies.</p> <p>Group work to validate the detail analysis of all technologies.</p> <p>Mode: Presentation followed by plenary/group discussion.</p> <p>Materials required: Detail financial analysis document, chart papers, stick papers, markers, LCD projector and computer.</p> <p>Duration: 2 hours</p>	<p>Clear understanding on financial analysis carried out and anticipated cost/ benefits of the proposed selected technologies.</p> <p>Feedback from the participants.</p>
4. <b>How to secure financing?</b>	<p>Presentation on Financial Institutions and available loan options.</p> <p>Mode: Presentation and Q/A session.</p> <p>Materials required: List of FIs and their loan offers, LCD projector and computer.</p> <p>Duration: 1 hour</p>	<p>Participants become aware of different financial institutions that provide loans and understand different financing options available.</p>
5. <b>Success Stories from Guest Speakers</b>	<p>Presentation/sharing stories by entrepreneurs/farmers who have adopted modern energy powered technologies followed by Q/A.</p> <p>Materials required: LCD projector and computer.</p> <p>Duration: 30 mins – 1 hour</p>	<p>Participants become aware from experiences of entrepreneurs on their success factors, benefits received from the technologies, worries and concerns faced.</p>
6. <b>Next steps and evaluation</b>	<p>Participants make individual assessments of the proposed technologies and propose next actions.</p> <p>Participants provide written feedback.</p> <p>Mode: Individual work</p> <p>Materials required: Formats for action plan and evaluation sheet.</p> <p>Duration: 30 mins</p>	<p>Participants prepare their action plans for engagement post the training.</p> <p>Participants provide suggestions to improve the training effectiveness.</p>

## Part B - Session Details

### 1. Introduction to the Value Chain(s)

Objectives of the session:

- Familiarise participants with the value chain development concept.
- Capacitate participants to understand possibilities in energy integration opportunities in different stages of the value chain.

Content details:

#### 1.1 The Value Chain Development Concept

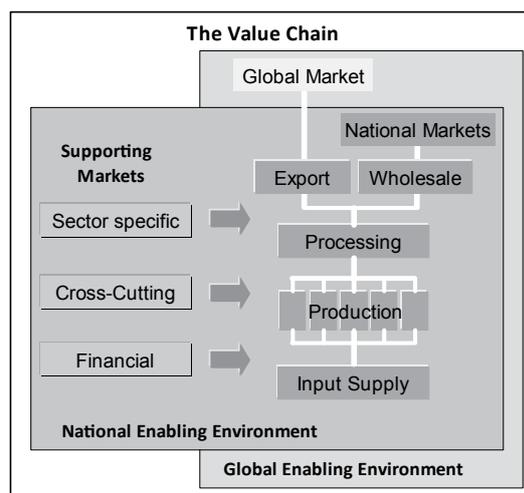
Value chains encompass the full range of activities and services of market actors required to bring a product or service from its conception to its end use and beyond. It includes producers, processors, input suppliers, exporters, retailers, etc. (both vertical and horizontal linkages) and can be defined by a particular finished product or service.

##### 1.1.1 The Value Chain Methodology<sup>5</sup>

The overarching goal of an intervention is to increase industry growth while assuring meaningful poverty reduction. The Value Chain approach is a powerful tool for designing interventions. An intervention strategy must start with an understanding of the threats and opportunities for participants in a market; in other words, the strategy must start with a competitive analysis of the market(s) targeted.

The Value Chain Approach assesses the constraints to and opportunities for enhancing an industry's competitiveness through a diagnostic framework that includes five elements:

- End Market Opportunities
- Enabling Environment (international and national)
- Inter-firm Cooperation: Vertical Linkages
- Inter-firm Cooperation: Horizontal Linkages
- Supporting Markets (sector-specific and non-sector specific services, including financial services)
- Firm-level Upgrading (product and process upgrading)



<sup>5</sup> Details of the value chain approach is provided in the reference document: the Value Chain Approach

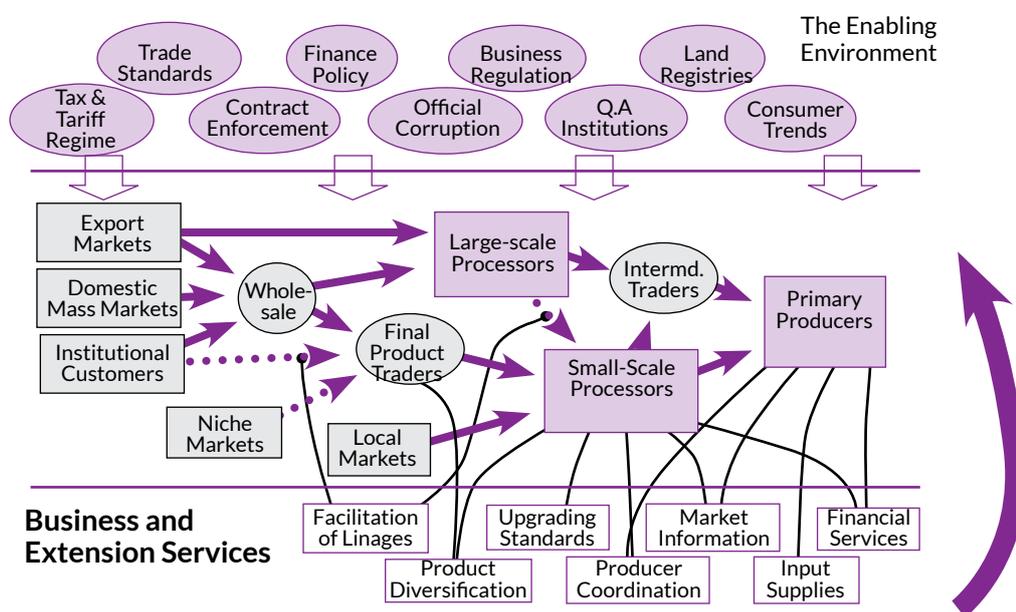
### 1.1.2 Value Chain Map

Value chain map is made up of three areas

- The market chain;
- The supporting inputs and services;
- The enabling environment.

Below figure presents a generic value chain map while specific commodity maps are available in respective sections

### A Framework to Understand Market System and Value Chains



### 1.2 Modern Energy Powered Technologies

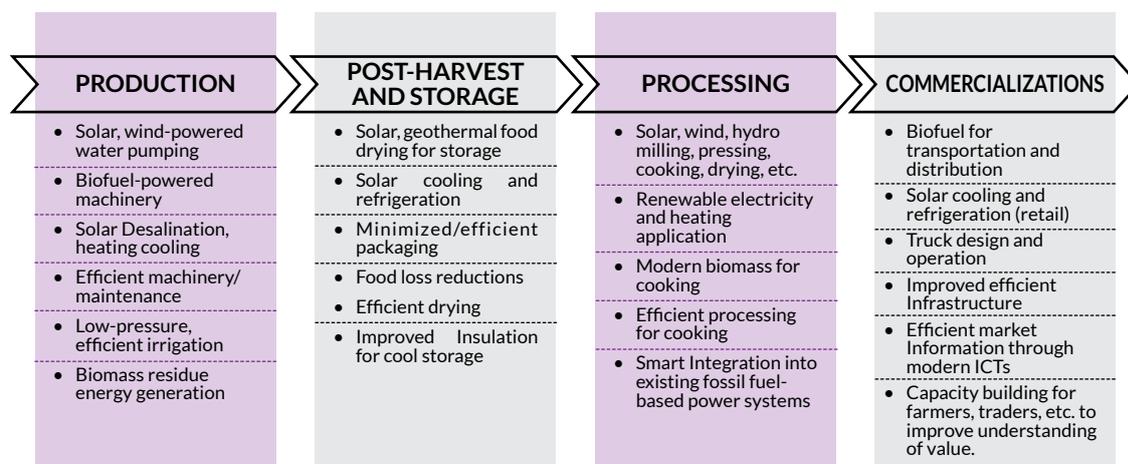
Modern energy powered technologies are defined as electricity applying technologies and/or utilising clean heating and cooking facilities (for example; fuels and stoves that do not cause air pollution). According to the World Bank definition, these are the ‘technologies that offer promise in addressing both climate change and energy access goals’.

Renewable energy is already widely used throughout the agro-food sector, either directly to provide energy supplies on-site or indirectly as a result of being integrated into the existing conventional energy supply system (Sims et al., 2011). Renewable energy sources tend to be widely dispersed throughout rural areas. So, their availability has the potential to provide a reliable and affordable energy supply that can become an essential component to meet the objectives and expectations of the stakeholders engaged as mentioned above. Reducing the dependence of the agro-food system on fossil fuels using renewable energy is feasible for on-farm

activities such as milking, cooling, grading, processing, packaging, transporting and distributing as well as cooking. In rural areas in developing countries and emerging economies, renewable energy being generated for such productive uses presents the opportunity to also provide much needed basic energy services.

The use of clean and modern energy powered technologies offers various benefits such as improved health, time saving, reduced drudgery, water savings, improved soil quality and nutrient values, biodiversity protection, food security, and better livelihoods and quality of life. Hence, there can be higher incentives to use energy wisely (by improving efficiencies) as well as by developing local renewable energy resources for use by small and medium enterprises processing the food. Modern energy technologies are being used to heat water, dry products, pasteurizing milks, processing etc. Similarly, use of refrigeration for cooling and cold storage is another common example of energy use. Further transportation of the food products requires huge amount of energy, also to preserve while transporting. Since organic wastes are often produced both on-farm and at the processing plant, investments in anaerobic digestion plants to produce biogas that can be used to provide heat, power or transport fuels has been widely deployed.

The energy requirement in the value chain differs in various stages. Different levels of energy are required at production, processing, packaging, storing and transportation as depicted in figure below.

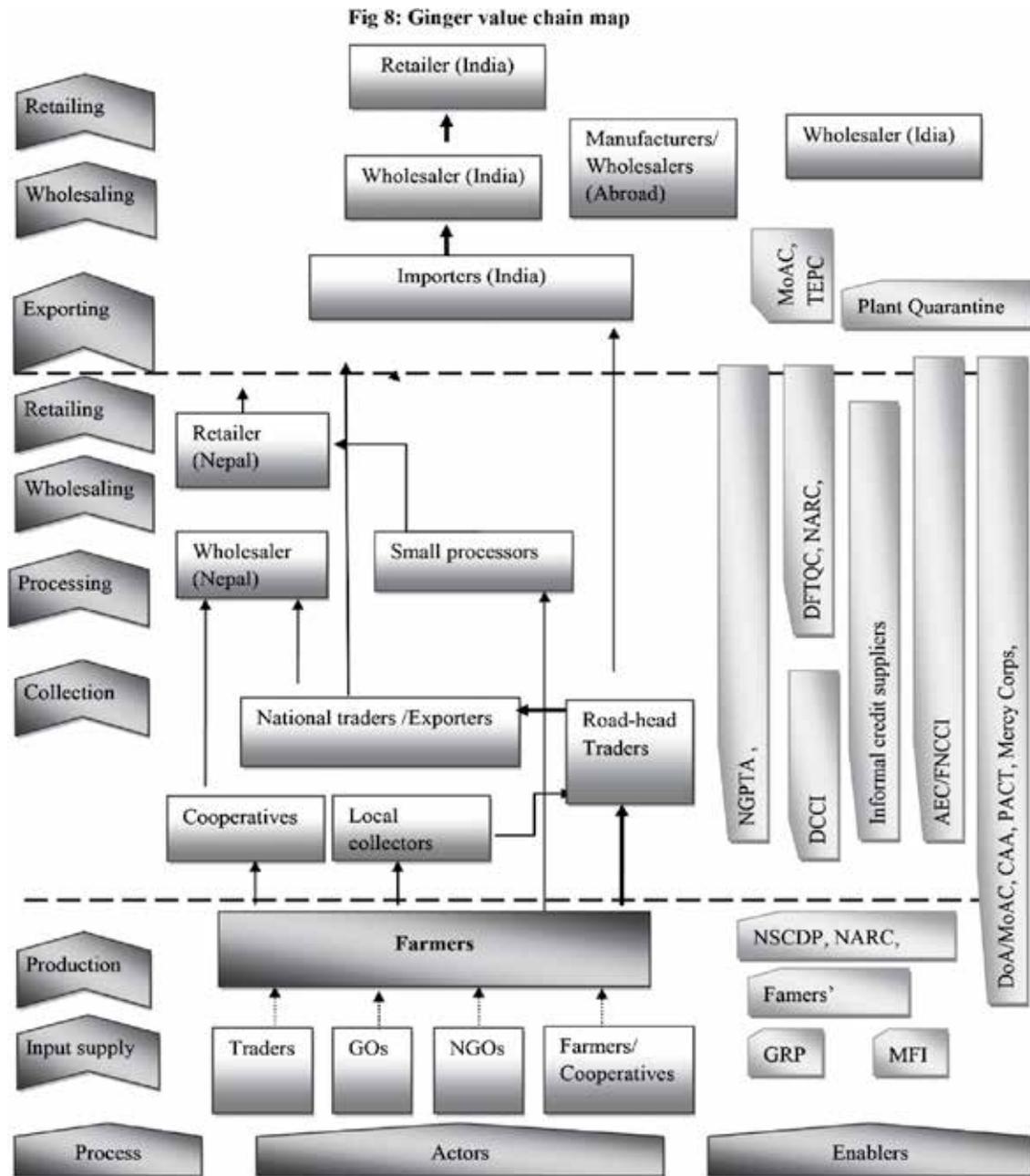


### 1.3 Ginger

Ginger is cultivated mainly in the mid-hills and some plain areas of Nepal. Of the total production, 60 per cent is exported, while the rest is consumed within the domestic market. While India is the biggest market for Nepali Ginger, it is also exported overseas countries, including Gulf countries. Raw Ginger and dried candies are the major exportable forms. Ginger is exported to India through the border areas of Kakarvitta in the east, Bhairahawa in the west and Nepalgunj in the mid-west. Due to favorable climatic conditions and increased demand in domestic and export markets, Ginger farming has gained popularity among farmers in mid hills on Nepal. Between 2008 and 2012, the world Ginger market grew at a speed of 10 per cent annually while the share of Nepal's Ginger in this world production stood at 12 per cent.

Nepal's share of Ginger production in South Asia is 21.39 per cent. The statistics of the Trade and Export Promotion Centre shows that Ginger exports jumped significantly by 162.49 per cent to 62, 843 tonnes in 2012-13. Ilam, Panchthar, Tehrathum, Kavrepalanchowk, Palpa, Nawalparasi, Tanahu, Kaski, Dang, Salyan, and Pyuthan are the top districts in Ginger production in Nepal.

Value Chain Map



Source: Adapted from NEAT, USAID, 2012

The below is the SWOT analysis of Ginger:

STRENGTH	WEAKNESS
<ul style="list-style-type: none"> <li>• Private sector led agro-vet centres available for required supplies of fertilizers, pesticides, insecticides and other materials</li> <li>• Traditional crop skilfully incorporated into farming system</li> <li>• Possibility of inter-cropping with maize, bean and vegetables; so, a very profitable crop</li> <li>• Very nominal labour cost for weeding</li> <li>• Fertile red soil and hill climate of Nepal highly suitable for producing Ginger with excellent aroma and other valuable chemical contents</li> <li>• Ease of entry into Ginger farming due in part to existence of established cooperatives for marketing the crop</li> <li>• Private sector initiations in product diversification</li> <li>• Ginger storing practices adapted by farmers in the pit is easy and affordable</li> <li>• Government institutions such as Spice Development Programme and private sector institutions such as National Ginger Producers and Traders Association, and Cooperatives in place to guide Ginger industry</li> </ul>	<ul style="list-style-type: none"> <li>• Inadequate supply of quality seed and knowledge on suppliers</li> <li>• Lack of knowledge on seed production and storage</li> <li>• High cost of inputs (fertilizer, pesticides) and no subsidy from government</li> <li>• Prevalence of Rhizome rot disease</li> <li>• Traditional cultivation practices</li> <li>• Perishable nature of product</li> <li>• Low productivity</li> <li>• Lack cleaning/washing facility and know-how- GoN established the cleaning/washing facility but not functional yet due to technical failure</li> <li>• Lack of storage, processing facilities and collection centres</li> <li>• High custom clearance charge</li> <li>• Frequent restriction on import by India (formal and informal)</li> </ul>
OPPORTUNITY	THREAT
<ul style="list-style-type: none"> <li>• Huge demand of quality inputs</li> <li>• Availability of quality seed production</li> <li>• Improving post-harvest practices</li> <li>• High scope of area expansion and productivity</li> <li>• Opportunity to produce Ginger organically</li> <li>• Technology introduction for production and diversification for value addition</li> <li>• Nepali Ginger branded and promoted as organic and grown traditionally will command a premium price in international markets</li> </ul>	<ul style="list-style-type: none"> <li>• Flow of low and unregistered quality inputs from India</li> <li>• Loss of up to 30% Ginger in the field and during storage due to rhizome rot disease</li> <li>• Migration of young labour force to urban areas for better employment opportunities</li> <li>• Farmers hesitant in production due to infestation of rhizome rot disease</li> <li>• Very high price fluctuations</li> <li>• High dependence of market price in Nepal on Ginger production and pricing in India</li> </ul>

OPPORTUNITY	THREAT
<ul style="list-style-type: none"> <li>Linkage with DFTQC has technical capacity to provide technical support on Ginger processing</li> </ul>	<ul style="list-style-type: none"> <li>Availability of cheap processed products supplied by India in Nepalese market</li> <li>Bangalore Ginger is considered to have good quality with proportionate and big fingers</li> <li>Cochin Ginger have high starch content and are assumed of good quality</li> <li>In global market, Chinese Ginger is the major competitor for Nepali Ginger, which is attractive in appearance</li> </ul>

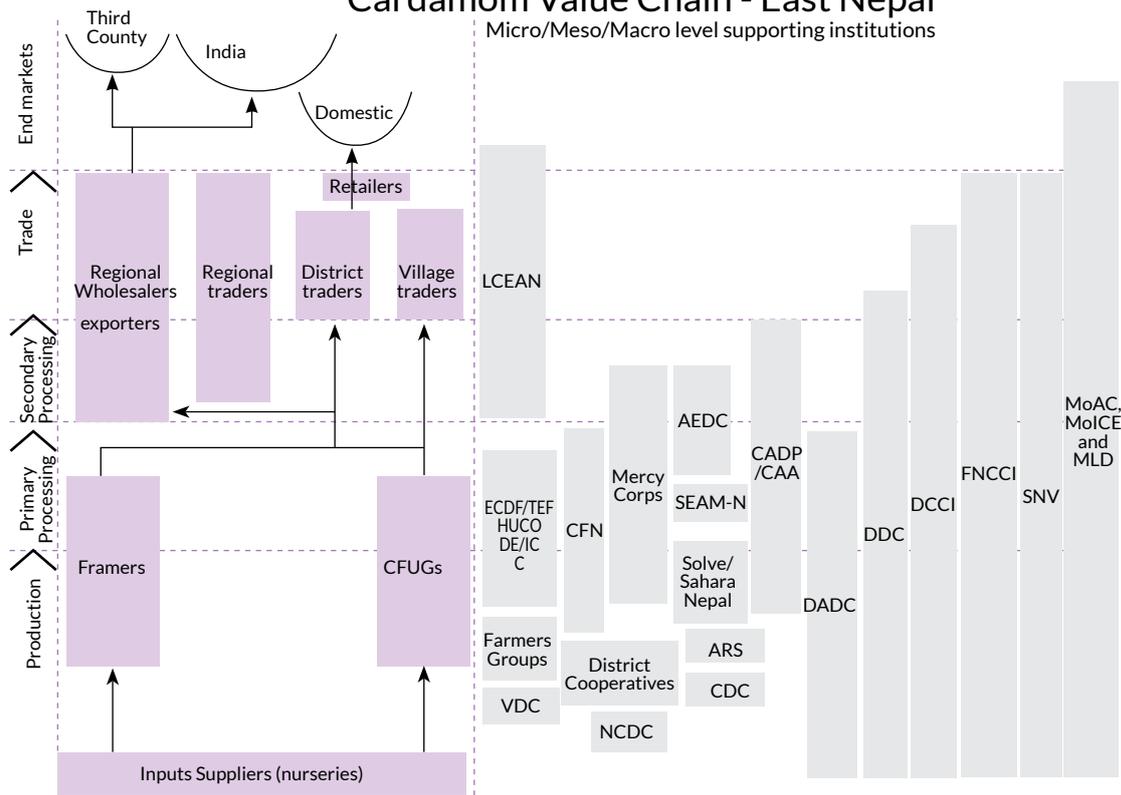
The following table shows the elaborated list of technologies that are applicable to the Ginger value chain.

Production	Harvesting	Post-Harvest	Processing and Value addition
<ul style="list-style-type: none"> <li>- Power weeder</li> <li>- Sprinkler Irrigation</li> </ul>	<ul style="list-style-type: none"> <li>- Fossil fuel powered harvesters vary in sizes and utility.</li> </ul>	<ul style="list-style-type: none"> <li>- Temperature controlled storage</li> <li>- Automated Washer with dehumidification</li> <li>- Water pumping for washing</li> </ul>	<ul style="list-style-type: none"> <li>- Solar or hot air dryers</li> <li>- Peeler, Slicer and/or grinder</li> <li>- Juice expresser</li> <li>- Oil extraction through distillation</li> <li>- Complete assembly line with cleaning, peeling, cutting and drying for larger enterprise</li> <li>- Packaging products: Ginger ale, juice, paste, powder, pickles etc.</li> </ul>

## 1.4 Large Cardamom

Nepal is the third largest exporter of Large Cardamom (*Amomum Sabulatum*, Roxb) and is identified and listed by NTIS 2010 and ADS 2015 as a priority crop. The Eastern Development Region produced 4,907 MT (in 2015) which is 94 per cent of total production (5, 225 MT). It fetches high benefit to cost ratio for the farmers which is resulting in increasing trend of land under cultivation. The major constraint in production has been viral infestation coupled with buyer led price determination system. Often, the price of Large Cardamom is fixed before the harvesting and financial transaction is done with local traders in advance. From energy technology perspective, proper drying and storage facility would be a priority.

## Cardamom Value Chain - East Nepal



The below is the SWOT analysis of Large Cardamom:

STRENGTH	WEAKNESS
<ul style="list-style-type: none"> <li>• Export potential due to enhanced flavour and taste</li> <li>• Geo climatic advantage in cultivation</li> <li>• Nominal tariff for export</li> <li>• Dedicated research centre- Pakhribas, Dhankuta around the target districts</li> <li>• Low investment</li> <li>• Plants have a long productivity period</li> <li>• Identified as a major cash crop by the Agriculture Development Strategy (ADS)</li> </ul>	<ul style="list-style-type: none"> <li>• Rain fed and traditional planting system</li> <li>• Quality and quantity of saplings not adequate</li> <li>• No major crop improvement practices considered by farmers</li> <li>• Extension service weak and R&amp;D needs upgrade</li> <li>• Low quality of product (99% of Large Cardamom dried on the traditional dryers (bhattis))</li> <li>• High transportation cost as farms are off located</li> <li>• Lack of knowledge on storage</li> <li>• Illegal taxes and fees</li> <li>• Over dependency in Indian market</li> <li>• Market intelligence and direct access poor</li> <li>• Structure and operations of facilities for phytosanitary inspection and product quality testing are poor</li> </ul>

OPPORTUNITY	THREAT
<ul style="list-style-type: none"> <li>• Huge potential of expansion</li> <li>• Increasing focus on R&amp;D, quality control of saplings</li> <li>• Low investment and hence preferred by farmers</li> <li>• Large land areas having suitable soils and climatic conditions are available in target districts</li> <li>• Several ongoing initiatives in the region</li> <li>• Production of Large Cardamom in competing countries like Sikkim, India and Bhutan decreasing</li> <li>• Increasing international demand for premium quality cardamom</li> <li>• Potential for developing niche markets with branding for premium quality cardamom and differentiating Nepalese cardamom</li> <li>• Potential for finding new markets and adding value</li> <li>• Availability of new technologies like CO<sup>2</sup> extraction for extracting essential oil</li> <li>• Focused program for rehabilitation after viral intrusion initiated by GoN</li> </ul>	<ul style="list-style-type: none"> <li>• New varieties could disrupt the international reputation of Nepalese cardamom</li> <li>• Viral (Chirkey and Furkey) and other diseases (rhizome rot) are spreading and detrimental, with no specific means to cure</li> <li>• Crop loss due to pests and other diseases is growing</li> <li>• Sikkim can come up with increased production as government of India has largely invested for last few years to revamp the production</li> <li>• Dominance by a single export market (India)</li> <li>• Deteriorating transport infrastructures</li> <li>• Radically fluctuating prices make planning difficult</li> </ul>

The following table shows the elaborated list of technologies that are applicable to the Large Cardamom value chain.

Production	Harvesting	Post-Harvest	Processing and Value addition
Solar pumps or Electric pumps for Trench irrigation or base pooling		<ul style="list-style-type: none"> <li>- Electric Winnowing</li> <li>- Electric/Solar Dryer or dehumidifier</li> <li>- Bio-mass gasifier for drying</li> <li>- Efficient wood-fired drying</li> </ul>	- Packaging and labelling

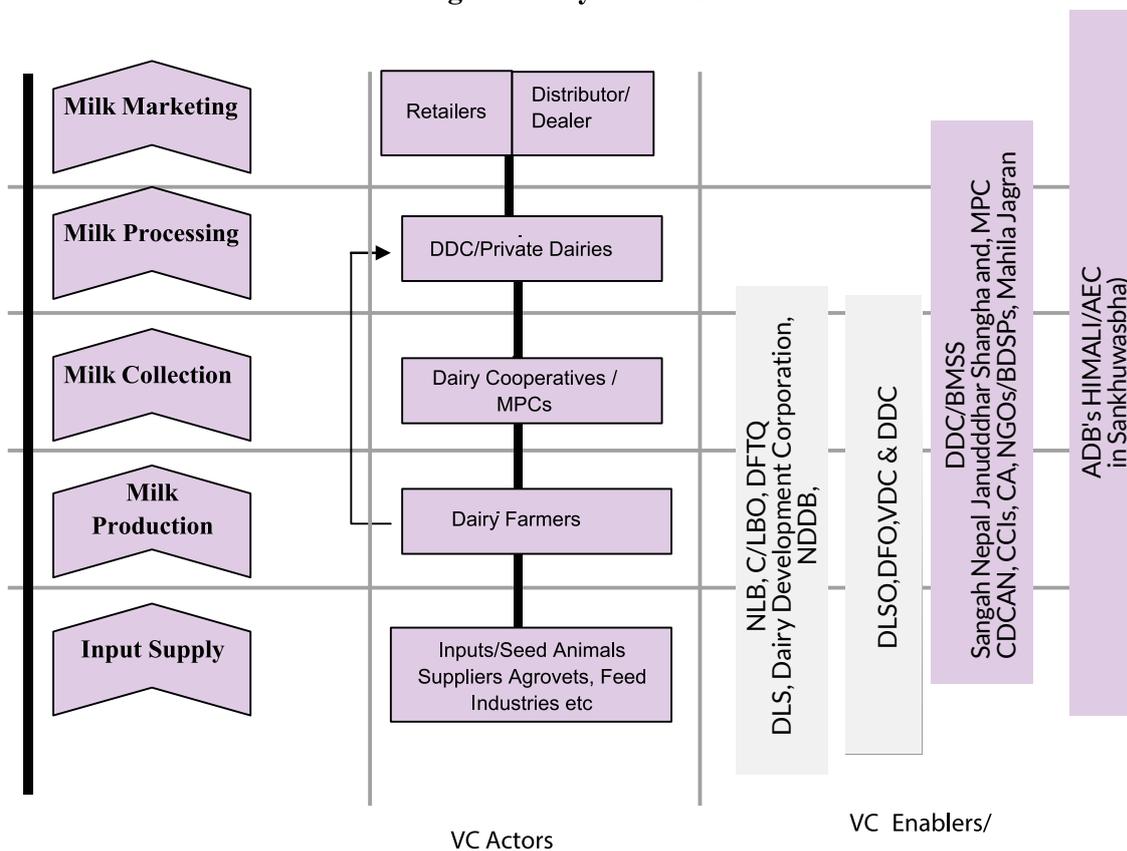
## 1.5 Dairy

Dairy farming is the dominant activity of crop-livestock integrated farming practice among smallholder farmers in Nepal, with 80 per cent of farm households rearing dairy animals (cows and buffaloes). In addition, the sector is the largest contributor of the livestock sector to Nepal's agricultural GDP.

Government along with many non-government organisations has given priority to develop this sector. Conventional farming practices have been a major challenge along with limited availability of veterinary service in the sector. Veterinary services are not available even in urban areas. Milk holidays in some parts of hilly region and new product design for Dairy industry is another challenge. There are dairies operating in many parts of country but the technologies used there are still traditional.

The value chain map

**Fig 11: Dairy Value Chain**



The SWOT analysis is given below:

STRENGTH	WEAKNESS
<ul style="list-style-type: none"> <li>• Availability of private agro-vet centres at local level, one of the best example business development service providers in the far-flung areas</li> <li>• Large number of small holder farmers engaged and benefited</li> <li>• Regular cash flow for small holder farmers</li> <li>• Dairy cooperatives have strongly developed and have become a strong channel between the rural milk producers and the milk processing industries</li> <li>• Private sector initiative in product diversification</li> <li>• Market opportunities of milk and milk products have increased particularly in the densely populated urban areas</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of quality forage</li> <li>• Serious depletion of animal feeding base due to deterioration in the forest areas</li> <li>• Shortage of improved breeding bulls as well as artificial insemination services</li> <li>• Low productivity with 670 litres/ milking animals (438 litres/milking cow and 854/milking buffalo)</li> <li>• Subsistence production systems and scattered production with no commercial orientation. This has higher the production cost and collection cost</li> <li>• Farmers lack knowledge and skills on improved Dairy farming</li> <li>• Milk holidays during flush season (August-September to January-February) due to low absorption capacity of DDC and private sectors</li> <li>• Competition with cheaper milk products from India and other countries</li> </ul>
OPPORTUNITY	THREAT
<ul style="list-style-type: none"> <li>• Technology introduction</li> <li>• Expansion of forage based milk production system, which found to be remunerative for producers</li> <li>• Farmers shifting from subsistence farming to commercial farming</li> <li>• Unmet domestic demand of Dairy products</li> <li>• Encourage local level processing as increased demand of Churpi as Dog Chew in USA</li> <li>• Expansion of milk collection centres</li> <li>• Product diversification</li> </ul>	<ul style="list-style-type: none"> <li>• No access to community forest for fodder grass and grazing</li> <li>• High opportunity costs of land and labour particularly around the main highways and townships where the Dairy farming activities is mostly carried out</li> <li>• Flooding of cheap Dairy products from India and third countries</li> <li>• Frequency of strikes due to political instability</li> </ul>

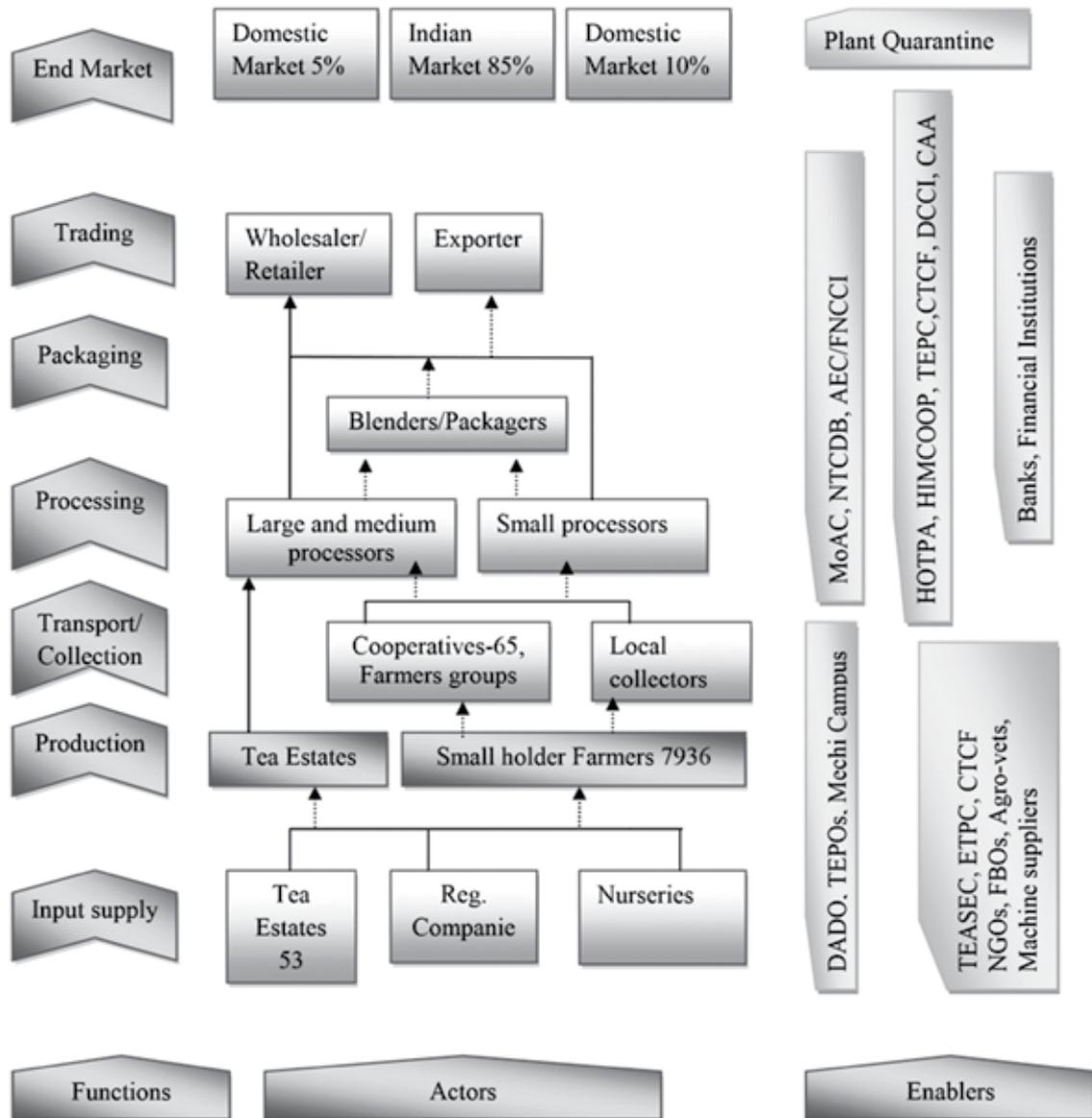
The following table shows the elaborated list of technologies that are applicable to the Dairy value chain.

Production	Harvesting	Post-Harvest	Processing and Value addition
<ul style="list-style-type: none"> <li>- Vaccine Refrigerator</li> <li>- Grass Cutter for feed</li> <li>- Pumping of water for cattle</li> <li>- Laboratory equipment (such as Autoclave) for artificial insemination</li> </ul>	<ul style="list-style-type: none"> <li>- Electric milking machines for enterprises having 10+ cattle</li> </ul>	<ul style="list-style-type: none"> <li>- Chilling Vat</li> <li>- Solar Milk Chillers</li> <li>- Pasteurizers</li> <li>- Fat and SNF testing machine</li> </ul>	<ul style="list-style-type: none"> <li>- Packaging (Sealing and Filling machines)</li> <li>- Chiller or Freezer</li> <li>- Cream Separator (Centrifuges)</li> <li>- Ice-cream Maker</li> <li>- Khuwa making Machine</li> <li>- Butter churn</li> <li>- Automatic Ghee maker</li> <li>- Cheese/Chhurpi Making (Cheese VAT, Cheese Press, Cutter, Cold Storage)</li> <li>- Yoghurt Incubator</li> </ul>

## 1.6 Orthodox Tea

Nepal's Orthodox Tea has huge potential in the niche international markets as the demand for high end organic tea products are increasing rapidly around the global market. Nepal tea has comparative advantage as the bushes are younger than the famous Darjeeling tea. In Nepal, Orthodox Tea is produced and processed in the mountainous regions at an altitude ranging from 3,000–7,000 feet above the sea level. Ilam district alone produced approximately 75% to 80% of the total Orthodox Tea. Remaining is produced in Tehrathum, Panchthar, Dhankuta, etc. Nepal exports approximately 2,200 MT of Orthodox Tea annually (which is approximately 90 to 95% of total production), out of which approximately 85% assumed to be exported to India remaining to Germany, Japan, Russia and few other countries. Sales revenue from the Orthodox Tea is approximately USD 5.9 million.

The value chain map:



Source: Adapted from NEAT, USAID, 2012

The below is the SWOT analysis:

STRENGTH	WEAKNESS
<ul style="list-style-type: none"> <li>• Good climate and geographical conditions</li> <li>• Large area under tea cultivation</li> <li>• Environmentally friendly crop</li> <li>• Private sector led agro-vet centres available for required supplies of fertilizers, pesticides, insecticides and other materials</li> <li>• Young tea bushes (relative to nearby India's bushes)</li> <li>• Short crop cash cycle</li> <li>• Cultivation methods and required standards clearly spelled out</li> <li>• Cooperative model reaping benefits to farmers</li> <li>• Steady growth in export volume and earnings</li> <li>• Presence of large, medium, and small processors with sufficient and varied processing capacity</li> <li>• GoN prioritized crop</li> </ul>	<ul style="list-style-type: none"> <li>• Rain fed system and need irrigation for proper production</li> <li>• Absence of commercial nurseries for supply of saplings</li> <li>• Quality check of inputs not available</li> <li>• Limited availability of organic manure to opt for organic farming</li> <li>• Farmers' lack knowledge and skills on organic cultivation</li> <li>• Labour shortage</li> <li>• Poor on-farm infrastructure</li> <li>• Low productivity (274kg/ha) yield comparatively 25% and 30% low than India and Sri Lanka (MoCS, 2010)</li> <li>• High cost of organic certification</li> <li>• Delay in VAT refund on exports</li> <li>• No duty rebate in packing materials and processing equipment</li> </ul>
OPPORTUNITY	THREAT
<ul style="list-style-type: none"> <li>• Expansion of cultivation area</li> <li>• Private sector led extension model with buy-back guarantee</li> <li>• Establishment of commercial nurseries</li> <li>• Commercial production of organic manure and pesticides through tea cooperatives</li> <li>• Introduction of plucking machine for improvement in plucking and addressing the labour shortage</li> <li>• Develop good brand image, including geographical indicators (especially in response to declining image of Darjeeling tea)</li> </ul>	<ul style="list-style-type: none"> <li>• Farming heavily dependent on rainfall</li> <li>• Low quality of inputs being noticed in the market</li> <li>• Issues of intellectual property rights may arise as the cultivated varieties are mostly from China and India</li> <li>• Migration of young labour force to urban areas for better employment opportunities</li> <li>• Loss of potential markets due to poor product quality; declining prices for poor quality teas globally, indicating need to increase quality and consistency standards</li> <li>• Heavy reliance on Indian processing and marketing, resulting in loss of Nepali brand identity</li> <li>• Commodity chain governance not operating smoothly</li> <li>• Frequent dispute between farmers and processors for fixing the price of green leaf</li> <li>• Labour strikes and factory shutdown</li> </ul>

The following table shows the elaborated list of technologies that are applicable to the Orthodox Tea value chain.

Production	Harvesting	Post-Harvest	Processing and Value addition
<ul style="list-style-type: none"> <li>- Mechanical Tea Pruner</li> <li>- Riding type pest controlling machine</li> <li>- Operator riding tea pruning machine</li> </ul>	<ul style="list-style-type: none"> <li>- Plucking machine:               <ul style="list-style-type: none"> <li>i) Battery powered Tea plucker (single operator)</li> <li>ii) Gasoline powered Tea plucker (single operator)</li> <li>iii) Operator riding type Tea plucking machines</li> <li>iv) Two men operating plucking machine (battery or gasoline powered)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- Wither: Axial flow fan</li> <li>- Roller: Electric roller</li> <li>- Dehumidifiers for fermentation</li> <li>- Mechanical rotor vane</li> <li>- Roll-breaker and green-leaf sifter: mechanical</li> <li>- Dryer: Mechanical (tray) dryer, Heat controlled drying machine</li> </ul>	<ul style="list-style-type: none"> <li>- Mechanical sieve grading and sorting machines</li> <li>- Packaging: portable electric tea packaging</li> </ul>

## 2. Proposed Modern Energy Powered Technologies and Their Applications

Objectives of the session:

- i) Inform participants about the selected technologies.
- ii) Familiarise participants with technical details of each technology.
- iii) Communicate availability and ease of operation of technologies.
- iv) Identify the appropriate technology.
- v) Discuss on possibilities of adoption of selected technologies with technology customization according to their needs.
- vi) Deliberate on a set of pre-requisite criteria for successful adoption of technology.

Group discussion guidelines:

- Divide groups according to the value chains.
- Discuss on proposed technologies referring to the reports provided (technology description document - desk study report).
- Derive brief prerequisite criteria for successful adoption of the technologies.
- Identify the right technology as per their situation.

Relevant information:

Based on the following listed criteria, the final technologies for the four value chains were examined, assessed and recommended in the study:

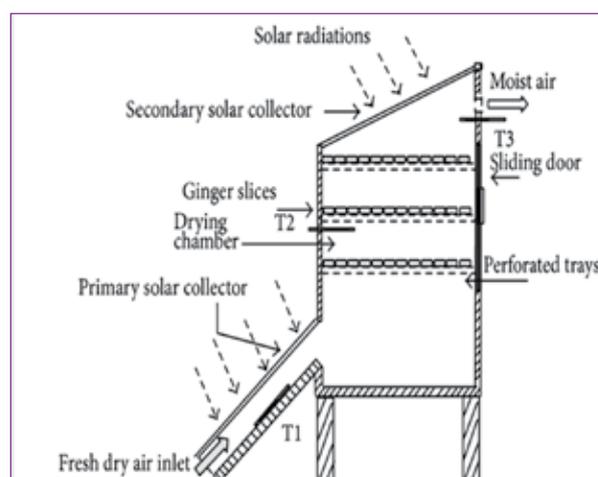
- Is functionally appropriate?
- Does it maintain the output quality of the product?
- Is it accessible and affordable by low income farmers?
- Is it easy to operate and maintain?
- Is there a potential of adoption at scale?

## 2.1 Ginger

The specific recommended technologies for Ginger value chain are:

### 1.1.1 Solar Powered Ginger Dryer

The solar powered Ginger dryer works on thermal power using solar collectors. This dryer constitutes of a mixed mode box-cabinet with natural circulation. There is a primary solar collector with a transparent sheet is located over the collector and a secondary solar collector oriented North-South is covered with a single layer of thick UV stabilized polyethylene film and hinged at the top of the drying chamber. The fresh air is sucked in from under the primary collector and heated through the air duct and flows to the drying chamber. Secondary collector allows the solar radiations to drying chamber and further enhances the drying rate by greenhouse effect. The drying chamber is coated with black paint, thermally insulated with asbestos sheets to minimize the heat loss provided with the support for sample holding mesh trays having area 1 m<sup>2</sup>. The general rule of thumb is that 1 m<sup>2</sup> of tray area is needed to lay 10 kg of produce; an average dryer can dry around 250 kg of Ginger with 3 days drying time.



Schematic diagram

<b>Technical Viability Analysis</b>	<p><b>Type of energy required in modern technology:</b> Solar thermal</p> <p><b>Availability and reliability of energy technology:</b> depends on the solar radiation</p> <p><b>Size and volume:</b> moderate in size, suitable for small to medium enterprises.</p> <p><b>Type of energy used currently:</b> open sun-drying</p> <p><b>Enhancement of productivity:</b> With closed drying, the output is more hygienic and due to green-house effect, the drying process is faster; hence enhances productivity.</p> <p><b>Ease of operation:</b> The dryer is easy to operate as it does not need high level of technical skills to operate.</p> <p><b>Skilled human resource:</b> Simple orientation on cleaning and using the technology will be required.</p> <p><b>Safety:</b> No imminent safety concerns.</p> <p><b>Market availability and transportation:</b> The technology is readily available in Nepali as well as Indian market. Even with transportation from India, the cost will remain same as buying in Nepali market.</p>
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### 2.1.2 Automated Ginger Washer

A Ginger washing machine is composed of stainless steel frame, speed motor, drum chamber, pipeline shower, sprinkler and water tank. Semi-automated or fully automated varieties of machines are available in market which utilise electric power. The required electric power can be supplied by grid electricity or from suitable solar PV system. However, it will be more viable to use grid-electricity if the size of the machine is large and requires significant quantity of electrical energy.

The machine uses surfing, bubbling and water spraying to wash ginger. During this process, it can completely clean the soil stuck in the gingers as well as use sterilization sprays to wash out the effect of pesticide residues on the surface. The machine can also wash other vegetables in addition to ginger but will require calibration in speed and flow of water.

Sample Technical Parameters:

Dimension (mm)	Weight (kg)	Power (kW)	Capacity (kg/h)
3000*1200*1300	420	2.95	300-500
4000*1200*1300	400	4.1	800
5000*1200*1300	500	5.1	1500
6000*1200*1300	600	5.5	2000

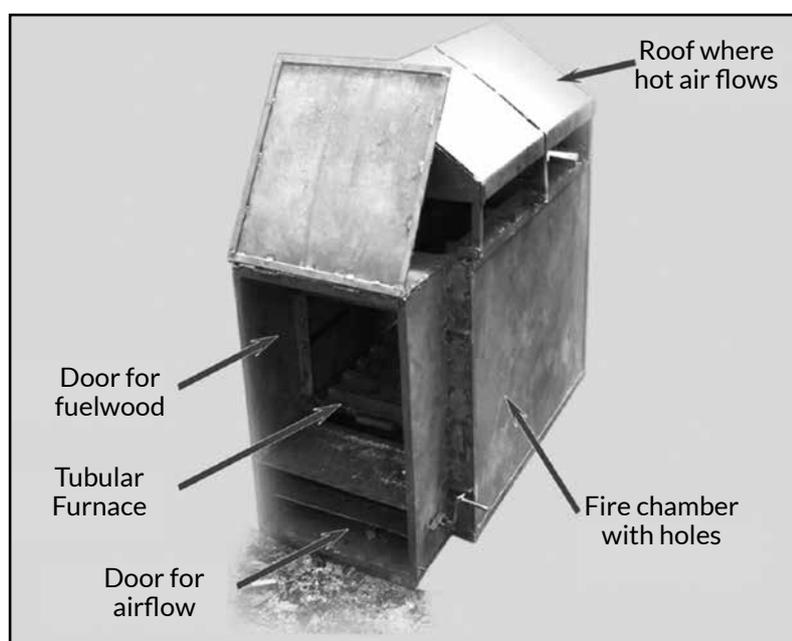
<b>Technical Viability Analysis</b>	<p><b>Type of energy required in modern technology:</b> Grid electricity or solar PV</p> <p><b>Availability and reliability of energy technology:</b> Grid electricity is mostly available, solar PV may be used as backup</p> <p><b>Size and volume:</b> Different sizes are available, which may meet the requirements of medium and large size enterprises.</p> <p><b>Enhancement of productivity:</b> Requires less manual work, efficient use of water, increase in speed of process.</p> <p><b>Ease of operation:</b> As it is mostly automated, it is easy to operate</p> <p><b>Skilled human resource:</b> Operator needs to be trained</p> <p><b>Safety:</b> Proper safety standards need to be maintained</p> <p><b>Market availability and transportation:</b> Can be imported from India or China</p>
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## 2.2 Large Cardamom

The specific recommended technology for Large Cardamom value chain is:

### 2.2.1 Improved Cardamom Dryer

Improved Cardamom dryer is an efficient drying method using fuelwood. These dryers are recently being piloted by Singhabahini Engineering Works Pvt. Ltd., Sunsari. An average improved dryer dries 1 kg of Cardamom utilising 1 kg of fuelwood whereas, traditional method requires 3 kg of fuelwood to dry similar capacity.



Improved Cardamom dryer

<b>Technical Viability Analysis</b>	<p><b>Type of energy required in modern technology:</b> Thermal energy using fuelwood</p> <p><b>Availability of energy required:</b> Supply of fuelwood needs to be maintained</p> <p><b>Efficiency of the selected modern technology:</b> Efficient and less carbon production than open fire</p> <p><b>Size and volume:</b> 1.80 m x 0.7 m x 1.3 m for drying 200 kg; 1m x 0.7 m x 1.3 m for drying 150 kg</p> <p><b>Quantity of energy usage:</b> 200 kg of fuelwood for drying 100 kg of cardamom</p> <p><b>Ease of operation:</b> Easy to operate</p> <p><b>Skilled human resource:</b> Requires orientation for using</p> <p><b>Safety:</b> Needs necessary safety measures.</p> <p><b>Maintenance and after-sale services:</b> Manufacturer provides</p> <p><b>Market availability and transportation:</b> One manufacturer in Nepal</p>
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## 2.3 Dairy

The specific recommended technologies for Dairy value chain are:

### 2.3.1 Cream Separator

Cream separation machine can be operated using electricity from Solar PV hybrid with energy from Micro Hydro Project or national grid. About 0.4 kW electric power is required to operate the machine that can separate cream from 500 litres of milk in an hour. In order to operate the proposed cream separator using solar PV, a 1.2 kWp sized solar PV system is needed to be installed.

The separators are abrasion and rust proof, therefore, can serve for long duration as per needs of entrepreneurs. As the machines are manufactured using high quality materials, they are durable and can also be customized as per the requirements.

Sample Specifications for 500 Ltr/hr Electric Cream Separator:

- Machine Capacity: 500 Ltr/hr
- Tank Cap.: 40 Litres
- No of S.S. Discs: 35
- Motor: 1425 RPM Single Phase Electric Motor 0.25 HP / 0.50 HP
- Separation Temperature: 35 - 40 C/95-108 F
- Solid Removal Time: 1.5 Hour
- Machine Length: 660 mm X Width: 550 mm X Height: 1200 mm
- Machine Weight: Nett - 70 kg; Gross - 145 kg Approx.
- Bowl Material: M.S./S.S. 304
- Spout Set Material: CRCA Sheet/S.S. 304 Sheet
- Receiving Tank Material: Aluminum Sheet/S.S. 304 Sheet
- Useful in Dairy Plant



Electric Cream Separator – can be powered using solar PV

**Technical  
Viability  
Analysis**

**Type of energy required in modern technology:** Electricity from Solar PV system

**Availability and reliability of energy technology:** energy system is reliable but capacity depends on solar radiation.

**Size and volume:** moderate in size

**Type of energy used currently:** manual separator or by heating in traditional cook-stoves

**Ease of operation:** easy to operate.

**Skilled human resource:** Training is required

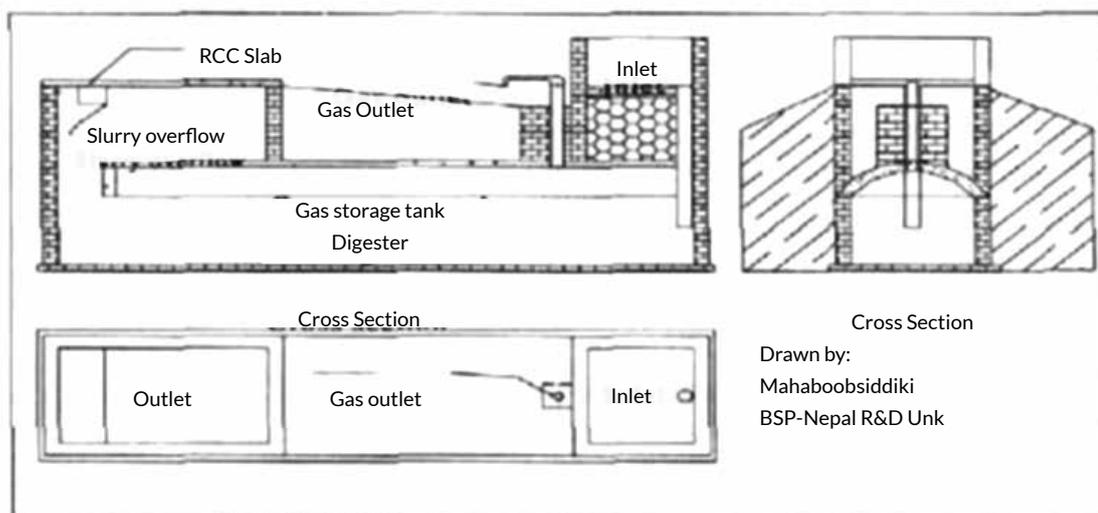
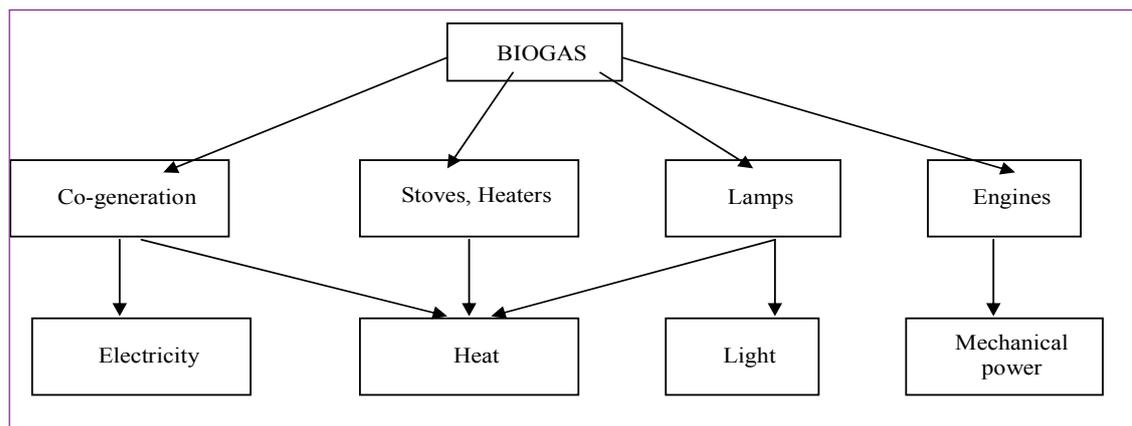
**Safety:** Safety procedures need to be implemented

**Market availability and transportation:** The technology is available in Nepali market and can be easily purchased from Biratnagar

### 2.3.2 Biogas Plant for Thermal and Electrical Power Generation

Biogas is a combustible fuel produced through anaerobic digestion process. Anaerobic means “in the absence of oxygen”. Biogas consists of roughly 40%–70% methane, with the rest being CO<sub>2</sub> and trace amounts of H<sub>2</sub>O, H<sub>2</sub>S, H<sub>2</sub> and NH<sub>3</sub> produced by the microbiological process. The amount of methane in the biogas is largely a function of the organic input menu. Methane is virtually odourless and is invisible in bright daylight. It burns with a clear blue flame without smoke and is non-toxic. It produces more heat than kerosene, wood, charcoal, cow-dung chips etc.

Organic wastes from Dairy processing units are ideally suited as inputs to a biogas plant. Biogas, when utilized in a combined heat and power (CHP) unit produces electrical energy for consumption and heat energy for further use. The heat produced by the CHP is used to heat the digestion process to improve biogas yield. Biogas can also be cleaned up for injection into boiler as a fuel substitute for conventional fuel. The remaining by-product of the digestion process is digestate which is a fermented organic material which may be used as high-quality fertilizer. A farm with 15-17 cattle can feed a biogas plant of 50 m<sup>3</sup> that can produce 3 kW of electricity and 200 kg bio-slurry per day.



Tunnel type with gas storage on displacement principle

<b>Technical Viability Analysis</b>	<p><b>Type of energy required in modern technology:</b> Organic waste of biomass to produce bio-energy</p> <p><b>Availability of energy required:</b> System can be designed for required energy output</p> <p><b>Availability and reliability of energy technology:</b> Supply of feed needs to be maintained</p> <p><b>Efficiency of the selected modern technology:</b> Highly efficient use of biomass (waste)</p> <p><b>Size and volume:</b> As per required (can be designed for small or medium-scale)</p> <p><b>Ease of operation:</b> Moderate</p> <p><b>Skilled human resource:</b> Needs to be trained</p> <p><b>Safety:</b> Considerable safe but safety procedures should be followed</p> <p><b>Market availability and transportation:</b> Can be constructed by skilled masons and technical assistance is readily available. Construction materials can be transported easily.</p>
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### 2.3.3 Milk Chilling Vat

Chilling of milk is necessary after receiving milk at collection/chilling center in order to control growth of microorganisms, minimize micro-induced changes and maximize its shelf life. Chilled milk can easily and safely be transported without further deteriorative changes due to microbial growth.

Bulk milk coolers are generally installed at chilling centers. Milk Chilling Vat can be operated using electricity from Micro Hydro Project or the national grid or solar PV. About 2.64 kW of electric power is required to operate the compressors of Chilling Vat that can hold 500 litres of milk. The collected milk at a milk collection center needs to be kept in the Chilling Vat for about 3 to 24 hours before the supplying to Dairy industry through milk tankers. The Chilling Vat consists of a double jacketed vat fitted with a mechanical agitator. It also has provision for circulation of chilled water which comes from the chilled water tank.

Chilling Vats range from 300-2000 litres capacity having productive life of 10-15 years and require electrical power of 3-15 kW.

<b>Technical Viability Analysis</b>	<p><b>Type of energy required in modern technology:</b> Electric power from grid/ solar PV</p> <p><b>Availability and reliability of energy technology:</b> For reliability solar PV with battery backup in hybrid with grid electricity</p> <p><b>Size and volume:</b> Varies from small portable to large sizes.</p> <p><b>Ease of operation:</b> Easy to operate</p> <p><b>Skilled human resource:</b> Orientation required for operation and maintenance</p> <p><b>Safety:</b> requires appropriate safety measures.</p> <p><b>Market availability and transportation:</b> Easily available in Biratnagar, Morang and Kathmandu.</p>
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### 2.3.4 Automated Milking Machine

The automated milking machines are an effective means of milking cows which operate from electric power. The machine includes teat cups that contact the cow's teats and remove the milk, a claw where milk pools as it is removed from the four teats, vacuum tubes that provide vacuum to the teat cups and a milk tube that removes milk away from the claw, a source of vacuum for the machine, and a pulsator that regulates the on-off cycle of the vacuum. Many milking machines today have an automatic take-off (ATO or detacher) device that removes the machine from the cow when milking is completed.

Automated milking machine can be operated from using electricity from Solar PV, Micro Hydro Project or the national grid. The machines are mobile fitted with wheel, portable and very suitable for small farms in any geography as well. A machine embedded with one bucket with capacity of 10 litres, can milk 1-10 cows/hour and have a liner life of 3000 milking life. It uses the electric motor of 0.5 HP (1440 RPM) with milking claw of 240 CC and pulsation ratio of 60:40 (60PPM 2+2 Type).

<b>Technical Viability Analysis</b>	<p><b>Type of energy required in modern technology:</b> Solar PV/grid electricity</p> <p><b>Availability of energy required:</b> Can be designed as per requirement</p> <p><b>Size and volume:</b> Portable in size and moderate in volume.</p> <p><b>Enhancement of productivity:</b> Saves time and efforts and ease in transportation as well.</p> <p><b>Ease of operation:</b> Moderate</p> <p><b>Skilled human resource:</b> Training required</p> <p><b>Safety:</b> Decreases the direct contact with animal, hence enhances safety</p> <p><b>Market availability and transportation:</b> Available in Nepali, Indian and Chinese markets and may require transportation.</p>
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### 2.3.5 Refrigeration for Sexing Technology and Vaccines

The storage of vaccines is very vital in Dairy value chain to retain their effectiveness. Most vaccines should be stored at 35 to 45° Fahrenheit. Also in Dairy value chain artificial insemination has become an efficient and cost-effective strategy to improve the genetics and reproductive performance of herd. An excellent method of storage of the vaccines and semen are through good freezers with uninterrupted power supply. A cattle farm/entrepreneur can easily store the vaccines and medicines of cattle in a normal refrigerator/freezer, which operates using electricity from solar PV, Micro Hydro project and/or National Grid.



If a cattle farm/entrepreneur has purchased a 100 litre refrigerator for storing vaccines and medicines then the farm/entrepreneur should install a solar PV system of 600 Wp to fulfill the electricity demand.

<b>Technical Viability Analysis</b>	<p><b>Type of energy required in modern technology:</b> Electric power from grid/ solar PV</p> <p><b>Availability and reliability of energy technology:</b> Hybrid systems are recommended for increasing reliability.</p> <p><b>Enhancement of productivity:</b> Safe and effective method of storage.</p> <p><b>Ease of operation:</b> Easy to operate</p> <p><b>Skilled human resource:</b> Not required for storage but trained human resource is required for insemination process.</p> <p><b>Safety:</b> Requires appropriate safety measures</p> <p><b>Market availability and transportation:</b> Easily available in Nepali market</p>
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### 2.3.6 Feed Processing Units

Generally, the feed industry is operating the plant using grid electricity with diesel generator as back-up. Instead of using diesel generator, the feed industry can make use of solar PV system as a back-up for the grid electricity.

The process of feed making is:

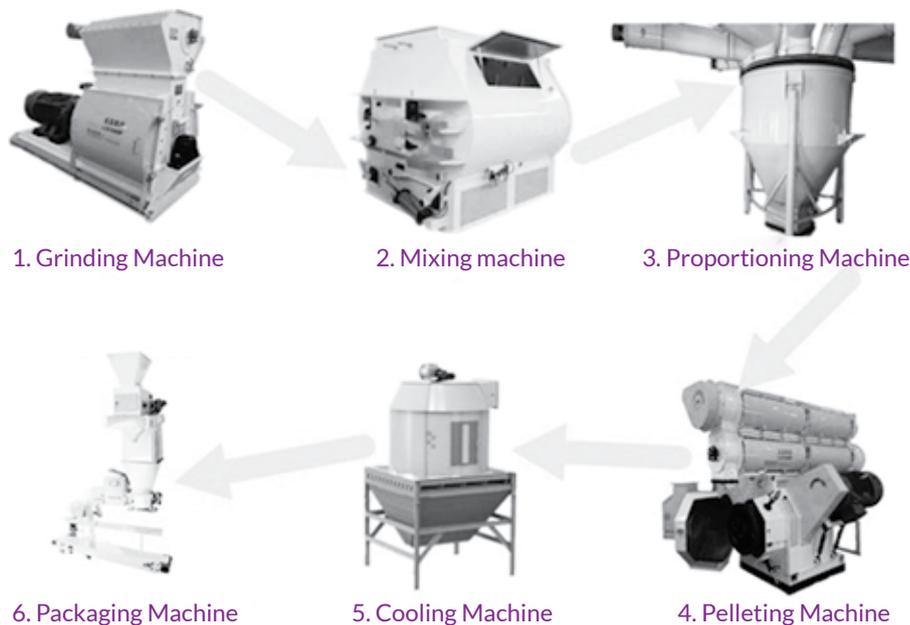
- Grinding of cattle's feed ingredients such Maize, Mustard Cake, Barn, Molasses, Straw, Urea etc.
- Elevation of the Grinding materials of Cattle's feed ingredients.
- Mixing of cattle's feed ingredients.

- Packaging of final product.

In order to deliver 10 tonnes cattle feed per day, the following units with specified capacity are needed:

- 22.4 kW Motor with Grinding unit
- 4.47 kW Motor with Elevator unit
- 14.92 kW Motor with Mixing unit
- 0.746 kW Motor with Packaging unit

If the plant operates of 8 hours in a day, the total electrical demand of the plant will be 45 kW, where 35 kW will be supplied through Grid electricity and rest 10 kW from Solar PV system (30 kWp). The solar system will supplement the operation during the low voltage and power cuts.



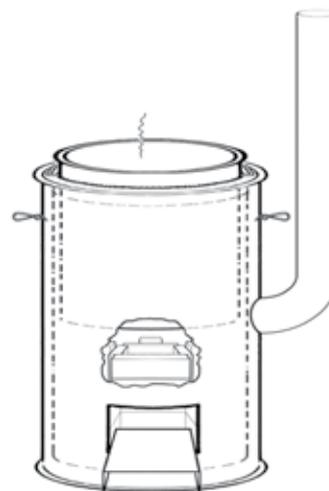
Process flow for high capacity animal feed making machine

<b>Technical Viability Analysis</b>	<p><b>Type of energy required in modern technology:</b> Electricity from grid/ solar PV</p> <p><b>Availability and reliability of energy technology:</b> Hybrid systems are recommended for increasing reliability.</p> <p><b>Enhancement of productivity:</b> Increases the productivity, multi-purpose with packaging.</p> <p><b>Ease of operation:</b> Moderate</p> <p><b>Skilled human resource:</b> Training is required</p> <p><b>Safety:</b> Requires appropriate safety measures</p> <p><b>Market availability and transportation:</b> Diesel operated system in existence in Nepali market which can be replaced with electric power, hence, available but transportation due to its large size might be difficult.</p>
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### 2.3.7 Efficient Stoves for Cheese Making

Currently, most of the cheese and churpi production enterprises use traditional cook-stoves for heating milk. This not only hampers their health but also the environment. In order to replace traditional cook-stoves, efficient institutional rocket stoves are proposed.

The institutional rocket stove consists of a cylinder that surrounds the larger pot creating a 16-mm gap which is especially effective in transferring heat because the pot is larger. Larger pots have more surface area so greater amounts of heat pass into the food. In fact, using larger pots decreases the amount of fuel used and helps to reduce the emissions made when cooking. When a chimney is attached to the stove, the hot gases are forced to flow down another gap on the outside of the inner cylinder. All the heat has already scraped against the pot before it exits out of the chimney.



These stoves range from 100-300 litres capacity with increased thermal efficiency by 35% than that of traditional cook-stoves.

<b>Technical Viability Analysis</b>	<p><b>Type of energy required in modern technology:</b> Thermal power using fuelwood</p> <p><b>Availability of energy required:</b> Can be designed as per requirement</p> <p><b>Availability and reliability of energy technology:</b> Supply of fuelwood needs to be maintained</p> <p><b>Efficiency of the selected modern technology:</b> Efficient than traditional cooking methods.</p> <p><b>Size and volume:</b> Small to moderate in size</p> <p><b>Ease of operation:</b> Easy</p> <p><b>Skilled human resource:</b> No such skills required for operation</p> <p><b>Safety:</b> Appropriate safety measures need to be implemented</p> <p><b>Market availability and transportation:</b> Although the exact technology available in Indian market but availability of number of cook stoves companies allow possibility of local production. Easier to transport.</p>
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### 2.3.8 Cold Storage

The Dairy products need a temperature controlled storage facility before they are dispatched to the market. The Dairy products need to be stored in a cold place to any damage from production to supply to a Dairy industry.

A 1000 m<sup>3</sup> cold storage facility requires around 65 kW of electricity to operate. Solar PV system of that scale will be highly expensive, hence, a grid connected cold storage system is proposed by the study.

<b>Technical Viability Analysis</b>	<p><b>Type of energy required in modern technology:</b> Electricity from grid</p> <p><b>Availability and reliability of energy technology:</b> Mostly reliable but may implement a back-up facility for reliability</p> <p><b>Size and volume:</b> Varies from small to large size</p> <p><b>Enhancement of productivity:</b> Effective measures for bulk storage</p> <p><b>Ease of operation:</b> Easy</p> <p><b>Skilled human resource:</b> Training required for maintenance (not required for operation)</p> <p><b>Safety:</b> Requires safety measures</p> <p><b>Market availability and transportation:</b> Readily available in Nepali market</p>
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### 2.3.9 Electric Heater

For pasteurization, milk should be heated to 63°C for 30 minutes. However, there are different temperature ranges for heating milk in order to produce different outputs such as cheese, lollypop, dog chew (churpi) or other dairy products.

A toilet connected biogas plant of 10 m<sup>3</sup> (also using cattle dung) can produce thermal power to heat 250 litres of milk (to make dog chew, cheese, lollypop and other dairy products etc.). Similarly, 10 kWh of electrical energy is required to heat same amount of milk using electricity from Micro Hydro Project or the national grid electricity. The heating tank should be made of stainless steel having gross volume of 250 litres with heater of 4 kW.

<b>Technical Viability Analysis</b>	<p><b>Type of energy required in modern technology:</b> Electricity from Grid/solar or thermal energy from biogas</p> <p><b>Availability and reliability of energy technology:</b> If using thermal energy, then feed supply needs to be maintained; back-up or hybrid system with solar PV may be used for increasing reliability of electrical energy</p> <p><b>Efficiency of the selected modern technology:</b> Efficient and less carbon production than using fuelwood</p> <p><b>Size and volume:</b> Portable to large size</p> <p><b>Enhancement of productivity:</b> Increment in production than traditional heating methods, reduces the time</p> <p><b>Ease of operation:</b> Moderate</p> <p><b>Skilled human resource:</b> Needs to be trained for operation and maintenance</p> <p><b>Safety:</b> Requires appropriate safety measures</p> <p><b>Market availability and transportation:</b> Available in Nepali market</p>
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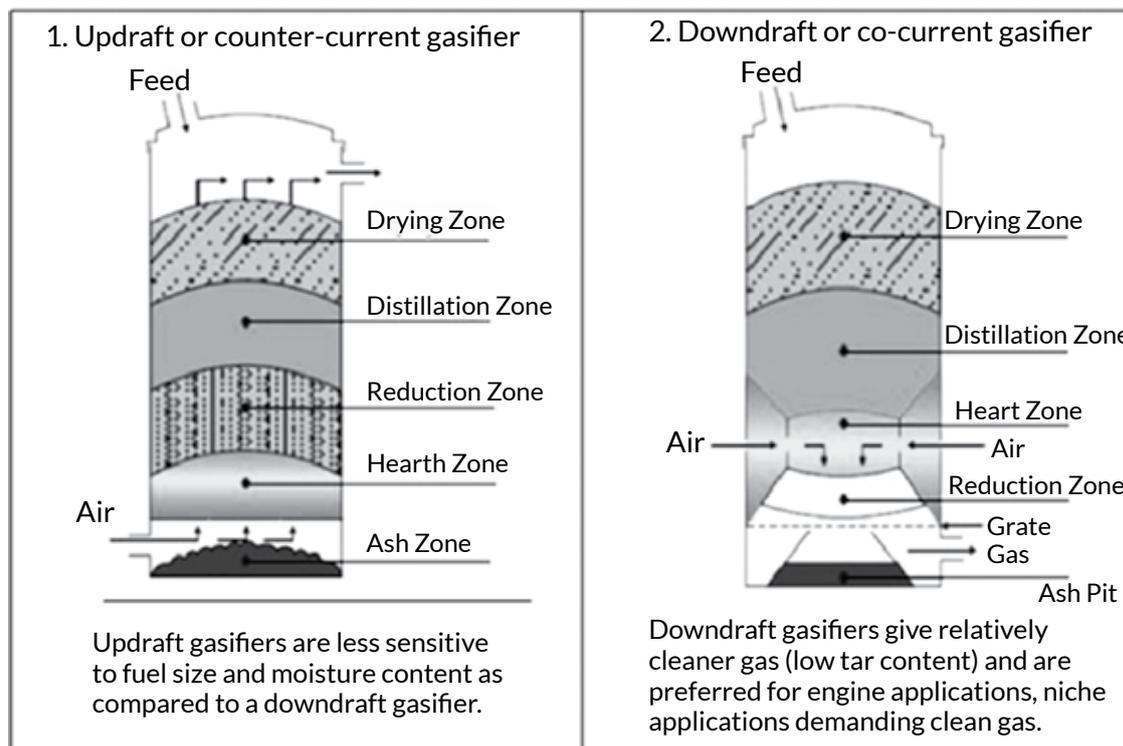
## 2.4 Orthodox Tea

The specific recommended technologies for Orthodox Tea value chain are:

### 2.4.1 Biomass Gasifier for Thermal Power in Orthodox Tea Processing

Biomass gasification is a process of converting solid biomass fuel into a gaseous combustible gas (called producer gas) through a sequence of thermo-chemical reactions. The gas is a low-heating value fuel, with a calorific value between 1000-1200 kcal/Nm<sup>3</sup> (kilo calorie per normal cubic metre). Almost 2.5-3.0 Nm<sup>3</sup> of gas can be obtained through gasification of about 1 kg of air-dried biomass.

This technology is slowly replacing both traditional biomass uses and gas-powered systems, as it provides an excellent de-centralized source of energy at an affordable cost. Apart from rural households, biomass fuels are the main source of energy to a large number of small, rural and cottage industries. The technology can be used in heat generation as well as electricity production which can be used for drying Orthodox Tea as well as use the electrical power to run the motor various Dairy appliances.



Schematic diagram

<b>Technical Viability Analysis</b>	<p><b>Type of energy required in modern technology:</b> Thermal energy using Biomass and/or farm waste</p> <p><b>Availability of energy required:</b> System can be designed for required energy output</p> <p><b>Availability and reliability of energy technology:</b> Supply of biomass or feed needs to be maintained</p> <p><b>Efficiency of the selected modern technology:</b> Highly efficient use of biomass</p> <p><b>Size and volume:</b> As required (can be designed for small or medium-scale)</p> <p><b>Ease of operation:</b> Moderate</p> <p><b>Skilled human resource:</b> Operator needs to be trained</p> <p><b>Safety:</b> Standard safety procedures need to be maintained</p> <p><b>Market availability and transportation:</b> Can be manufactured in Nepal or in India; small sizes are easier to transport</p>
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### 2.4.2 Hybrid Tea Withering

Normally withering is carried out by spreading the leaves thinly on banks of trays or “tats” made of tightly stretched jute hessian or wire-netting. The tats are kept 12 to 15 centimeters apart, to allow free access of air. There are two types of withering; open withering and closed withering. The open or “chung” type of withering accommodation admits of no control of rate of withering except by thickness of spread and the length of time of the withering phase. This is “natural withering” in its simplest form. The average time span for withering is 18 to 20 hours where “tats” are used. In modern trough withering system 16-18 hours is the duration of wither with normal ambient air. In rainy season, to remove the surface moisture, heaters are used along with fans for two hours.

Sample Technical parameters:

Capacity	Power	Weight	Size
60 kg/h	13 kW	1500 kg	5000x1250x800 mm

The required electric power can be supplied through electricity from grid/micro-hydro or by suitable solar PV system.

<b>Technical Viability Analysis</b>	<p><b>Type of energy required in modern technology:</b> Electric power from Grid/solar PV</p> <p><b>Availability of energy required:</b> Required energy can be supplied from grid</p> <p><b>Availability and reliability of energy technology:</b> Solar PV with battery backup hybrid with grid electricity makes the system reliable</p> <p><b>Size and volume:</b> Small to moderate in size</p> <p><b>Quantity of energy usage for current volume:</b> Moderate</p> <p><b>Ease of operation:</b> Easy to operate</p> <p><b>Skilled human resource:</b> Training is required</p> <p><b>Safety:</b> Will require appropriate safety measures</p> <p><b>Market availability and transportation:</b> Available in Indian and Chinese markets, will need transportation</p>
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### 3. Financial Feasibility Analysis/Business Model of Selected Technologies

Objectives of the session:

- i) Orient participants on investment costs required for each technology and explain the benefits in return
- ii) Capacitate them to carry out simple financial analysis for choosing the technology
- iii) Validate the detail financial analysis presented

Group Work Guidelines:

- The participants will work in groups or in plenary
- They will discuss on the assumptions and parameters provided for the financial viability; sample provided below.

Financial analysis details:

The financial analysis of the selected technologies is a key tool to adopt the technologies into their work and businesses by the entrepreneurs. The financial analysis should provide a clear understanding of replacement costs, increased productivity and hence, revenue due to the replacement and other associated costs and benefits. Sample financial analysis of the selected technologies along with their assumptions is given below.

## 3.1 Ginger

### 3.1.1 Solar Powered Ginger Dryer

<p><b>Financial feasibility analysis:</b></p>	<p>Capacity of the system: 250 kg of Ginger drying in 3 days cycle.</p> <p>Operating Life: 10 years</p> <p>Although the system can be in operation whole year, it is assumed that the system will be in operation for 4 months (2 months each during 2 crop cycles of Ginger where a crop cycle is generally a month long).</p> <p>Investment streams:</p> <p>Total installation cost of the plant is of NPR 100,000.</p> <p>Operating cost of the plant is NPR 12,000 which includes cost of human resource. The maintenance cost is NPR 5,000 per year.</p> <p>Income streams:</p> <p>The income stream includes the incremental income of the dried Ginger. Although the supply of dried Ginger is not undertaken at commercial scale at the moment, citing to the trend in Indian market and consultation in field an incremental income of NPR 5 per kg of dried Ginger is assumed in the calculation. As the system will generate 10,000 kg of dried Ginger per year contributing to the yearly income of NPR 50,000.</p> <p>Assumptions:</p> <ul style="list-style-type: none"> <li>• The system will operate only 4 months, 2 months each during Ginger crop cycle. (2 crop cycles a year of Ginger)</li> </ul> <p>The detailed financial analysis is attached in the financial worksheet.</p>
<p><b>Profitability:</b></p>	<p>IRR: 2%</p> <p>NPV: 28,000</p> <p>Breakeven Point: 5 years</p>
<p><b>Recommendation:</b></p>	<p>The plant is suitable in small enterprise and farmer level.</p>
<p><b>Limitations:</b></p>	<p>There is possibility of decay and loss of Ginger in the event of prolonged rain and less availability of solar radiation.</p>

### 3.1.2 Automated Ginger Washer

<p><b>Financial feasibility analysis:</b></p>	<p>Capacity of the system: 500 kg per hour.          Operating Life: 15 years          Although the system can be in operation whole year, it is assumed that the system will be in operation for 2 months only during the 2 crop cycles of Ginger where a crop cycle is generally a month long.          Energy consumption: 18 kWh per day (3 kW system operating 6 hours per day)          Investment streams:          Total installation cost of the plant is of NPR 1.5 Million.          Operating cost of the plant is NPR 168,000 which includes cost of human resource and electricity cost. The maintenance cost is NPR 40,000 per year.          Income streams:          The income stream includes the incremental income of the washed Ginger. The incremental income will be NPR 5 per kg washed Ginger (field consultation). The system can process 180 tonnes of Ginger per year contributing to the yearly income of NPR 900,000.          Assumptions:</p> <ul style="list-style-type: none"> <li>• The system will operate only 2 months during 2 crop cycles of Ginger production.</li> <li>• The system will operate 6 hours a day.</li> <li>• The operation of system will require an operator (at NPR 1,000 per day) and 3 labors (at NPR 500 per day).</li> </ul> <p>The detailed financial analysis is attached in the financial worksheet.</p>
<p><b>Profitability:</b></p>	<p>IRR: 33%          NPV: 25 Million          Breakeven Point: 3 years</p>
<p><b>Recommendation:</b></p>	<p>As the average production of Ginger in intervening area is around 13 tonnes per hectare per year, to feed the system with 180 tonnes of Ginger (requires Ginger from 14-hectare area), the system is more suitable at medium enterprise level.</p>
<p><b>Limitations:</b></p>	<ul style="list-style-type: none"> <li>• This is only a seasonal operation.</li> <li>• Maintenance of the plant needs to be a regular practice.</li> </ul>

## 3.2 Large Cardamom

### 3.2.1 Improved Cardamom Dryer

<p><b>Financial feasibility analysis:</b></p>	<p>Capacity of the system: 1500 kg per week (current operation is 1000 kg per week due to lack of inputs, the financial analysis is carried based on what capacity will make the system breakeven).</p> <p>Operating Life: 6 years</p> <p>Although the system can be in operation whole year, at the moment is in application for a week operation in an entire year.</p> <p>Investment streams:</p> <p>Total installation cost of the plant is of NPR 35,000.</p> <p>Operating cost of the plant is NPR 2,100 which includes cost of human resource. At the end of third year operation the base grate should be replaced which cost around NPR 3,000.</p> <p>Income streams:</p> <p>The income stream includes the saving of the fuelwood than the traditional method of drying. The system saves 2 kg of fuelwood per kg of cardamom than the conventional method. Thus, 3,000 kg of fuelwood will be saved contributing to the yearly income of NPR 15,000.</p> <p>Assumptions:</p> <ul style="list-style-type: none"> <li>• The annual operational days are one week.</li> <li>• The fuelwood cost is NPR 5 per kg.</li> <li>• The system requires 1 kg of fuelwood to dry 1 kg of cardamom compared to 3 kg of fuelwood for traditional method. (as per consultation with supplier)</li> </ul> <p>The detailed financial analysis is attached in the financial worksheet.</p>
<p><b>Profitability:</b></p>	<p>IRR: 11%</p> <p>NPV: 15,000 Million</p> <p>Breakeven Point: 3 years</p>
<p><b>Recommendation:</b></p>	<p>The dryer can be used for drying multiple crop harvest. The capital investment in the dryer will make economic sense if it is used for drying multiple crop harvest.</p>
<p><b>Limitations:</b></p>	<p>Initial cost is high for small holding farmers.</p>

### 3.3 Dairy

#### 3.3.1 Cream Separator

<p><b>Financial feasibility analysis:</b></p>	<p>Capacity of the plant: 3,000 litres of milk processing per day (500 litres per hour with 6 hours of operation)</p> <p>Energy consumption: The total energy 0.4 kW will be supplied by solar system of 1.2 kWp.</p> <p>Operating Life: 10 years</p> <p>Investment streams:</p> <p>Total installation cost of the system is of NPR 415,000, machine cost is NPR 55,000 and NPR 360,000 for 1.2 kWp solar PV system (solar system with batteries is provided with average per kWp of solar system being NPR 300,000).</p> <p>Annual operating cost of the system is NPR 50,000 which includes cost of human resource (system manned by single operator at NPR 5,000 per month). The annual maintenance cost of the plant is NPR 20,000; which includes solar plant and machine maintenance after 3 years of operation.</p> <p>Income streams:</p> <p>The plant will generate income primarily from production of cream which is used in ghee/butter production. The current (average) market price of ghee (may vary according to type of feeds) is NPR 750 per kg. We assumed around 5% increment due to enhance in quality of the production by the system i.e. NPR 37 per kg of cream of incremental rate. The total gross income from system is NPR 280,000 (from 7,500 kg of cream from 1% fat content 750,000 litres of milk the system is capable of processing).</p> <p>Assumptions:</p> <ul style="list-style-type: none"> <li>• The annual operational days are of 250.</li> <li>• The fat content in the milk is 1%.</li> </ul>
<p><b>Profitability:</b></p>	<p>IRR: 31%</p> <p>NPV: 500,000</p> <p>Breakeven Point: 3 years</p>
<p><b>Recommendation:</b></p>	<p>The system can be recommended for medium and large-scale operations and commercially viable.</p>
<p><b>Limitations:</b></p>	<p>Initial training for operators is necessary.</p>

### 3.3.2 Biogas Plant for Thermal and Electrical Power Generation

<b>Financial feasibility analysis:</b>	<p>Capacity of the system: 50 m<sup>3</sup></p> <p>Operating Life: 15 years</p> <p>The plant will require 250 kg dung per day, which can produce 10 m<sup>3</sup> purified biogas and 3 kW of electricity per day. This plant capacity can be achieved with 10-15 numbers of cattle (Reference: Biogas Plant in Chitwan, implemented by Practical Action, 2016).</p> <p>Investment streams:</p> <p>Total installation cost of the plant is of NPR 1.5 Million, which covers cost of civil works, generator, equipment etc.</p> <p>Operating cost of the plant is NPR 300,000, which includes cost of feedstocks and human resource. The annual maintenance cost of the plant is NPR 10,000.</p> <p>Income streams:</p> <p>There are two plausible income streams, viz., (i). Income from energy saving (such as thermal heat generation with conventional methods like fuelwood) and (ii). Bio-fertilizer production and sales.</p> <p>The anticipated annual income from energy saving is of NPR 750,000 and the income from bio-fertilizer is of NPR 250,000.</p> <p>Assumptions:</p> <ul style="list-style-type: none"><li>• The annual operational days are of 240. The anticipated electrical generation is of 3,600 kWh per year (assuming 5 hours of generation per day, amounting to 36,000, at NPR 10/Unit).</li><li>• The energy saving from conventional source of energy (fuel wood) is of NPR 1,000 per day, amounting to NPR 24,000 (assuming 200 kg fuelwood per day at NPR 5 per kg of fuelwood).</li><li>• It is assumed that the price of bio fertilizer is NPR 15 per kg and can generate 200 kg per day amounting to NPR 720,000 per year.</li><li>• It is assumed that feedstock required for the plant operation is 1,000 kg per year amounting to NPR 120,000 per year at NPR 500 per kg.</li><li>• The plant will be manned by 3 operators, incurring an expenditure of NPR 180,000 per year at NPR 5000 operational cost per month.</li></ul> <p>The detailed analysis is provided in the financial worksheet.</p>
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<b>Profitability:</b>	IRR: 28% NPV: 2.5 Million Breakeven Point: 4 years
<b>Recommendation:</b>	The plant is suitable for medium scale operations of below 5 kW, however, there is scope to increase it up to 10-15 kW based on availability of feedstock. The plant can be used for multiple usages in accordance to the demands of the dairy unit.
<b>Limitations:</b>	<ul style="list-style-type: none"> <li>• Continuous supply of feedstocks shall be ensured.</li> <li>• Maintenance of the plant needs to be a regular practice.</li> </ul>

### 3.3.3 Milk Chilling Vat

<b>Financial feasibility analysis:</b>	<p>Capacity of the system: 500 litres per day Energy consumption: 72 kWh per day Operating Life: 15 years Investment streams: Total installation cost of the plant is of NPR 450,000, which covers cost of generator, equipment etc. Annual operating cost of the plant is NPR 160,000 which includes cost of electricity supply and human resource. The annual maintenance cost of the plant is NPR 22,500. Income streams: The milk chilling system will enhance the self-life of milk by 24 to 48 hours, which will provide an incremental income of NPR 3 per litre (Ref: field consultation). That means, the annual income from the Milk chilling system will be of NPR 375,000. Assumptions:</p> <ul style="list-style-type: none"> <li>• The annual operational days are of 250.</li> <li>• The plant will be manned by 2 operators, incurring an expenditure of NPR 100,000 per year.</li> </ul>
<b>Profitability:</b>	IRR: 24% NPV: 580,000 Breakeven Point: 4 years
<b>Recommendation:</b>	The plant is suitable for medium scale operations which may benefit up to 20 dairy farmers.
<b>Limitations:</b>	<ul style="list-style-type: none"> <li>• Continuous supply of electricity shall be ensured.</li> <li>• Maintenance of the plant needs to be a regular practice.</li> </ul>

### 3.3.4 Automated Milking Machine

<p><b>Financial feasibility analysis:</b></p>	<p>Capacity of the system: 100 litres per day (assuming the maximum capacity- 10 liter per cattle in a cattle farm comprising 10 cattle).</p> <p>Energy consumption: 0.4 kWh per day</p> <p>Operating Life: 10 years</p> <p>Investment streams:</p> <p>Total installation cost of the system is of NPR 100,000.</p> <p>Annual operating cost of the system is NPR 72,000 which includes cost of electricity supply and human resource. The annual maintenance cost of the plant is NPR 10,000, which includes liner replacement every year.</p> <p>Income streams:</p> <p>The system will enhance efficiency of milking by 1 litre per cattle. This efficiency will produce 10 litres of milk per day from a dairy farm (comprising 10 cattle).</p> <p>The anticipated income from the dairy farm will be of NPR 126,000.</p> <p>Assumptions:</p> <ul style="list-style-type: none"> <li>• The annual operational days are of 300.</li> <li>• The plant will be manned by 1 operator, incurring an expenditure of NPR 60,000 per year.</li> <li>• The unprocessed milk selling rate at the farm level is NPR 42 per litre (Ref: field consultation).</li> <li>• The electricity charges are NPR 10 per unit.</li> </ul>
<p><b>Profitability:</b></p>	<p>IRR: 32%</p> <p>NPV: 305,000</p> <p>Breakeven Point: 4 years</p>
<p><b>Recommendation:</b></p>	<p>The machine is suitable for medium scale farm with minimum 10 cattle.</p>
<p><b>Limitations:</b></p>	<ul style="list-style-type: none"> <li>• Initial training for operators is necessary.</li> <li>• Periodical calibration of machine is important.</li> </ul>

### 3.3.5 Refrigeration for Sexing Technology and Vaccines

<p><b>Financial feasibility analysis:</b></p>	<p>Capacity of the system: 10 litres            Energy consumption: Solar PV system of 0.3 kWp.            Operating Life: 15 years            Investment streams:            Total installation cost of the solar PV system is of NPR 80,000,            Cost of the cooling machine (Deep fridge - NPR 15,000)            Annual operating cost of the system is NPR 36,000 which includes cost of human resource.            The annual maintenance cost for machine and solar PV system is NPR 5,000.            Income streams:            The income of the system is through selling vaccines and other medicines.            Assumptions:</p> <ul style="list-style-type: none"> <li>○ The annual operational days are of 300.</li> <li>○ Two operators at NPR 500 per day are required for operation.</li> <li>○ Current price of one AI is at NPR 2000 per cattle and can store in the solar powered fridge of 10 litres up to 50 straws of AI semen to be in breakeven</li> </ul>
<p><b>Profitability:</b></p>	<p>IRR: 30%            NPV: 158,000            Breakeven Point: 2 years</p>
<p><b>Recommendation:</b></p>	<p>The technology is recommended at the rural context.</p>
<p><b>Limitations:</b></p>	<ul style="list-style-type: none"> <li>• The initial cost of solar PV is very high in the current context of Nepal.</li> <li>• Maintaining -100 degree Celsius for Semen might be a technical issue.</li> </ul>

### 3.3.6 Feed Processing Units

<p><b>Financial feasibility analysis:</b></p>	<p>Capacity of the plant: 10 tonnes/day</p> <p>Energy consumption: The total energy requirement is 45 kW; out of which, grid electricity will contribute 35 kW and 10 kW will be supplied by solar system.</p> <p>Operating Life: 20 Years</p> <p>Investment streams:</p> <p>Total installation cost of the system is of NPR 22 Million civil cost is NPR 7 million for the plant. The estimated investment for procuring machineries for feed processing is of NPR 6 million. The investment required for the solar system is NPR 9 Million (for 10 kW capacity a 30 kWp solar system with batteries is provided with average per kWp of solar system being NPR 300,000).</p> <p>Annual operating cost of the system is NPR 1 million which includes cost of electricity supply and human resource. The annual maintenance cost of the plant is NPR 120,000, which includes solar plant and machine maintenance.</p> <p>Income streams:</p> <p>The plant will generate income primarily from animal feeds. The current (average) market price of animal feed (may vary according to type of feeds) NPR 32 per kg. The total gross income from animal feed is NPR 12.8 Million.</p> <p>Assumptions:</p> <ul style="list-style-type: none"> <li>• The annual operational days are of 240.</li> <li>• The plant will be manned by 10 human resource (2 operators and 8 labors), incurring an expenditure of NPR 480,000 per year.</li> <li>• The electricity charges are NPR 10 per unit.</li> <li>• The solar PV is considered as a back-up of power and not a substitute or alternative to grid.</li> </ul>
<p><b>Profitability:</b></p>	<p>IRR: 36%</p> <p>NPV: 57 Million</p> <p>Breakeven Point: 3 years</p>
<p><b>Recommendation:</b></p>	<p>This business proposition is for medium and large-scale operations and commercially viable.</p>
<p><b>Limitations:</b></p>	<p>Initial training for operators is necessary.</p>

### 3.3.7 Efficient Stoves for Cheese and Churpi Making

<p><b>Financial feasibility analysis:</b></p>	<p>Capacity of the system: The system can process 300 litres of milk per day.</p> <p>Energy consumption: The total energy requirement is 150 kg of fuelwood per day (assuming 1 kg of fuelwood is required to heat 2 litres of milk for cheese making)</p> <p><b>Operating Life: 5 years</b></p> <p>Investment streams:</p> <p>Total installation cost of the system is of NPR 100,000.</p> <p>The annual maintenance cost of the plant is NPR 5000.</p> <p>Income streams:</p> <p>The system is 35% more efficient than traditional cook stoves resulting into savings of 10,500 kg of fuelwood per year resulting to savings of NPR 53,000 in a year.</p> <p>Assumptions:</p> <ul style="list-style-type: none"> <li>• The annual operational days are of 200.</li> <li>• The cost of fuelwood is NPR 5 per Kg</li> <li>• 1 kg of fuelwood can heat around 2 litres of milk to produce cheese (as per field consultation)</li> </ul>
<p><b>Profitability:</b></p>	<p>IRR: 10%</p> <p>NPV: 33,000</p> <p>Breakeven Point: 3 years</p>
<p><b>Recommendation:</b></p>	<p>The intervention is not commercially viable without additional support from government subsidy or donor. However, the improved stove will enhance efficiency of plant and dairy farmers can consider this technological option.</p>
<p><b>Limitations:</b></p>	<p>Micro-scale technology and life time of stoves are less than 5 years.</p>

### 3.3.8 Cold Storage

<p><b>Financial feasibility analysis:</b></p>	<p>Capacity of the plant: 1000 Cubic Meter, storing around 120 tonnes in two cycles of 6 months each.</p> <p>Energy consumption: The total energy requirement is 60 kW; out of which, grid electricity will contribute 50 kW and 10 kW will be supplied by solar system.</p> <p>Operating Life: 25 years</p> <p>Investment streams:</p> <p>Total installation cost of the system is of NPR 3.75 Million (excluding the civil cost). The investment required for the solar system is NPR 9 Million (for 10 kW capacity, a 30 kWp solar system with batteries is provided with average per kWp of solar system being NPR 300,000). Annual operating cost of the system is NPR 4 million which includes cost of electricity supply and human resource. The annual maintenance cost of the plant is NPR 20,000, which includes solar plant and machine maintenance.</p> <p>Income streams:</p> <p>The plant will generate income (i) the rental charge: NPR 100,000 at NPR 500 per quintal, (ii) Opportunity cost of storing: Current (average) market price of animal feed (may vary according to type of feeds) NPR 32 per kg. The total gross income from animal feed is NPR 12.8 Million.</p> <p>Assumptions:</p> <ul style="list-style-type: none"> <li>• The annual operational days are of 240.</li> <li>• The plant will be manned by 10 human resource (2 operators and 8 labours), incurring an expenditure of NPR 480,000 per year.</li> <li>• The electricity charges are NPR 10 per unit.</li> <li>• The solar PV is considered as a back-up of power and not a substitute or alternative to grid.</li> </ul>
<p><b>Profitability:</b></p>	<p>IRR: 28%</p> <p>NPV: 31 Million</p> <p>Breakeven Point: 4 years</p>
<p><b>Recommendation:</b></p>	<p>This business proposition is for large-scale operations and commercially viable.</p>
<p><b>Limitations:</b></p>	<ul style="list-style-type: none"> <li>• Initial training for operators is necessary.</li> <li>• This is a capital investment venture.</li> </ul>

### 3.3.9 Electric Heater

<p><b>Financial feasibility analysis:</b></p>	<p>Capacity of the system: The system can process 500 litres of milk per day.</p> <p>Energy consumption: The total energy requirement is 4 kW.</p> <p>Operating Life: 5 years</p> <p>Investment streams:</p> <p>Total installation cost of the system is of NPR 135,000.</p> <p>Annual operating cost of the system is NPR 32,000 which includes cost of electricity supply and human resource. The annual maintenance cost of the plant is NPR 7000.</p> <p>Income streams:</p> <p>The system will replace consumption of 50,000 kg of fuelwood per year resulting to a net income of NPR 200,000 per year.</p> <p>Assumptions:</p> <ul style="list-style-type: none"> <li>• The annual operational days are of 200.</li> <li>• The cost of fuelwood is NPR 5 per kg</li> <li>• 1 kg of fuelwood can heat around 2 litres of milk to produce cheese (as per field consultation)</li> <li>• The electricity per unit tariff is NPR 10.</li> </ul>
<p><b>Profitability:</b></p>	<p>IRR: 77%</p> <p>NPV: 390,000</p> <p>Breakeven Point: 2 years</p>
<p><b>Recommendation:</b></p>	<p>The intervention is not commercially viable without additional support from government subsidy or donor. However, the improved stove will enhance efficiency of plant and dairy farmers can consider this technological option.</p>
<p><b>Limitations:</b></p>	<p>Micro-scale technology and life time of stoves are less than 5 years.</p>

### 3.4 Orthodox Tea

#### 3.4.1 Biomass Gasifier for Thermal Power in Orthodox Tea Processing

<b>Financial feasibility analysis:</b>	<p>Capacity of the system: 3000 kg per day Operating Life: 20 years Investment streams: Total installation cost of the plant is of NPR 3.5 Million, which covers cost of civil works, generator, equipment etc. Operating cost of the plant is NPR 180,000, which includes cost of human resource. The annual maintenance cost of the plant is NPR 90,000. Income streams: The income of the system will be savings made from replacing diesel to fuelwood. A similar system will require 250 litres of diesel which will be replaced by system utilizing 3,000 kg fuelwood. The anticipated annual income from energy saving is of NPR 1.35 Million. Assumptions:</p> <ul style="list-style-type: none"><li>• The annual operational days are of 300.</li><li>• The 100 ml diesel is utilized to produce 1 kg of tea.</li><li>• Around 1.5 kg of fuelwood to produce 1kg of tea.</li></ul>
<b>Profitability:</b>	<p>IRR: 22% NPV: 3.5 Million Breakeven Point: 5 years</p>
<b>Recommendation:</b>	<p>The intervention is not commercially viable without additional support from government subsidy or donor. The technology is recommended to the tea farmers at medium and large scale.</p>
<b>Limitations:</b>	<p>The initial investment cost is high.</p>

### 3.4.2 Hybrid Tea Withering

<p><b>Financial feasibility analysis:</b></p>	<p>Capacity of the system: 60 kg per hour.</p> <p>Energy consumption: The total energy requirement is 13 kW supplied by Solar PV system of 40 kWp.</p> <p>Operating Life: 20 years</p> <p>Investment streams:</p> <p>Total installation cost of the system is of NPR 13.5 Million, 1.5 million for the machine and the investment required for solar PV system is NPR 12 Million (for 13 kW capacity, a 40 kWp solar system with batteries is provided with average per kWp of solar system being NPR 300,000).</p> <p>Annual operating cost of the system is NPR 200,000 which includes cost of human resource.</p> <p>The annual maintenance cost for machine and solar PV system is NPR 75,000.</p> <p>Income streams:</p> <p>The income of the system is through contribution in production of Orthodox Tea. The system will contribute to produce 72 tonnes of Orthodox Tea per year at 200 days operation with 6 hours of withering, the incremental income being NPR 80 per kg resulting to a net income of NPR 785,000 per year.</p> <p>Assumptions:</p> <ul style="list-style-type: none"> <li>• The annual operational days are of 200.</li> <li>• Two operators at NPR 500 per day are required for operation.</li> <li>• Current selling price of orthodox tea is around NPR 640 per kg, a general orthodox tea processing includes 8 steps (Tea leaf acquisition, steaming, withering, rolling, drying, storage, packaging and marketing/transportation). We have assumed each step to have equal contribution in the final product. Hence, NPR 80 per kg is incremental rate for each process.</li> </ul>
<p><b>Profitability:</b></p>	<p>IRR: 77%</p> <p>NPV: 390,000</p> <p>Breakeven Point: 2 years</p>
<p><b>Recommendation:</b></p>	<p>The intervention is not commercially viable without additional support from government subsidy or donor as the initial cost of solar PV installation is high.</p>
<p><b>Limitations:</b></p>	<p>The initial cost of solar PV is very high in the current context of Nepal.</p>

## 4. How to Secure Financing?

Objective of the session:

- i) Inform the participants about Financial Institutions and their available financial (loan) products
- ii) Reflect on the loan repayment capacity and schedule required
- iii) Discuss about available support from government and other organisations

Session Guidelines:

- The trainers should provide a list of interested local/regional/national FIs as well as their relevant financial products (if available)
- Facilitate Q/A sessions from the participants

Relevant information:

UNNATI-A2F partner banks:

- Prabhu Bank
- NMB Microfinance
- Chhimek Microfinance
- Sahara Saving and Credit Cooperative
- Jeewan Bikas Samaj
- Everest Bank
- Laxmi Bank
- Siddhartha Bank
- Nerude Microfinance
- Forward Microfinance
- NMB Bank
- Nirdhan Utthan Microfinance
- Sana Kishan Development Bank

The recent available financial (loan) products and relevant details from the above Financial Institutions need to be collected and shared to the participants.

## 5. Success Stories from Guest Speakers

Objectives of the session:

- i) Experiences of entrepreneurs/farmers who have adopted modern energy powered technologies are shared.
- ii) Success factors, benefits, worries and concerns of entrepreneurs/farmers are shared.

Session guidelines:

- Present guest speakers to share their experiences and stories on adoption of modern energy powered technologies.
- Facilitate Q/A session.

## 6. Next Steps and Evaluation

Objectives of the session:

- i) Prepare action plans of the participants for engagement post the event.
- ii) Carry out evaluation of the training.

Session guidelines:

- Request each participant to make individual assessments on the proposed technologies and propose next actions/develop their activity plan for adopting the technology.
- Agree on the next steps between the organizers and the participants.
- Request participants to fill up a training evaluation form for suggesting improvements to the training content and delivery.

## SECTION IV: MOVING FORWARD

After the training program, participants and trainers will agree for a follow-up meeting date or action to share progress made.

## SECTION V: REFERENCES

The primary reference documents for carrying out the trainings/orientation programme are documents submitted by Practical Action Consulting to UNCDF during the course of the assignment, which are:

SN	Document	Reference organization
1	Desk Study Report on “Study on opportunities of installing modern energy powered technologies in the selected agriculture value chains and their financing opportunities”	Practical Action Consulting
2	Field Visit Report	Practical Action Consulting
3	Financial Analysis Report	Practical Action Consulting
4	Final Report on “Study on opportunities of installing modern energy powered technologies in the selected agriculture value chains and their financing opportunities”	Practical Action Consulting

For further reading and information clarification, following documents may also be referred to:

SN	Document	Reference organization
1	PMSD Roadmap	Practical Action
2	Value Chain Study: Market Linkages and Value Addition	UNNATI Inclusive Growth Programme
3	A Simple Solar Dryer in Nepal	Practical Action
4	Multiuse Solar Pump of 10,000 ltr Capacity per hour	Practical Action
5	Adoption of Technologies for Sustainable Farming Systems	Wageningen University
6	Business Models for Scaling Up Energy Access	International Finance Corporation

SN	Document	Reference organization
7	Opportunities for Agri-Food Chains To become Energy-Smart	Food And Agriculture Organization (FAO)
8	Powering Agri food Value Chains	REEP
9	Small scale Solar Milk Cooler	Hoheheim University
10	Biomass Gasifier for Thermal and Power Applications	TERI
11	Butter Churner/ Cream Separator	Mahesh Engineering works
12	Ginger Washing Machine	DEEPAK ENGINEERS
13	Potable Milking Machine	Sajware
14	Solar powered Milk Chiller	Future Entech
15	Tea Withering Machine	Quzhou Surri
16	Agriculture Value Chain Financing: Reference manual for ToT for BFIs	Practical Action Consulting
17	The Value Chain Approach	<a href="http://pdf.usaid.gov/pdf_docs/pnaeb536.pdf">http://pdf.usaid.gov/pdf_docs/pnaeb536.pdf</a>

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