

**OPPORTUNITIES FOR REDUCING POST-HARVEST LOSSES OF CACTUS PEAR  
(OPUNTIA FICUS-INDICA) TO SMALL-HOLDER FARMERS IN EASTERN TIGRAY,  
NORTHERN ETHIOPIA**



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September 2018

Velp

The Netherlands

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# **OPPORTUNITIES FOR REDUCING POST-HARVEST LOSSES OF CACTUS PEAR (OPUNTIA FICUS-INDICA) TO SMALL-HOLDER FARMERS IN EASTERN TIGRAY, NORTHERN ETHIOPIA**

Research Report Submitted to Van Hall Larenstein University of Applied Sciences in partial fulfilment of the requirements for the Master's Degree in Agricultural Production Chain Management: Horticulture Chains

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By

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## **Acknowledgement**

First of all, the son of St. Mary should be acknowledged for enabled me to complete this master's course.

My second appreciation goes to the Netherland fellowship program scholarship offer from the Dutch government. It would not have been possible to attend this amazing master's program without their funding. I also would like to express my heartfelt gratitude to the Dutch host institute, Van Hall Larenstein University of applied science for giving me the opportunity to study this master's program.

My genuine gratitude goes to my supervisor Prof. Euridice L. Abarca for all her patience, motivation, immense knowledge and continuous support during the research work. Her guidance helped me in all the times of research starting from proposal to final research write-up. I could not have imagined finishing this work without having a better advisor and mentor like her.

My sincere appreciation also goes to the specialization Coordinator Ms Albertien Keijen for her continues encouragement and mentoring throughout the study program. I will not forget her lifetime advises improving my competency.

I would like to thank the director of Cactus Pear Institute Director of Adigrat University, Mr Yemane Kaesay for helping me in finding essential key-informants and assistance in data collection from processing units.

My heartfelt thanks goes to Mr Berhane Hailu from HELVETAS for supporting me to get documents about the value chain of cactus pear it's loss in Eastern Tigray. He was really ultimately positive guy.

Last but not the least, my special thanks go to my husband Mr Gabriel Temesgen for his constant inspiration and support during this thesis work and life in general. I could not be able to study here without having an incredible and helpful person like him.

**Dedication**

This paper is dedicated to my husband, Gabriel Temesgen, who has been a constant source of support and inspiration during the challenges of life. I am truly grateful for having you in my life.

## Table of Contents

Acknowledgement .....	i
Dedication .....	iv
List of Tables .....	viii
List of Figures .....	ix
Acronyms .....	x
Abstract .....	xi
1.INTRODUCTION .....	1
1.1. Background .....	1
1.2. Problem Statement .....	1
1.3. Objective .....	3
1.4. Research Questions .....	3
1.5. Scope of the Study .....	3
2. LITERATURE REVIEW .....	4
2.1. Theoretical Literature .....	4
2.1.1. Value Chain .....	4
2.1.2. Value Chain Analysis .....	4
2.1.3. Sustainable Value Chain .....	4
2.1.4. Small-holder Producers .....	5
2.1.5. Post-Harvest Losses .....	5
2.1.6. Quantitative and Qualitative losses .....	5
2.1.7. Post-Harvest Chain .....	5
2.1.8. Post-Harvest Management .....	5
2.1.9. Post-Harvest management strategies .....	6
2.2. Empirical Literature .....	6
2.2.1. Agricultural Production and Challenges in Ethiopia .....	6
2.2.2. Challenges of Horticulture production in Ethiopia .....	6
2.2.3. Cactus Pear Production in Tigray .....	6
2.2.4. Factors Affecting Post Harvest losses of cactus pear in Tigray .....	7
2.3. Conceptual Framework .....	9
3. RESEARCH METHODOLOGY .....	10
3.1. Area Description .....	10
3.2. Research Design .....	11

3.3. Sampling Techniques .....	11
3.3. Method of Data Collection.....	12
3.3.1. Secondary Data Collection .....	12
3.3.2. Primary Data Collection .....	12
3.4. Method of Data Analysis.....	13
4.RESULT AND ANALYSIS.....	16
4.1. VALUE CHAIN OF CACTUS PEAR IN EASTERN TIGRAY .....	16
4.2. DESCRIPTION OF STAKEHOLDERS AND THEIR ROLE IN THE CHAIN .....	18
4.2.1 Input Suppliers .....	18
4.2.2. Smallholder Farmers/Producers .....	18
4.2.3. Middleman/Collectors .....	23
4.2.4. Processor (Agame Beles).....	24
4.2.5. Wholesalers.....	24
4.2.6. Retailers .....	25
4.2.7. Consumers .....	26
4.2.8. Supporters.....	26
4.2. Information and Product Flow in the Cactus Pear Value Chain.....	27
4.2.1. Product Flow .....	27
4.2.1. Information Flow.....	27
4.3. Profit and Value Share of the Chain Actor .....	27
4.4.1. The volume of Post-harvest loss at Producer Level.....	30
4.4.2. The effect of Post-harvest Losses on Smallholder Farmers Income .....	30
4.4.3. Existing Post-Harvest Handling Practices of Farmers .....	31
4.5. Internal and External Factor Analysis .....	42
4.5.1. Stakeholder Analysis .....	42
4.5.2. SWOT ANALYSIS .....	43
5.DISCUSSIONS.....	44
5.1. Factors Affecting the Cactus Pear Post-Harvest Losses .....	44
5.1.1. Pre-harvest Factors .....	44
5.1.2. Post-harvest Factors .....	44
5.1.3. Market Constraints .....	46
.....	47
5.2. Existing Strategies Implemented to Reduce Post Harvest Losses .....	47

5.3. Suggestions to Improve the Current Post-Harvest handling practices.....	47
5.4. Sustainability Issues in the Cactus Pear Value Chain .....	47
6. CONCLUSION.....	49
7. RECOMMENDATIONS.....	50
REFERENCES.....	52
ANNEXES .....	55
Annexe 1: Independent Sample test between household type and total losses .....	55
Annexe 2: Correlation between Age and Loss .....	55
Annexe 3: ANOVA result for Education Level and Total Post-harvest Loss .....	55
Annexe 4: Correlation between total loss and family size.....	56
Annexe 5: Correlation between total loss and years of experience on cactus production.....	56
Annexe 6: Correlation between cactus land and loss.....	56
Annexe 7: Independent Sample test for comparing production Between the Two PA .....	57
Annexe 8: Correlation between profit and Total Loss .....	57
Annexe 9: independent sample test for total loss across time of harvest .....	57
Annexe 10: Independent Samples test for comparing the mean value between harvesting tools across Loss .....	58
Annexe 11: Key Informant Interview with Agriculture office and Cactus Pear Institute.....	59
Annexe 12: Field Survey and Interviews with Chain Actors.....	60
Annex 13: Pictures of Focus Group Discussion with Participatory Method .....	61
Annex 14: Questionnaire .....	62
Annex 15: Interview and FGD Checklist.....	65
Annexe 16: List of key Informants and Actors .....	66

## List of Tables

Table 1: Cactus production, wastage and consumption in Tigray .....	8
Table 2: Summary of research strategies .....	14
Table 3: Cross tabulation between the PA and household type .....	18
Table 4: Descriptive statistics for Age of the respondents .....	19
Table 5: Descriptive Statistics for Family Size .....	20
Table 6: Descriptive statistics showing total land holding .....	21
Table 7: Descriptive Statistics for Production Per Season .....	22
Table 8: Gross Margin and Value Share of Cactus Pear Value Chain in Eastern Tigray .....	29
Table 9: Descriptive Statistics showing a profit .....	30
Table 10: Crosstab Between the specific time of harvest and time .....	31
Table 11: Crosstabulation between harvesting loss and causes .....	35
Table 12: Crosstabulation between sorting and sorting criteria .....	36
Table 13: Frequency table for losses during sorting and packaging .....	37
Table 14: Cross tabulation for transportation and ways of transportation .....	38
Table 15: Frequency table for losses during transportation .....	38
Table 16: Descriptive Statistics Showing Amount of Sell from Total Production .....	39
Table 17: Descriptive Statistics Showing Market Price .....	40
Table 18: Frequency table showing availability of loss on selling .....	41
Table 19: Stakeholders Matrix for Cactus Pear Value Chain in Eastern Tigray .....	42
Table 20: SWOT Analysis for Internal and External Factor Analysis of the Cactus Pear Value Chain .....	43
Table 21: Impact of the new chain in reducing post-harvest losses in theory of change format .....	51
Table 22: Independent sample test between household type and total losses .....	55
Table 23: Correlation between Age and Loss .....	55
Table 24: ANOVA result for education level and total post-harvest Loss .....	55
Table 25 : correlations between total loss and family size .....	56
Table 26: Correlation between total loss and years of experience on cactus production .....	56
Table 27: Correlation between cactus land and loss .....	56
Table 28: Independent Sample test for comparing production Between the Two PA .....	57
Table 29: Correlation between profit and total Loss .....	57
Table 30: independent sample test for total loss across time of harvest .....	57
Table 31: Independent Samples test for comparing the mean value between harvesting tools across Loss .....	58
Table 32: production and marketing cost .....	62
Table 33: List of the Key informant and chain actor's interviewee .....	66



## List of Figures

Figure 1: Problem tree to Visualize the Problem.....	2
Figure 2: Factors involved in the management of value chain .....	4
Figure 3: Conceptual Framework.....	9
Figure 4: Map of Ethiopia showing the location of Tigray, Eastern Tigray and Ganta Afeshum District.....	10
Figure 5: Research Design .....	11
Figure 6: Error Bar showing the mean comparison of the two PA .....	19
Figure 7: Pie Chart Showing education level .....	19
Figure 8: Histogram showing years of experience on cactus pear production .....	20
Figure 9: Bar graph showing land allocation across PA .....	21
Figure 10: Pie chart showing cactus varieties grown.....	21
Figure 11: Error Bar Showing production across PA .....	22
Figure 12: Bar graph showing pest and disease occurrence.....	23
Figure 13: Pie charts showing the Value share of actors in the two market Chanelle's .....	29
Figure 14 : Bar graph for the volume of post-harvest loss at producer level .....	30
Figure 15 : Bar graph showing seasons for harvesting .....	31
Figure 16: Error bar for harvest at specific time and loss .....	31
Figure 17: Bar graph showing for harvest at specific time and loss .....	32
Figure 18: Bar graph showing harvesting tools.....	33
Figure 19: Error bar showing harvesting tools via loss .....	33
Figure 20: Pie chart showing storage on the field .....	34
Figure 21: Histogram showing amount of loss during harvesting .....	35
Figure 22: Bar graph showing perception of farmers on storage loss.....	36
Figure 23: Bar graph showing packaging materials .....	37
Figure 24: Bar graph showing causes of transportation loss.....	39
Figure 25: Bar Graph Showing Selling across PA.....	40
Figure 26: Bar graph showing causes of losses on sell .....	41
Figure 27: New proposed cactus pear value chain .....	51

## Acronyms

ACIAR	Australian Center for International Agricultural Development
ADLI	Agricultural Development Led Industrialization
ADU	Adigrat University
BoPF	Bureau of Plan and Finance
CIAT	Internal Center for Tropical Agriculture
CRS	Catholic Relief Society
CSA	Central Statistics Authority
DAFF	Department of Agriculture, Forestry and Fishery
EIA	Ethiopian Investment Agency
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
FHH	Female Headed Households
GAFEIAS	Global Association for Environmental Investments and Sustainability
GDP	Gross Domestic Product
ILO	International Labor Organization
MHH	Male Headed Households
NGO	Non-Governmental Organization
PA	Peasant Association
PESTEC	Political, Economic, Social, Technological, Environmental and Cultural
SWOT	Strength, Weakness, Opportunity and Threat
TARI	Tigray Agricultural Research Institute
UNIDO	United Nations Industrial Development Organization
USAID	U.S Agency for International Development

## **Abstract**

*Agriculture is the mainstay of the Ethiopian economy. However, the production of crops in the Northern Ethiopia especially Tigray Region is at subsistence level due to drought, erratic rainfall and poor soil fertility. Since cactus pear is a drought-resistant plant, it is considered as a lifesaver fruit and a strategy for poverty reduction in a drought-affected area of the region. Despite its contribution to household income and food security in the area, the cactus per sub-sector is experiencing many constraints with limited attention given to its post-harvest loss management. Therefore, this research was carried out to identify opportunities for reducing post-harvest losses and recommend possible strategies to reduce post-harvest losses thereby improve production and smallholder's income. Both probability and non-probability techniques were employed to collect the data. Ganta Afeshum district was selected from Eastern Tigray, and two peasant associations (Buket and Golea) were also selected from the district purposively for being potential in cactus production. Simple random sampling techniques were employed to survey 30 households from each of the two peasant associations, and a semi-structured questionnaire was used as a tool for data collection. Moreover, in this research 2 collectors, 2 wholesalers, 1 processor, 3 retailers, 2 consumers were interviewed; and two focus group discussion was also done with 10 key farmers using semi-structured checklist; and key informant interview with governmental and non-governmental organizations were interviewed to gather more information about the cactus pear production, post-harvest losses, the strategies used to reduce the post-harvest losses and suggestions to improve the post-harvest management. To enter and analyse the quantitative data, SPSS version 20 was used whereas MS-word were used to transcribe the qualitative data. The data were presented using frequency and descriptive tables and graphs. The data analysis was also done using chain map, correlations, stakeholder matrix and gross margin. Mean comparison like ANOVA and t-test between variables were used. The analysis result shows that the present cactus pear value chain involves main actors and supporters. However, there is inadequate information flow and informal market linkages among actors in the cactus pear value chain. The farmer's gross margin is higher when they sell to the processor than sell to collectors. The significant postharvest loss in the cactus pear value chain is at producer level followed by wholesalers and retailers. The maximum and minimum volume of post-harvest losses at producer level is 4212 and 240 kgs per season. Post-harvest loss was caused by limited farmers skill on farm management and harvesting, low market price, limited market information, absence of producer organization, poor post-harvest handling, absence of cold storage, absence of collection centers, poor infrastructure, inadequate credit access, using traditional transportation system, absence of quality control, illegal traders, inadequate research and extension services and using inappropriate packaging material. Therefore, it is recommended to provide adequate practical training, forming producer organisation and constructing collection centres, credit access, cold storage facilities and upgrade the new chain which passes through processor to reduce post-harvest losses thereby improve production and household income.*

**Keywords:** Cactus pear; Post-harvest losses; Profit margin; Value-chain

# **1.INTRODUCTION**

## **1.1. Background**

Agriculture is the backbone of Ethiopian economy for sustaining growth and poverty reduction, which contributes approximately 42 % of national GDP, 88 % of the export value and 85 % of employment creation (FAO, 2016 and Menale et al., 2009). The country generates 95% of annual gross agricultural output from smallholder farmers with an average farm size ranging from 0.5 to 2 hectares (FAO, 2016).

Tigray region is part of northern Ethiopia, where more than 85% of the population directly depends on agriculture mainly on crop production (CRS, 2012 and UNIDO, 2015). The share of agriculture accounts 38.7 percent of the gross regional income registered in the past five years (BoPF, 2011). However, the Tigray region is one of the most land degraded and drought-affected areas in the country. Subsistence farming dominates the agricultural production in the region due to low productivity which is strongly affected by erratic and insufficient rainfall, and small areas of cultivation (UNIDO, 2015). Due to the conditions above, the regional government have chosen the production of the cactus pear plant as a strategy for poverty reduction (Meaza et al., 2010).

The cactus pear plant grows in the marginalised and drought-affected areas of eastern and southern Tigray and is a robust plant that endures drought, erratic rainfall and poor soil fertility. The rural community in the area is highly dependent on the plant for household consumption and livestock feed (ICC, 2018). It has also been playing a significant economic role in improving household income and reducing food insecurity (HELVETAS, 2012 and CRS, 2012). Despite its contribution to household income and food security, its production remains for local/domestic consumption. The production of cactus pear faces different challenges, i.e., limited technical skills of producers, most plants are not planted in easily manageable systems like raw planting; there is also little value addition. Moreover, during the harvest season, about 60% of the fruit spoils due to poor post-harvest handling practices (UNIDO, 2016).

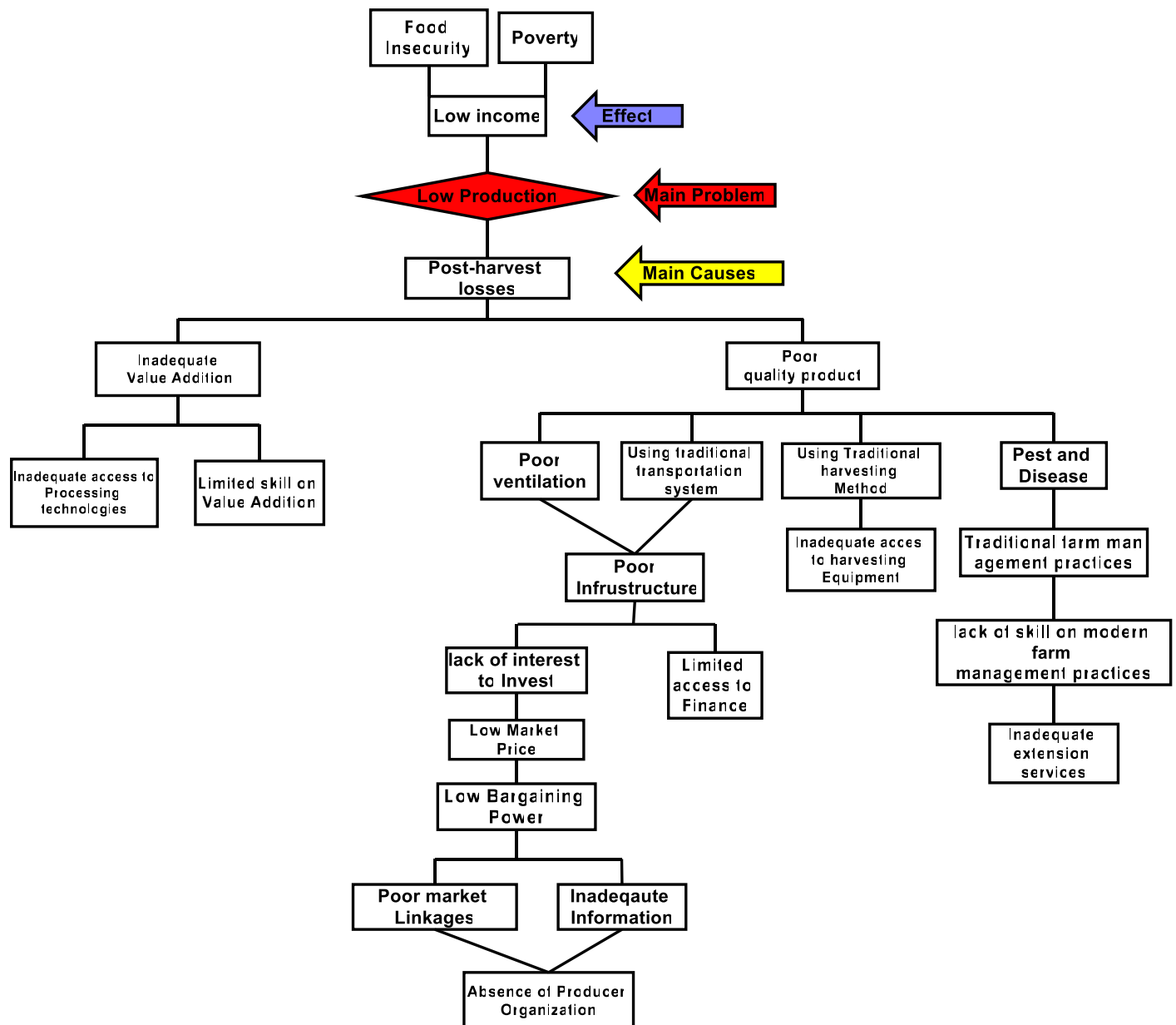
## **1.2. Problem Statement**

The rural community in eastern Tigray uses the cactus pear plant as a staple food, livestock feed and for soil conservation. The fresh fruit is also used as a source of additional income (Meaza et al., 2010). Besides, there are high demand for the fresh and processed fruit at the local, national and international markets (Nefzaoui et al., 2010 and UNIDO, 2015). Despite this market potential, the cactus pear subsector is still constrained by high production losses, which is mainly caused by post-harvest wastages (ICC,2018; Meaza et al., 2010 and UNIDO, 2015). In the Tigray region about 60% of cactus pear production is lost every year due to poor post-harvest management practices (UNIDO, 2015) and others factors (see figure 1). The latter has substantial consequences for the smallholder farmers that remain with low income. To mitigate this problem, the Regional Government of Tigray designed a cactus-based development program. Despite the efforts of the Regional Government in involving different stakeholders in the cactus development programs, these measurements did not bring a breakthrough in changing the current post-harvest losses. Realizing the relevance of bringing innovative solutions/recommendations that can be adopted by small-holder farmers to reduce post-harvest losses and thereby to improve smallholder income in eastern Tigray, the Cactus Pear Institute Director of Adigrat University has requested the research presented in this project proposal.

**Problem Owner (funding organisation):** Cactus Pear Institute Director of Adigrat University, Ethiopia

The Institute has a mission of improving the socio-economic and environmental contribution of cactus pear by 2020. It mobilises research and development in value addition, cactus pre/post-harvest management practices and market access to the rural community.

Figure 1: Problem tree to visualise the problem



### **1.3. Objective**

To recommend strategies that can be adopted by producers to reduce postharvest losses of cactus pear which will have a contribution to improving smallholder farmers income in Eastern Tigray.

### **1.4. Research Questions**

**Main Question 1:** What are the stakeholders and market situation of cactus pear?

#### **Sub-Questions**

- 1.1. What are the actors, supporters and influencers of the chain and their role in the chain?
- 1.2. What do the product and information flow in the value chain looks like?
- 1.3. What are the costs, profit and value share of the actors in the chain?

**Main Question 2:** What does the post-harvest loss situation look like?

#### **Sub-Questions**

- 2.1. Which part of the chain has the most post-harvest losses?
- 2.2. What are the factors and volume of postharvest losses in the value chain?
- 2.3. What is the effect of postharvest losses on smallholder farmers income?
- 2.4. What are the existing strategies implemented to reduce the post-harvest losses at the producer level?
- 2.5. What type of improvement can be practised in harvesting, grading, packing, storing and transportation?

### **1.5. The scope of the Study**

This study focuses on post-harvest losses and post-harvest handling strategies of cactus pear in Ganta Afeshum district of Eastern Tigray. Two peasant associations with 60 sampled respondents were selected for the survey. Though data was collected from trader, processor, wholesaler and retailer in the cactus pear value chain, the primary target of this research is to recommend innovative strategies for smallholder farmer. Data was also collected from governmental and non- governmental officials on the existing post-harvest losses, support services, current strategies to reduce the post-harvest losses in the chain.

## 2. LITERATURE REVIEW

### 2.1. Theoretical Literature

#### 2.1.1. Value Chain

It is a full range of activities that are vital to bringing a product or service from conception, through the intermediary production, distribution to final consumers, and final disposal. Value chain includes activities such as design, production, marketing, distribution, and support services up to the ultimate consumer. It is a sequence of operations where actors are required to bring products to the market. The surrounding environment of the value chain is formed by supporting functions and influencers such as rules and regulations which is vital to the chain (ILO,2011). The effective value-chains encompasses product, money and information flows enabled by chain members relationships (ACIAR,2016).

#### 2.1.2. Value Chain Analysis

As FAO reports it in 2006 report, the value chain analysis is used to analyse the factors affecting the chain including access to and requirements of end market users; the legal, regulatory and policy environment; coordination among actors; and the level of support services. Value chain analysis can be described through value chain mapping which enables the flows of products, principal actors and value-adding processes in the chain to be seen clearly and ensures none of the critical elements of the value chain is ignored (Vermeulen et al., 2008). In addition to that, the value chain map is a possible starting point for the inclusion of smallholder producers, and it is particularly useful when actors do not have the same level of information about the market context (Lundy et al., 2014).

Figure 2: Factors involved in the management of the value chain

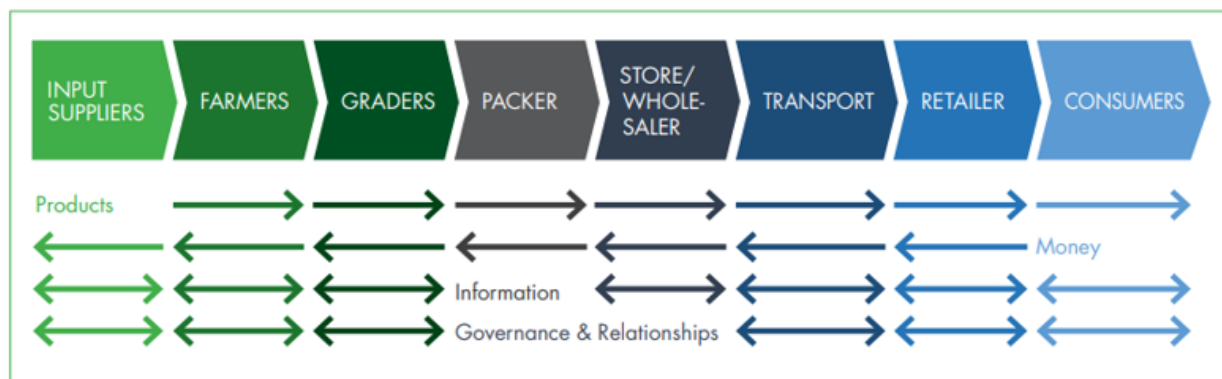


Figure 3: Factors involved in the management of value-chains

Source: ACIAR, 2016

#### 2.1.3. Sustainable Value Chain

The sustainable value chain is defined as a full range of farms and firms and the successive coordinate value-adding activities that produce raw agricultural materials and convert them into food products to sell for the final consumers and disposed of after use. In a manner that is profitable along the chain, has broad-based benefits for society, and does not permanently deplete natural resources. Developing a sustainable value chain can offer essential pathways out of poverty for small-holder producers in developing countries (FAO,2014).

#### **2.1.4. Small-holder Producers**

In developing countries, smallholder producer refers to a farmer who has limited resource endowment as compared to others in the sector. They are also explained as farmers who are owning small plots of land on which they grow subsistence crops, and one or two cash crops depend mostly on family labour mainly. The smallholder production system in developing countries primarily characterised by using simple, outdated technologies, low return, high seasonal labour fluctuation and a vital production role is practised by women (DAFF, 2012)

#### **2.1.5. Post-Harvest Losses**

Postharvest loss is a degradation of food production in quantity and quality from harvest to consumption. While the decline in quality includes those that affect the nutrient/caloric composition, the acceptability, and the edibility of a given product whereas losses in quantity refer to that loss of the amount of a product. Quantity loss is more common in developing countries (Kiaya, 2014).

The post-harvest loss is an urgent problem, and it is particularly acute in developing countries where this loss reduces smallholder farmers income by at least 15% for 470 million (Rockefeller Foundation, 2015). Aulakh and Regmi (2013) added that post-harvest losses in the low-income countries mainly occur at a producer level and middle stages of the food supply chains with low wastage at a consumer level. Due to this fact, many smallholder farmers in developing countries live on the margins of food insecurity so that a reduction in post-harvest losses could have an immediate impact on their livelihoods (Kiaya, 2014). Therefore, this research mainly analyses the quantities and quality loss of cactus pear producer, traders, processors and at the wholesaler's level.

The main reasons for post-harvest losses in developing countries along the supply chain are the early harvest followed by farmers, inadequate storage facilities, lack of infrastructure, lack of processing facilities, and inadequate market facilities (Aulakh and Regmi, 2013). Moreover, Kiaya (2014) added that in these countries the losses are mainly related to finance, managerial and technical skill limitation of harvesting techniques, storage and cooling facilities in harsh climatic conditions, infrastructure, packaging and marketing systems.

#### **2.1.6. Quantitative and Qualitative losses**

Quantitative loss refers to a reduction in the weight of the fruits and vegetables which is caused by factors such as spillage, pest attacks and due to physical changes in temperature, moisture content and chemical changes. On the other hand, the qualitative loss can occur due to the incidence of insect pest occurrence, birds, handling practices, physical changes or chemical changes, contamination of microorganisms and pesticide residues (Aulakh and Regmi, 2013).

#### **2.1.7. Post-Harvest Chain**

The postharvest chain encompasses the organised activities from the time of harvest through crop processing, marketing, until the moment of sale to the consumer. The post-harvest chain includes the actors that are responsible for post-harvest handling and storage of produces after harvest by producers, processing by processing companies and distribution of the products by actors such as middlemen, wholesalers, exporters, retailers and street vendors (Van et al.,2017).

*The post-harvest chain has processes and measures which are directed towards achieving customer requirements and satisfying the rules and regulations imposed by other stakeholders such as the government (Van et al.,2017).*

#### **2.1.8. Post-Harvest Management**

Post-harvest management is all about the organisation and coordination of processes and measures in the post-harvest chain to achieve customer requirements and satisfying the rules and regulations imposed by the



other stakeholders. Therefore, postharvest management can be described as the whole processes and measures that contribute to the flow of agricultural products that have been harvested or to be harvested (Van et al.,2017).

#### **2.1.9. Post-Harvest management strategies**

To mitigate the above-mentioned post-harvest problems, the following strategies had been identified by the Rockefeller Foundation in 2015:

- ❖ Market linkages of smallholder farmers to the potential buyers;
- ❖ organising farmers for providing training on postharvest management, promote adoption of technologies, and aggregate crops to meet buyer quantity and quality requirements;
- ❖ promoting agricultural investments and facilitate distribution and acquisition of technologies through developing advanced finance mechanisms, particularly for smallholder farmers.

## **2.2. Empirical Literature**

### **2.2.1. Agricultural Production and Challenges in Ethiopia**

Agriculture is a backbone of Ethiopian Economy, and it contributes approximately 42 percent of national GDP. The livelihood of 80 percent of the country's population depends on agriculture. The annual gross total agricultural output of the country is generated from smallholder farmers who mainly produce crop and livestock on an average land holding of 0.5 to 2 hectares (FAO, 2016). Realizing this fact, the Ethiopian government prioritises agricultural development through setting some policy measures like agricultural development led industrialisation (ADLI) to develop agriculture as a source of production for direct consumption and raw material for industrial processing (EIA, 2012).

### **2.2.2. Challenges of Horticulture production in Ethiopia**

Though the Ministry of Agriculture in Ethiopia is struggling to increase horticultural production, the production of fruits and vegetables in Ethiopia is scattered (Sebeko,2015). The production losses of perishable produce (vegetable and fruits) accounts up to 30% which caused by the presence of high moisture content (65–95%), insect infestation and damage during post-harvest handling techniques (Abraha et al., 2018). Sebeko (2015) added that the major obstacles of post-harvest losses of horticultural produces along the supply chain are lack of information access, application of better technology, credit services and the fragile infrastructure.

*There are also many intermediaries between producers and consumers to distribute the product to the central market. The hindering factor which is mainly related to the supply chain for fresh produce in Ethiopia originates from limited knowledge about postharvest handling and lack of infrastructure. Production losses often occur in all phases of postharvest handling such as storage, packaging, transportation, processing and marketing (Sebeko,2015).*

### **2.2.3. Cactus Pear Production in Tigray**

Like other parts of Ethiopia, agriculture is the mainstay of more than 85% of Tigray population. Though the rural community is directly dependent on agriculture, there are long periods of drought and unreliable rainfall, compounded by excessive human and livestock pressures on the land resulting in low production and food insecurity (Yaye, 2010). This is why the cactus plant has chosen by the regional government as a poverty reduction strategy.

The plant has adapted perfectly to the northern arid and semi-arid regions of the country which characterised by drought, erratic rainfall, and soil infertility. The plant had a significant contribution to the rural community in the times of drought and considered as a life-saving crop to both humans and animals. It has also become the primary source of income and food for the production seasons of a year (May-August) (Nefzaoui et al., 2010).

Cactus plant was introduced to northern Ethiopia at the end of 19th Century by Italian missionary (Yaye, 2010). Tigray region is one of the driest regions in Northern Ethiopia where cactus pear plantation covers a relatively extensive area and of which its most substantial proportion is in eastern, with significant extension to southern Tigray (HELVETAS, 2012). Nowadays the landscape of the highlands is fully integrated with the plant, and it is becoming a dominant plant in the area. That is why the plant is considered as much part of the culture and livelihood of the rural people. Moreover, the plant is also recognised as an integral part of the environment and food security due to the plant's ability to spread aggressively without the presence of any natural factors (Nefzaoui et al., 2010).

*Though cactus pear has excellent potential to processed through value addition, the vast quantities of the fruit are consumed in fresh form. Moreover, the surplus is wasted due to limited skill on full utilisation and processing potential. On the other hand, Over the last few years, the economic interest and the demand of cactus plant has remarkably increased. Apart from it, there are also different challenges faced by the country like lack of access to improved varieties, production techniques and processing technologies (Nefzaoui et al., 2010)*

Moreover, due to lack of technical skill on modern cactus orchard management practices, its production in the region was done traditionally, and most cactus plantation in the region is found grown very densely, above height in the very sloppy area (Yaya, 2010).

#### **2.2.4. Factors Affecting Post Harvest losses of cactus pear in Tigray**

According to Kifleyesus and Tsegay (2009), the main factors which affect post-harvest losses of cactus pear are as follows: -

- ❖ Little awareness of consumers about edibility of cactus pear outside Tigray region.
- ❖ High risk of traders due to its perishability. Most supermarkets receive the fruit through credit sales; this result higher risk for trader since spoiled fruit are not paid.
- ❖ Many producers in the Tigray region still use the traditional method of harvesting. This causes a hole in the fruit and increases spoilage of the fruit.
- ❖ Inadequate transportation equipment and inadequate infrastructure have led 25% of the fruit losses on average during loading unloading and transportation.
- ❖ Usage of inappropriate packaging materials facilitates spoilage of the fruit before reaching the market
- ❖ Availability of informal market led the producers to be exploited by the traders.

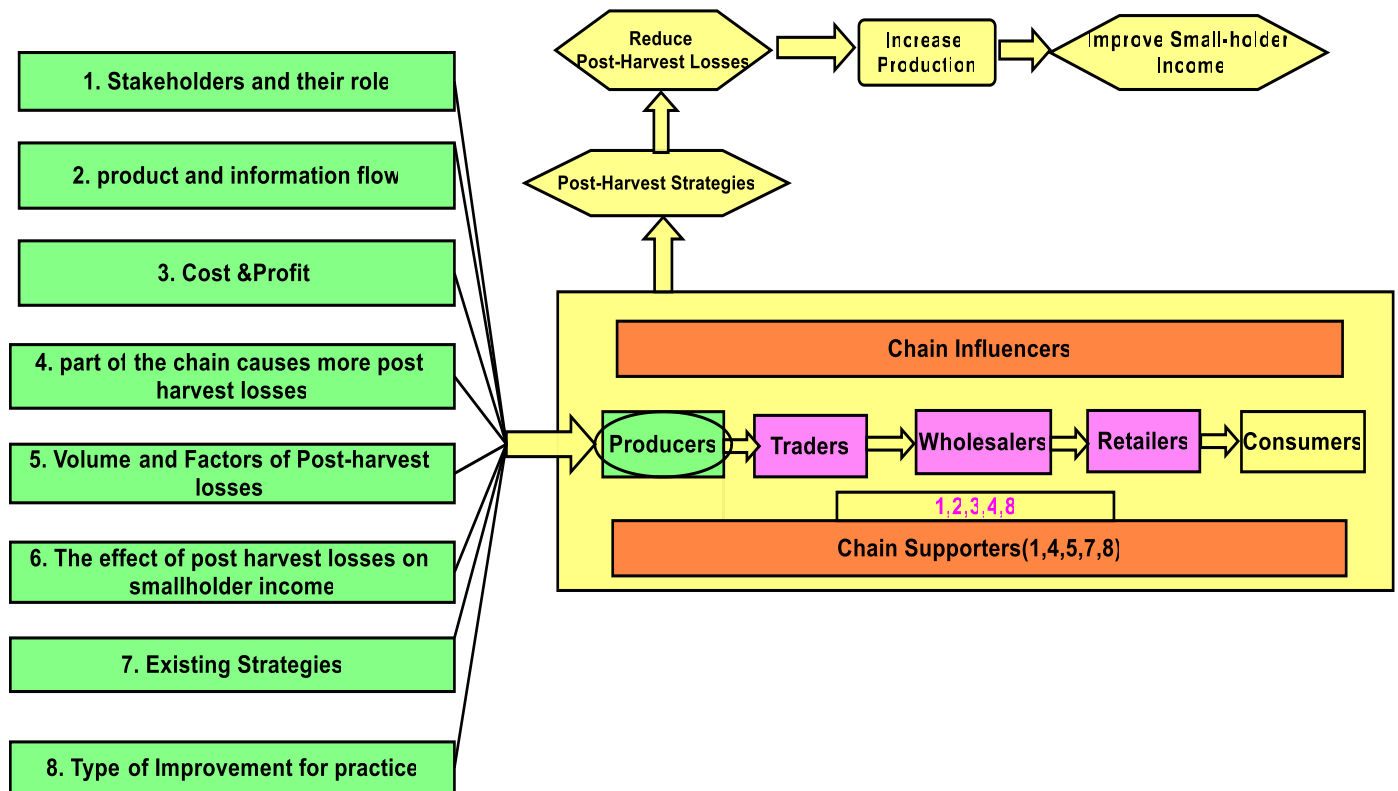
Table 1: Cactus production, wastage and consumption in Tigray

Description	Tones	Value in million birr*
Estimated total production	483,246	725
Estimated total wastage	149,806	225
Estimated net harvested volume	333,440	500
Own consumption, 50% of harvested volume	166,720	250
Total marketable fruit volume	166,720	250

Source: HELVETAS, Cactus Pear Sunrise Project, 2012

## 2.3. Conceptual Framework

Figure 3: Conceptual Framework



Conceptual Framework: Own Source, 2018

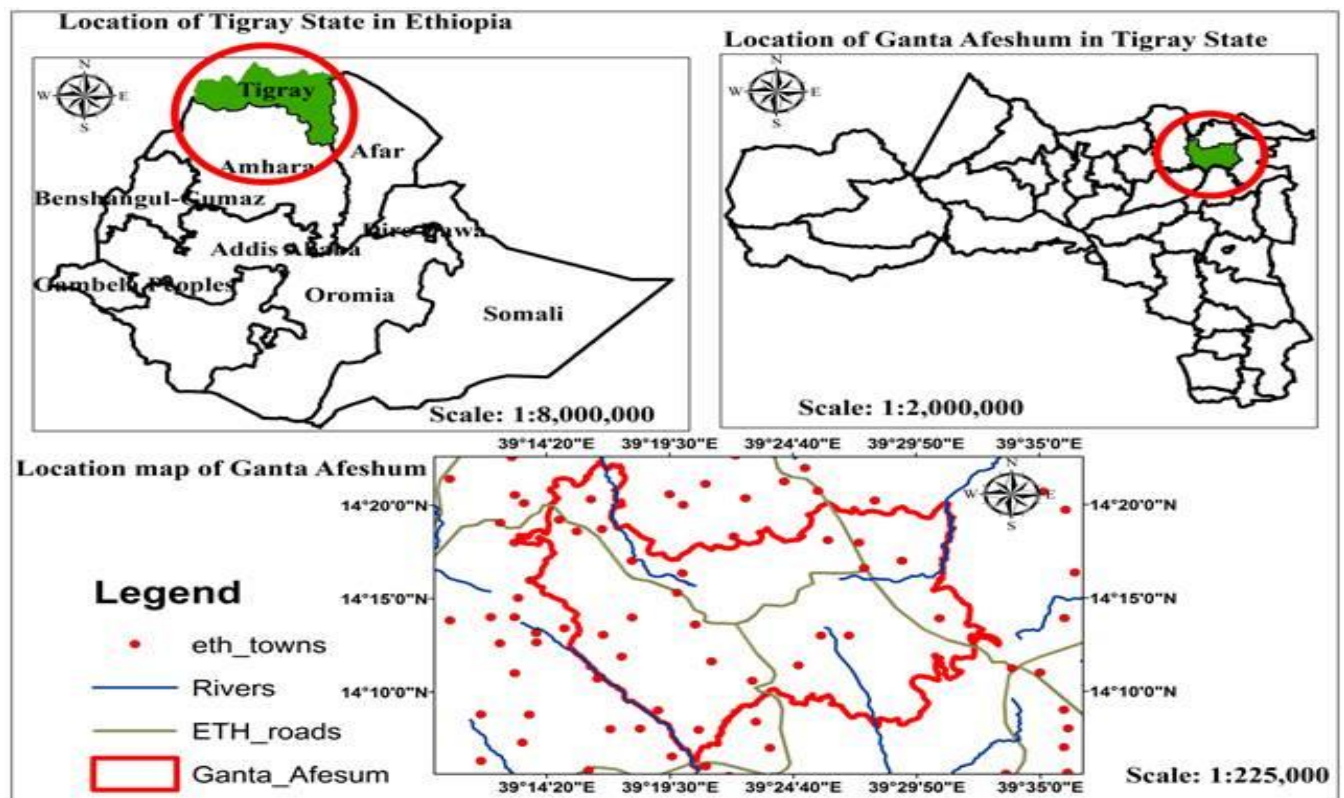
### 3. RESEARCH METHODOLOGY

#### 3.1. Area Description

The study was carried out in Ganta Afeshum district of Eastern Tigray, Northern Ethiopia. It is the dominant cactus pear producing area in Ethiopia. Ganta Afeshum is located about 115 KMs North of Mekelle (regional city) and 960 North of Addis Abeba (Capital city) (Misgna, 2015). The district is one of the seven districts of Eastern Tigray in Tigray region, Ethiopia (HELVETAS, 2012). The area has a total population of 97,233, of which 45,826 are men and 51,405 women (CSA,2013). It is situated at an altitude of 2457 meters above sea level. It also has a bimodal rainfall pattern with average annual rainfall between 450 and 650 mm, an average temperature ranging between 7.8°C and 24.2°C (Misgna, 2010).

Eastern Tigray is the aridest zone of Tigray region. It is characterized by land degradation and prone to drought with erratic rainfall. The area is conducive to produce cactus pear due to the unique characteristics of the plant to withstand harsh environments and its ability to mitigate land degradation. Moreover, the postharvest loss is the more severe problem in the area. There are also different project initiatives to rehabilitate and enhance the productivity and utilisation of cactus pear to improve the livelihood of the poor rural community (GAFEIAS, 2012).

Figure 4: Map of Ethiopia showing the location of Tigray, Eastern Tigray and Ganta Afeshum District

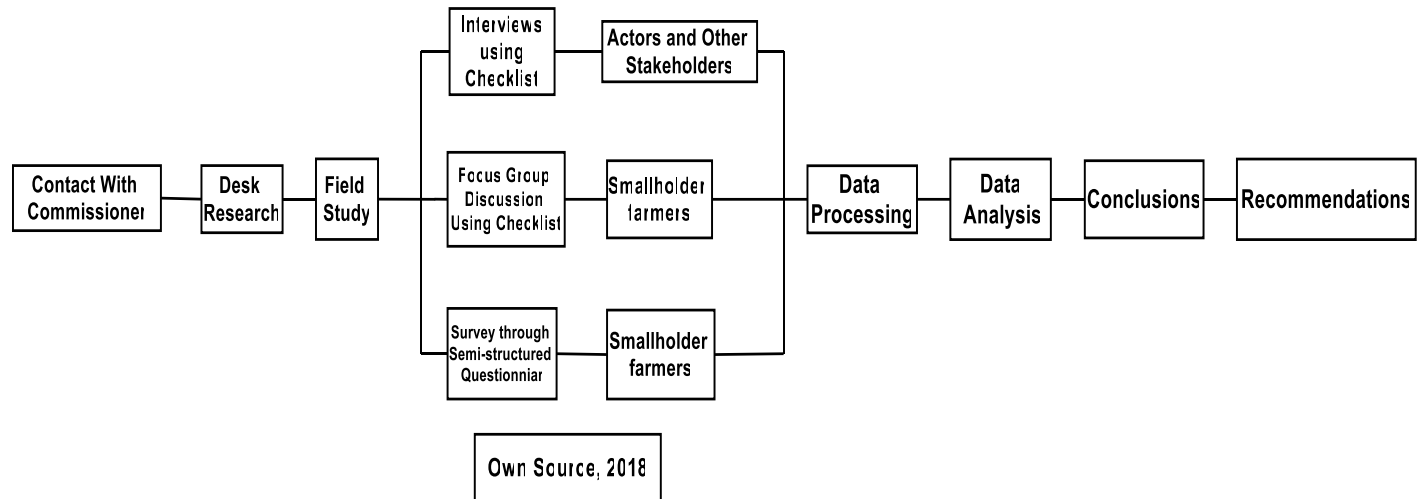


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### 3.2. Research Design

The research has both qualitative and quantitative approach. Both qualitative and quantitative methods of data collection and analysis were employed. The study used both secondary and primary source of information for primary and secondary data collection. The secondary data was collected through desk research whereas; the primary data was collected through the survey, key informant interviews/ interviews, direct observation and focus group discussion from farmers, actors and different chain supporters. The following figure illustrates how the steps of research followed each other.

Figure 5: Research Design



### 3.3. Sampling Techniques

In this research, both probability and non-probability sampling techniques was used.

- Ganta Afeshum district was selected purposively on the bases of being potential for cactus pear production from the areas of Eastern Tigray
- Two peasant associations (*tabias*) called 'Buket' and 'Golea' were chosen purposively in collaboration with the experts of the Bureau of Agriculture and Rural Development from the district, based on the volume of cactus pear production. A total of 30 farmers of each peasant association were randomly selected for the survey.
- Two traders, two wholesalers, one processor, three retailers, two consumers based on their involvement in the cactus pear value chain.
- One expert from each of the following offices was selected purposively for the key informant interview based on their awareness of the production and post-harvest losses of the fruit.
  - ❖ Bureau of Agriculture and Rural Development,
  - ❖ Cactus Pear Institute Director of Adigrat University,
  - ❖ Tigray Agricultural Research Institute and
  - ❖ HELVETAS Swiss Intercooperation
- ❖ 10 key farmers were selected purposively, selected with the help of the extension agent on the bases of their participation in the last training
  - The total sample for this research was 80 respondents

### **3.3. Method of Data Collection**

#### **3.3.1. Secondary Data Collection**

##### **Desk Research**

In this research, the desk research was conducted before and after the data collection. The purpose of desk researching was to identify the main causes of the problem and to support the findings. This desk research where both the national and international research were reviewed about cactus pear production, constraints and opportunities of cactus pear production, marketing, post-harvest loss and post-harvest handling practices. International project reports from Google and specific websites about cactus pear production and marketing were also consulted. Moreover, the published and unpublished reports of different supporters such as research centre, national and district agriculture offices, universities and NGOs were used to assess the current cactus pear production, market linkages, stakeholders and their role, post-harvest losses, the causes of post-harvest losses and current strategies to reduce post-harvest losses.

#### **3.3.2. Primary Data Collection**

The primary data was collected through survey, key informant interviews and focus group discussion.

##### **3.3.2.1. Survey**

The study was carried out with 60 farmers in Ganta Afeshum district of Eastern Tigray, Ethiopia. It was collected through pre-tested structured questionnaire. Both open and close-ended questions were included in the questionnaire included to collect both qualitative and quantitative data. Farmers demographic and socio-economic variables; such as age, household type, family size, education level, farm size, farming experience, membership to cooperatives, distance from market center, access to market information, access to extension service, access to credit services, farm management practices, pests and disease management practices, cactus pear harvesting methods, grading/sorting practices, ways of transportation, storage, costs of inputs and transportation, farm get price of cactus, payment method, relationship with local traders and supporters, causes of post-harvest losses, volume of post-harvest losses were gained from this survey.

##### **3.3.2.2. Interviews /key informant interviews**

The interview was conducted with chain actors (traders, wholesalers, processors, retailers and consumers) and supporters (experts from Bureau of agriculture and rural development, Cactus Pear Institute Director of Adigrat University, Tigray Agricultural Research Institute and HELVETAS (NGO)). The Interview was carried out in Adigrat (zonal city), Mekelle (regional city) and Addis Ababa (capital city). The interview was collected using a semi-structured checklist. The required information from this interview are transport cost, loading and unloading cost, price sold to buyers, market information, product quality, volume of post-harvest losses, causes of post-harvest, linkage with other actors and support service on production, marketing and post-harvest loss related issues, frequency of meeting actors as a supporter, government regulations etc.

### **3.3.2.3. Focus Group Discussions (FGD)**

The focus group discussion was conducted twice at the beginning and the end of the data collection. The semi-structured checklist was used for both FGDs. The first FGD was carried out before starting the survey with five key farmers. The focus group discussion was conducted in the farmers training centre (FTC) of the district. The five farmers were selected from the two peasant associations with the help of agriculture office expert. The main aim of the first FGD is to get data about the current post-harvest losses, the causes of the losses, its effect on smallholder income, existing support from different stakeholders to reduce the damage, the improvement type can be practised in reducing the loss etc. On the other hand, the second focus group discussion was conducted at the end of the data collection to receive feedback on the findings. This was done with the same five farmers of the two peasant associations.

### **3.4. Method of Data Analysis**

After the data collection, both qualitative and quantitative method of analysis was employed to analyse the collected data. Before the analysis, the quantitative data was coded and entered to SPSS version 20 and then processed to produce frequency tables, graphs, the means of different variables involved in the study. Whereas the qualitative data from supporters and actors were transcribed in MS-Word and used to support the quantitative data.

Analytical tools such as chain map, stakeholder matrix, SWOT analysis and economic parameters were used for analysis. The linkage between actors were analysed to indicate how the chain is functioning. To visualise the market price, overlays was shown in the whole chain map. Stakeholders were also indicated in the chain map based on their contribution across the chain. Stakeholder matrix were used to describe stakeholders and their role in the chain. Moreover, gross margin and value share were analysed to indicate the cost, profit and value share of each actor in the chain. SWOT was used to explain the external and internal factors (constraints and opportunities) for the development of post-harvest strategies in the area.

NB: For the detailed description of research methods in relation to research sub-questions, please see (table 2).



Table 2: Summary of research strategies

Research Sub-Questions	Respondents	Method of Data Collection	Tool for Data Collection	Tools for Data Analysis
<b>1.1.</b> What are actors, supporters and influencers of the chain and their role in the chain?	<ul style="list-style-type: none"> <li>Gov't and NGO officials</li> <li>traders, wholesalers, processors and retailers</li> <li>Key farmers</li> </ul>	<ul style="list-style-type: none"> <li>Desk Study</li> <li>Key inf. Interview</li> <li>interviews</li> <li>FGD</li> </ul>	<ul style="list-style-type: none"> <li>Literature review</li> <li>Semi-structured Checklist</li> <li>Semi-Structured Checklist and mapping</li> </ul>	<ul style="list-style-type: none"> <li>Chain map</li> <li>Stakeholder matrix</li> </ul>
<b>1.2.</b> What do the product and information flow in the value chain looks like?	<ul style="list-style-type: none"> <li>Traders, wholesalers, processors, retailers and consumers</li> <li>Smallholder farmers</li> </ul>	<ul style="list-style-type: none"> <li>interviews</li> <li>Survey</li> </ul>	<ul style="list-style-type: none"> <li>Semi-Structured Checklist</li> <li>Structured Questionnaire</li> </ul>	<ul style="list-style-type: none"> <li>Chain map</li> </ul>
<b>1.3.</b> What are the gross-margin and value share of the actors in the chain?	<ul style="list-style-type: none"> <li>Traders, wholesalers, processors and retailers</li> <li>Small-holder farmers</li> </ul>	<ul style="list-style-type: none"> <li>Interview</li> <li>Survey</li> </ul>	<ul style="list-style-type: none"> <li>Semi-Structured Checklist</li> <li>Structured Questionnaire</li> </ul>	<ul style="list-style-type: none"> <li>Gross Margin and Value share</li> </ul>
<b>2.1.</b> Which part of the chain has the most post-harvest losses?	<ul style="list-style-type: none"> <li>Gov't and NGO officials</li> <li>traders, wholesalers, processors and retailers</li> <li>key farmers</li> </ul>	<ul style="list-style-type: none"> <li>Desk research</li> <li>Key inf. Interview</li> <li>Interviews</li> <li>FGD</li> </ul>	<ul style="list-style-type: none"> <li>Literature review</li> <li>Semi-structured Checklist</li> <li>Semi-Structured Checklist</li> </ul>	
<b>2.2.</b> What are the factors and volumes of post-harvest losses in the chain?	<ul style="list-style-type: none"> <li>Gov't and NGO officials</li> <li>traders, wholesalers, processors and retailers</li> <li>Smallholder farmers</li> <li>Key farmers</li> </ul>	<ul style="list-style-type: none"> <li>Desk research</li> <li>Key inf. Interview</li> <li>Interviews</li> <li>Survey</li> <li>FGD</li> </ul>	<ul style="list-style-type: none"> <li>Literature review</li> <li>Semi-structured Checklist</li> <li>Structured questionnaire</li> <li>Semi-Structured Checklist</li> </ul>	<ul style="list-style-type: none"> <li>Bar graph and Bivariate correlations</li> </ul>
<b>2.3.</b> What is the effect of post-harvest loss on	<ul style="list-style-type: none"> <li>Small-holder farmers</li> <li>Key farmers</li> </ul>	<ul style="list-style-type: none"> <li>survey</li> <li>Desk study</li> <li>FGD</li> </ul>	<ul style="list-style-type: none"> <li>Semi-Structured Questionnaire</li> <li>Literature review</li> </ul>	<ul style="list-style-type: none"> <li>Bivariate Correlation</li> </ul>

smallholder income?			<ul style="list-style-type: none"> <li>• Semi-Structured Checklist</li> </ul>	
<b>2.4.</b> What are the existing strategies used to reduce the post-harvest losses at producer level?	<ul style="list-style-type: none"> <li>• Gov'tal and NGO officials</li> <li>• key farmers</li> </ul>	<ul style="list-style-type: none"> <li>• Key Informant Interview</li> <li>• FGD</li> </ul>	<ul style="list-style-type: none"> <li>• Semi-Structured Checklist</li> </ul>	
<b>2.5.</b> What type of improvement can be practised in fruit collection, grading, packing, storing and transportation?	<ul style="list-style-type: none"> <li>• Gov'tal and NGO officials</li> <li>• key farmers</li> </ul>	<ul style="list-style-type: none"> <li>• Desk study</li> <li>• Key Informant Interviews</li> <li>• FGD</li> </ul>	<ul style="list-style-type: none"> <li>• Literature review</li> <li>• Semi-structured Checklist</li> </ul>	

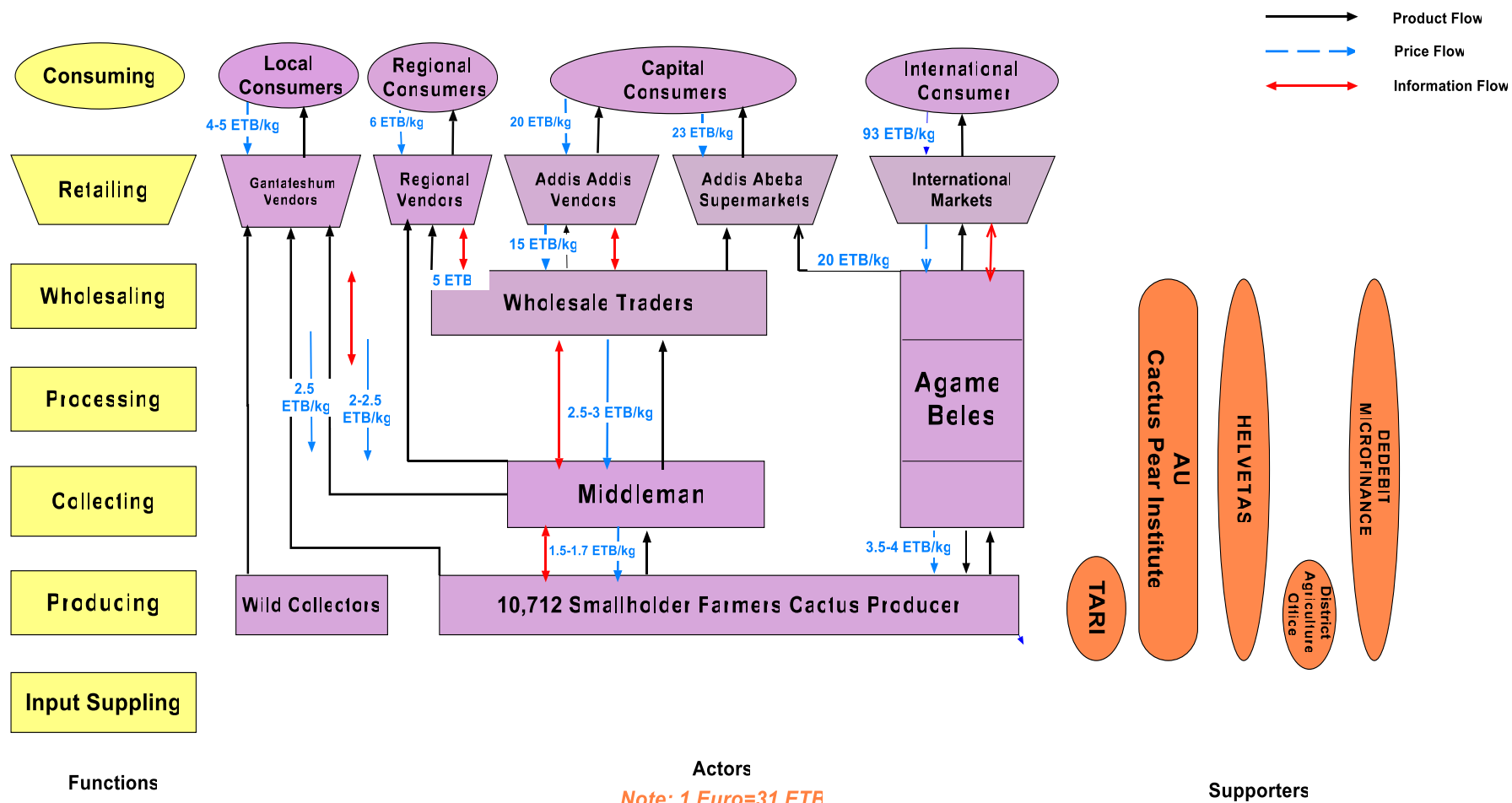
#### **4.RESULT AND ANALYSIS**

This chapter presents the finding of the survey, key-informant interviews, and the focus group discussions. In this chapter, the cactus pear value-chain and stakeholders, causes and effects of post-harvest losses and the current post-harvest handling practices will be discussed. Additionally, the internal and external factor analysis of cactus pear value chain will also be presented.

##### **4.1. VALUE CHAIN OF CACTUS PEAR IN EASTERN TIGRAY**

The cactus pear value chain mapping in Eastern Tigray was carried out on the bases of the information gained from the survey, key informant interviews, focus group discussion and interviews with actors such as traders, processors, wholesalers and retailers. The cactus pear value chain consists of different stakeholders such as producers, traders, processors, wholesalers, retailers, consumers and different support giving governmental and non-governmental organizations. The chain map below depicts that how the activities among the actors have been carried out and the relationship between different stakeholders looks like. Moreover, the chain map also shows that the product, price and information flows among the chain actors.

# Chain Map of Cactus Pear in Ganta Afeshum District, Eastern Tigray, Ethiopia



## 4.2. DESCRIPTION OF STAKEHOLDERS AND THEIR ROLE IN THE CHAIN

### 4.2.1 Input Suppliers

According to the survey, focus group discussion and the key informant interviews, there is no input suppliers in the cactus pear value chain. As it is indicated in the chain map, this is due to the reason that inputs such improved cactus variety, fertilizer and chemicals (Insecticides and pesticides) were not provided to the smallholder farmers. Though different governmental and non-governmental organizations such as Tigray Agricultural Research Institute, District and Regional Agriculture Offices, HELVETAS and Adigrat University Cactus Pear Institute were involved as a supporter in the cactus pear value chain, they are only providing training to some farmers once in a year. The Focus group discussion also discloses that the farmers did not volunteer to invest their money on buying agricultural input for cactus production because they were considering cactus pear plantation as a gift of nature.

### 4.2.2. Smallholder Farmers/Producers

According to the survey and the focus group discussion, in Eastern Tigray, cactus pear is produced by smallholder farmers with 0.25-2 hectares landholding. While more than half percent of the fruit from smallholder farmers sold to collectors/middleman the rest were sold to urban retailers, processors and directly to the consumers. The demographic and socio-economic characteristics of smallholder farmers are presented as follows: -

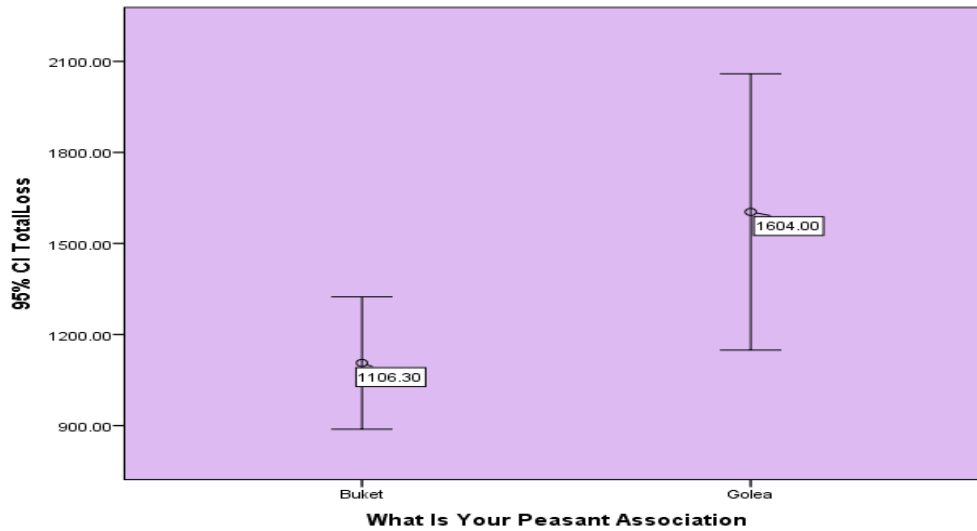
#### 4.2.2.1. Household Type:

As it is depicted in the table below (table 3), Out of the total 60 respondents, 50% of them were from Buket whereas the other 50 % were from Golea peasant association. Most (63%) of the respondents from Buket were female-headed households while 73% of the respondents from Golea were male-headed households. The error bar in figure 6 shows that the respondents from Buket have the lowest mean value for total loss than the respondents from Golea. So that, it can be concluded that the female-headed households have the lowest post-harvest losses than male-headed households. The independent sample test in (Annex 1) for the mean comparison also shows that there was a significant difference in the response of female and male-headed households towards the total post-harvest loss at a 95 % confidence interval. The total post-harvest loss was calculated from the sum total of harvesting, storing, sorting, packaging and transportation losses of sampled farmers in the survey. Moreover, the key informant interview with agriculture office experts reveals that women are more careful in picking fruits than man.

Table 3: Cross tabulation between the PA and household type

Peasant Association	Household Type		Total
	FHH	MHH	
Buket	19	11	30
Golea	8	22	30
Total	27	33	60

Figure 6: Error Bar showing the mean comparison of the two PA



#### 4.2.2.2. Age

As it is indicated in table 5; The maximum and minimum age of the sampled respondents was 74 and 27 respectively, the average age is 50.5, and the standard deviation is 12.05. As it is indicated in (Annex 2), though there is a positive relationship between age and total post-harvest loss, the relationship is not significant.

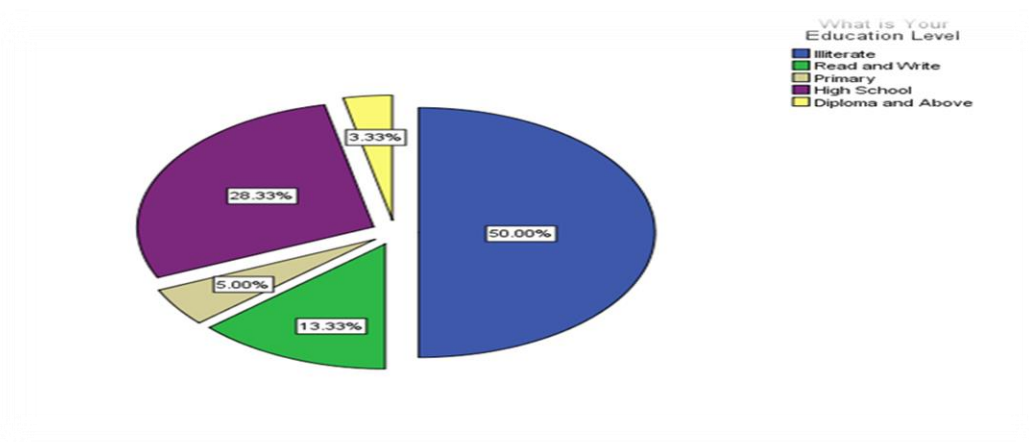
Table 4: Descriptive statistics for Age of the respondents

	N	Min	Max	Mean	Std. Dev
Age	60	27.00	74.00	50.52	12.05

#### 4.2.2.3. Education

The pie chart (figure 7) shows that the majority (50%) of the respondents were illiterate and 13% of them be able to read and write. Though 20% of them attended high school, only 3% of the respondents hold a diploma and above. From this, it can be concluded that majority of the respondents had no formal education. The ANOVA result in the (Annex 3) depicts that there is the significant mean difference between education levels towards the total cactus loss at 95% of confidence interval.

Figure 7: Pie Chart Showing education level



#### 4.2.2.4. Family Size

The survey result in the table below (table 8) shows that the maximum and minimum family size of the respondents is 9 and 2 respectively, the average family size is 5.27 and the standard deviation is 1.93. This average family size of the respondents is around the 4.3 average family size of Tigray region population census by Central Statistics Authority in 2007. According to the correlation (Annex 4), the relationship between family size and the total post-harvest loss is negative but not significant.

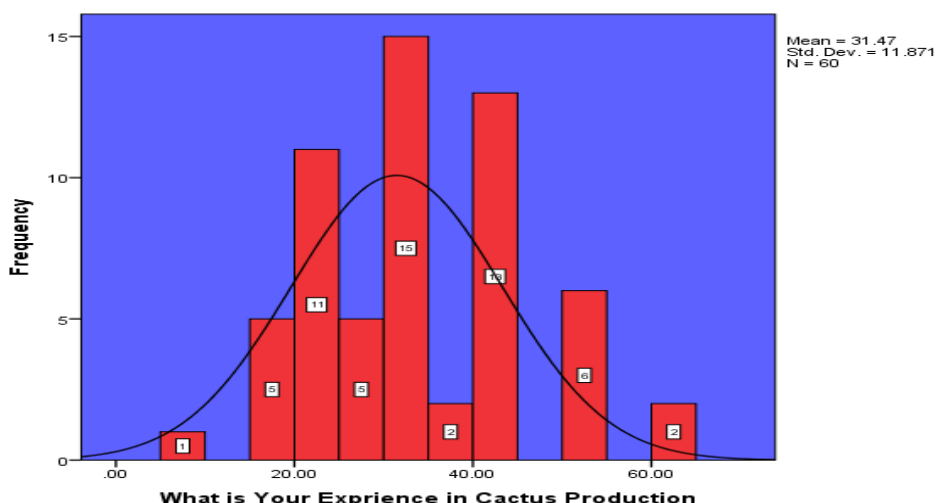
Table 5: Descriptive Statistics for Family Size

	N	Min	Max	Mean	Std. Dev
Family Size	60	2.00	9.00	5.23	1.94

#### 4.2.2.5. Experience of Cactus Pear production

The survey result indicates that the experience of respondents on cactus pear production ranges between 5 and 60 years with an average year of experience 31.47 and standard deviation of 11.87. According to the correlation result (Annex 5), there is a positive correlation between loss and years of experience. When there is an increment in farmers' experience of cactus pear production, the total post-harvest loss reduces.

Figure 8: Histogram showing years of experience on cactus pear production



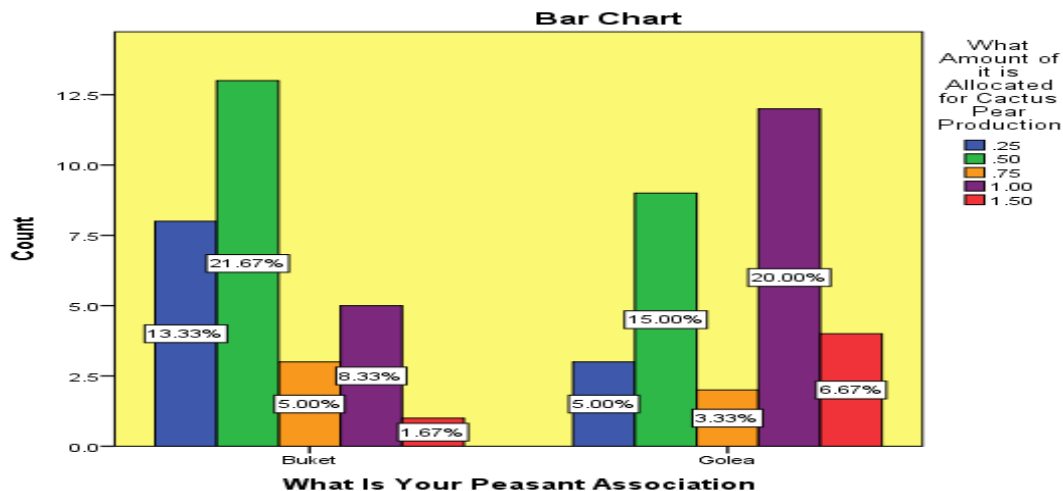
#### 4.2.2.6. Land Size

According to the survey result in table 11, the amount of total landholding ranges from 0.25 hectares to 2 hectares with a mean land size of 0.9 hectares. The histogram in figure 9 shows that the land allocated to cactus pear production ranges from 0.25 to 1.5 hectares and the majority (22%) of the respondents from Buket had 0.5-hectare while the 25% of respondents from Golea had 1-hectare covered with cactus pear from the total land holding. The correlation (Annex 6) shows that there is a significant positive relationship between land size allocated for cactus and total loss. This is interpreted as when the land size allocated for cactus pear increases at the same time the total post-harvest loss increases. This implies that the post-harvest management is difficult as the land size increases.

Table 6: Descriptive statistics showing total land holding

	N	Min	Max	Mean	Std. Dev
land size	60	.25	2.00	.91	.49

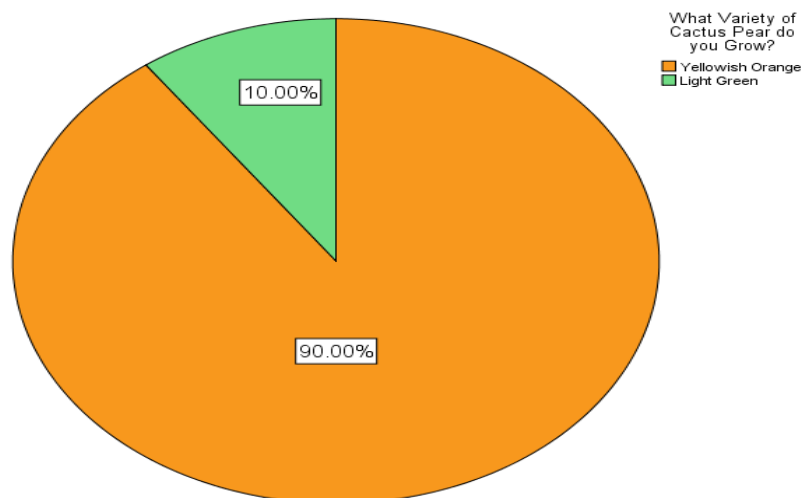
Figure 9: Bar graph showing land allocation across PA



#### 4.2.2.7. Cactus Variety

Out of the total sampled respondents, the majority (90%) of the farmers were growing the yellowish orange colour cactus while the rest 10 % growing the light green variety. Therefore, the yellowish orange colour is the most dominant fruit in Eastern Tigray. According to the interview with the agriculture expert and farmer themselves, the yellowish orange colour variety fruit is easily accessible and more demanded by the consumer than the other one.

Figure 10: Pie chart showing cactus varieties grown





#### 4.2.2.8. Cactus Pear Plantation and Management

From the FGD and key informant interviews with different officials, in Eastern Tigray, farmers are not using fertiliser, pesticide, and insecticide for cactus pear production. Moreover, the key farmers in the focus group discussion said that there is no weeding, pruning, row plantation and watering of cactus pear in the area. Due to not having plant spacing in the cactus pear plantation, all the surveyed respondents answered as they do not know the number of plants they have.

Picture Showing Plantation of cactus pear



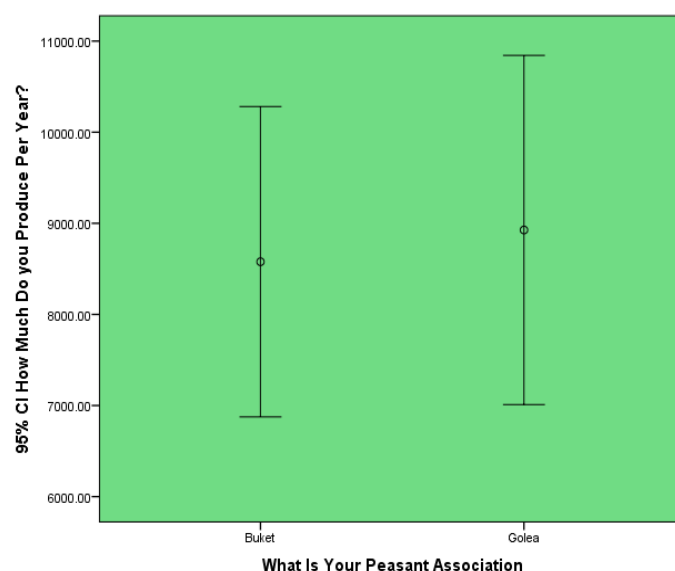
#### 4.2.2.9. Production Per Season

As it is shown in table 13, the survey result reveals that the minimum and maximum cactus pear production per season is 2,000 and 19,600 kilos respectively, with an average 8,752 kilos and standard deviation 4816.7. The error bar in figure 11 and the independent sample test (Annex 7) shows that there is no significant difference in the responses of farmers from the two peasant associations (Buket and Golea) towards the amount of production. This implies that the mean for cactus pear production in the two-peasant associations is almost equal.

Table 7: Descriptive Statistics for Production Per Season

	N	Min	Max	Mean	Std. Dev
Production	60	2000.00	19600.00	8752.4	4816.74

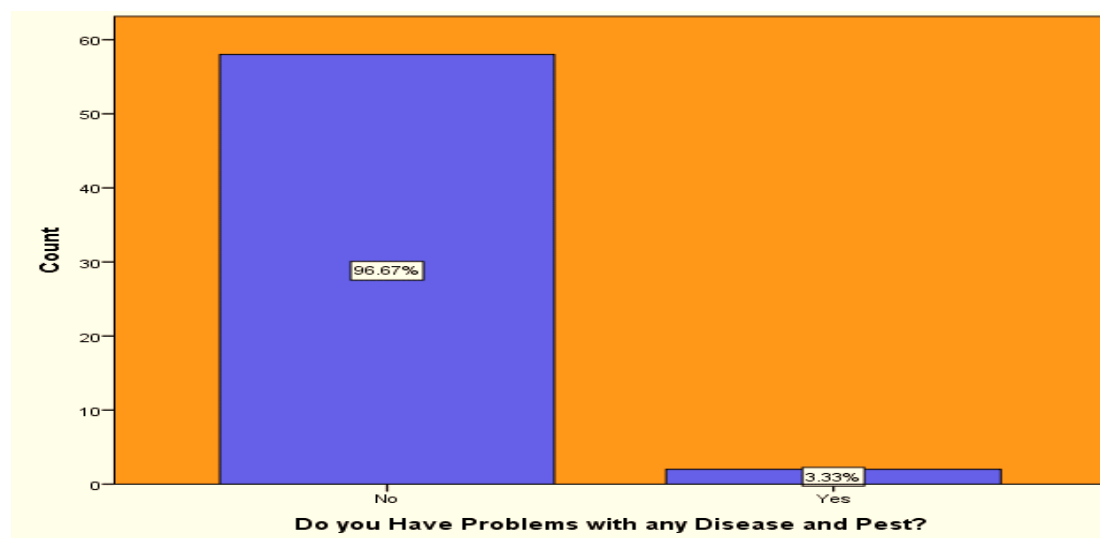
Figure 11: Error Bar Showing production across PA



#### 4.2.2.10. Post-harvest pest and diseases

The survey result (figure12) reveals that almost all the surveyed respondents (97%) replied that there is no post-harvest pest and disease occurrence in their cactus pear plantation during this production season. This is also supported by the interview with the cactus pear institute director of Adigrat University. However, the key informant interview with the focal person from HELVETAS (NGO) reveals that there was a rare occurrence of pest and disease like cochineal on the cactus pear plantation in Eastern Tigray during the past five years.

Figure 12: Bar graph showing pest and disease occurrence



#### 4.2.2.11. Access to Credit

Though all the sampled respondents replied that they have access to credit service from Dede-bit microfinance, they also mentioned that the credit is not specifically to improve cactus pear production and marketing. Moreover, the result from the focus group reveals that even though there is access to credit for farmers, the loan amount from the microfinance is not enough and it also needs collateral to show. The interview with HELVETAS and Cactus Pear Institute Director of Adigrat university also reveals that there is no special treatment for cactus pear producers concerning credit from Microfinance institutions.

#### 4.2.2.12. Producers Organizations

According to the survey, focus group discussion, key informant interview with agriculture experts and cactus pear institute director of Adigrat University there is no producers' organisation which is responsible for collecting and selling cactus pear in Eastern Tigray in general and Ganta Afeshum district in particular. Moreover, they also added that though there are some initiatives to form cooperatives from non-governmental organisations such as FAO and HELVETAS, the support from governmental offices is low.

#### 4.2.3. Middleman/Collectors

According to the survey, the key informant interview with the focal person from HELVETAS, interview with collectors and key farmers in the FGD, the collectors have a significant role in the Eastern Tigray cactus pear value chain. Specifically, their role in the chain is buying large amount cactus fruit from farmers, transporting the fruit from farm to the nearby town Adigrat using big car called 'ISUZU' and selling to wholesalers and the local retailers. At the beginning of the season (end of May), the collectors inform producers as they are going to buy them in every three days with the price 100 ETB per crates (weighing around 60 kg). The farmers start harvesting fruit the day before selling to collectors and use their packaging materials until the collectors come and put the fruit on their woody crates. The collectors also collect the unknown amount of cactus fruit from

farmers at the open market called '*Mayida Agame*' and pay them 120 ETB/crates. After buying the fruit, the collectors do simple sorting based on the market distance of buyers. They sell not much-ripped fruit to the wholesalers in the regional and capital cities, and the leftover (ripped or over ripped) is sold to local retailers. Since they have strong linkage with the wholesalers in the regional markets, they sell more significant amount of cactus fruit through this chain. They also have a direct linkage with local retailers but not as strong as wholesalers. According to them, they have a loss which is caused by temperature and overfilling of the crates during transportation.

#### **4.2.4. Processor (Agame Beles)**

According to the interview with the processor and key informant interview with cactus pear institute director and focal person of HELVETAS, Agame Beles is a small-scale enterprise which has 20 members of cooperative and established with the help of UNIDO. The aim of establishing this processing unit was to export cactus pear from Eastern Tigray to the domestic and international markets and thereby to benefit producers and to create employment to the youth. The role of this processing unit in the chain is collecting the fruit from farmers, transporting from farm to the processing unit, removing the glochid spine, sorting, brushing, packaging and selling the fresh fruit to the domestic and international markets. Though their plan to sell during the establishment of the project was 32 tons per day; they are now limited to process only 5000 kgs per day. According to the person from Agame Beles, this is because of different factors which are related to farmers (supply shortage due to not having an agreement), market-related problem (lack of market), financial constraint and bureaucracy in the governmental offices. Apart from it, regarding post-harvest losses and perception about causes of post-harvest losses, the interviewed person said that they have significant losses, and which is caused by lack of skill on harvesting, receiving not sorted fruit from farmers, not using cold storage facilities and refrigerated transportation system.

Picture showing cactus pear transportation and processing in Agame Beles



Source: Adigrat University Cactus Pear Institute Director, 2018

#### **4.2.5. Wholesalers**

The interview with the wholesalers in the capital and regional city reveals that their role in the chain is buying the cactus fruit from collectors, transporting the fruit from Adigrat to where they are (Addis Abeba, Mekelle, Adwa, Axum, Shire and Humera), sorting and selling to retailers. They have a significant financial power to deal with collectors on the price and amount of cactus pear that they receive from them. They send a big car with around 100 empty woody crates to receive the cactus fruit from the collectors. They prefer to transport the car during the night time to reduce loss on the time of transportation. Upon arrival they immediately sort the fruit on the bases of customer requirement before they sell. They sort the good shaped and not much-ripened fruit for the supermarkets, the ripened fruit with a little defect to street vendors, and they throw the spoiled fruit. They also use wooden crates as a packaging material to sell the fruit. They also added that, though they have their store for other fruits, they are not storing cactus fruit even for half a day because of the sensitive nature of the fruit. Additionally, they said that once if the fruit gets spoiled, they will be forced to sell it at a low price.



Regarding losses, they said though they are not storing the fruit, they still face losses. According to the perception of wholesalers, the cause for fruit spoilage was due to the damage created during harvesting, overfilling/load of crates during transportation and long/delayed transportation. Apart from this, the wholesaler from capital market said that their demand for cactus pear is growing over the last three years.

Picture showing interview with wholesaler in Addis Abeba 'Atkilt tera' and the spoiled fruit around the place



#### 4.2.6. Retailers

The interview with retailers and key informant interview with a focal person of HELVETAS Ethiopia indicates that the role of retailers in the cactus pear value chain encompasses direct buying from wholesalers, farmers and the processing unit, transporting, sorting, packaging and selling to the consumer. The retailers in the capital and regional cities mostly buy from a wholesaler while the retailers in the local market buy from directly farmers and collectors. On the other hand, the retailers in the international market buy from the processing unit (Agame Beles). All the retailers in the local and regional market sell the fruit in the open market and around the street, whereas the retailers in the capital city sell it in supermarkets and on the street as well. According to the interviewed retailers in the regional and capital markets, they sort the fruit at the time of arrival before sell. The fruit with big size and ripened with no defect is sold with good price whereas the small size and over ripped with little defect sold with low price. Regarding packaging material, most of the retailers in the capital city said that they use simple plastic bags when they sell to the travelling consumer. However, the retailers in the regional and local market are not using any packaging material, but they do peel the fruit to consumers. According to their perception, the fruit loss at the retailers' level is high. The reason for this was using inappropriate harvesting tool 'silki' by farmers damage the fruit and causes spoilage. Moreover, the transportation used by farmers is mostly human shoulder and animal backs that cause immediate sun contact which led to higher spoilage.

Picture showing the retailers in the local, regional and capital markets



#### 4.2.7. Consumers

The consumers are the end user of the cactus pear value chain. Their role in the chain is to buy the cactus fruit for consumption. According to the interview with the focal person from HELVETAS Ethiopia, In the cactus pear chain, the consumers are categorised as a local consumer, regional consumers, capital consumers and international consumers. According to him, most of the cactus fruit is consumed in the regional markets such as Mekelle, Adigrat, Adwa, Axum and Humera. As it is also indicated in the chain map, the majority of the consumers from the regional market consumes from street vendors with a reasonable price. The consumers from capital market buy both from supermarket and street vendors with a relatively high price. The consumers from the local market (Ganta Afeshum) mostly consumes from street vendors with low price.

#### 4.2.8. Supporters

The main supporters in the cactus pear value chain are the Bureau of Agriculture Office, HELVETAS Ethiopia, Tigray Agricultural Research Institute (TARI), Microfinance Institution (Dedebit) and Adigrat University Cactus Pear Institute (ADU). According to the interviews with the experts from Agriculture Office, TARI and ADU, their role in the chain is to support the main chain actors through providing training on how to improve production and reduce post-harvest loss via row plantation, harvesting techniques and Agro-processing such as changing the fruit to juice and jam. However, the survey result reveals that most of the respondents have no access to extension service from the Bureau of Agriculture. The key informant interview with cactus pear institute director reveals that though there is one expert at a regional agriculture office in the regional city 'Mekelle', there is no expert assigned specifically for cactus pear at the district level. Moreover, the surveyed respondents said that though there is an extension service from extension agents, it is not for cactus. However, the key farmers from the FGD said that there is training with the frequency of one-year interval from non-governmental organisations. Though the training are not inclusive to all farmers.

According to the key informant interview with HELVETAS, though there are some initiatives from NGOs nowadays, the attention of the government at a national level is low. The interview with ADU cactus pear Institute also reveals that though the fruit is included as a common commodity in the 'five-year growth and transformation plan II' at a regional level, the agricultural support from agriculture office is too low.

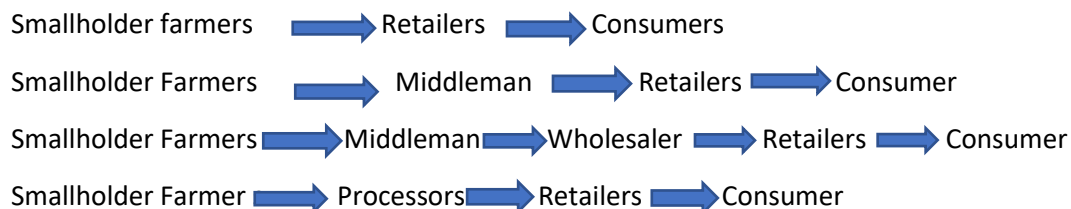
The interview with an expert from research institute also reveals that their focus is mainly on the utilisation of cactus cladode for livestock. The expert also added that there is no improved cactus variety released from the institute so far. However, as a research institute, they were part of training provision in collaboration with the non-governmental organisations to smallholder farmers.

On the other hand, the surveyed respondent also said they have access to credit service from Dedit microfinance. However, the credits are not specifically for the improvement of the cactus pear production. Moreover, the result from focus group reveals that even though there is access to credit, the loan amount from the microfinance is not enough and it needs collateral to show.

## 4.2. Information and Product Flow in the Cactus Pear Value Chain

### 4.2.1. Product Flow

As it is indicated in the chain map, the cactus fruit chain has different marketing channels which start from producer and ends with the consumer. According to the survey, FGD and key informant interview with HELVETAS Ethiopia, the cactus pear value chain in Eastern Tigray has four market channels in which the product flows to market. The FGD reveals that most of the cactus fruit is consumed in the regional markets followed by the local market so that the first and the third market channels were the dominant one in the cactus pear value chain of Eastern Tigray. The market channel of cactus pear value chain is as follows: -



### 4.2.1. Information Flow

According to the survey result, most (85 %) of the respondents replied that they do not have information about the market price and cactus demand in other markets while the rest those who were taking the retailer role replied as they know. Moreover, the interview with Adigrat University cactus pear institute director also reveals that since the majority of farmers in Eastern Tigray is illiterate, they are not recording their daily sale and cost. According to the person, being illiterate has a direct linkage with knowing the costs incurred and the ability to negotiate on price. The agriculture officials said that farmers are not using modern packaging material which makes the consumers trace it back if a problem occurred to the fruit. According to the information gained from the focal person in HELVETAS, the collectors has more market information like on the market situation, price and quantity demanded in the market than others so that they control the market and pay a lower price to the farmer.

## 4.3. Profit and Value Share of the Chain Actor

As it is shown in the table below (table 15), to compare the gross margin and value share farmers in the cactus pear value chain, the gross margin and value share of actors has calculated for the two market Chanelle's. The first part of the table shows the gross margin and value share of actors which involves farmers, collectors, wholesalers and retailers, whereas the second part of it shows the gross margin and value share of actors which involves farmers, processor and retailers.

In the first market Chanelle, the variable cost of farmers is 1.55 ETB/kg which is computed from the sum of costs for land rent, labour during harvesting and transportation, transportation cost, cost of packaging materials used and cost of spoiled cactus. The variable cost for collectors is 0.35 ETB/kg and which belongs to the cost of transportation to nearby town and cost of labour for loading and unloading; and the variable cost for wholesalers is 0.7 /kg ETB this is for the cost of transportation, labour for loading and unloading, packaging material, payment for rent of selling places and cost of spoiled cactus. According to the interview with different

actors and the wholesalers themselves, the variable cost for the wholesaler is quite high as the compared cost of the other actors except for the cost of farmers. The retailers have a relatively average variable cost 0.25 ETB, and this was for costs like transportation, loading unloading, packaging materials and cost of spoiled cactus fruit.

Whereas in the second market Chanelle, the variable cost of the processor is the highest and variable cost of farmers is the lowest. The cost of processor belongs to the cost of transportation, loading unloading, labour, house rent, tax, cost of electricity and packaging material where the variable cost for the retailers is for transportation, labour for loading/unloading, packaging materials and cost of spoiled cactus fruit.

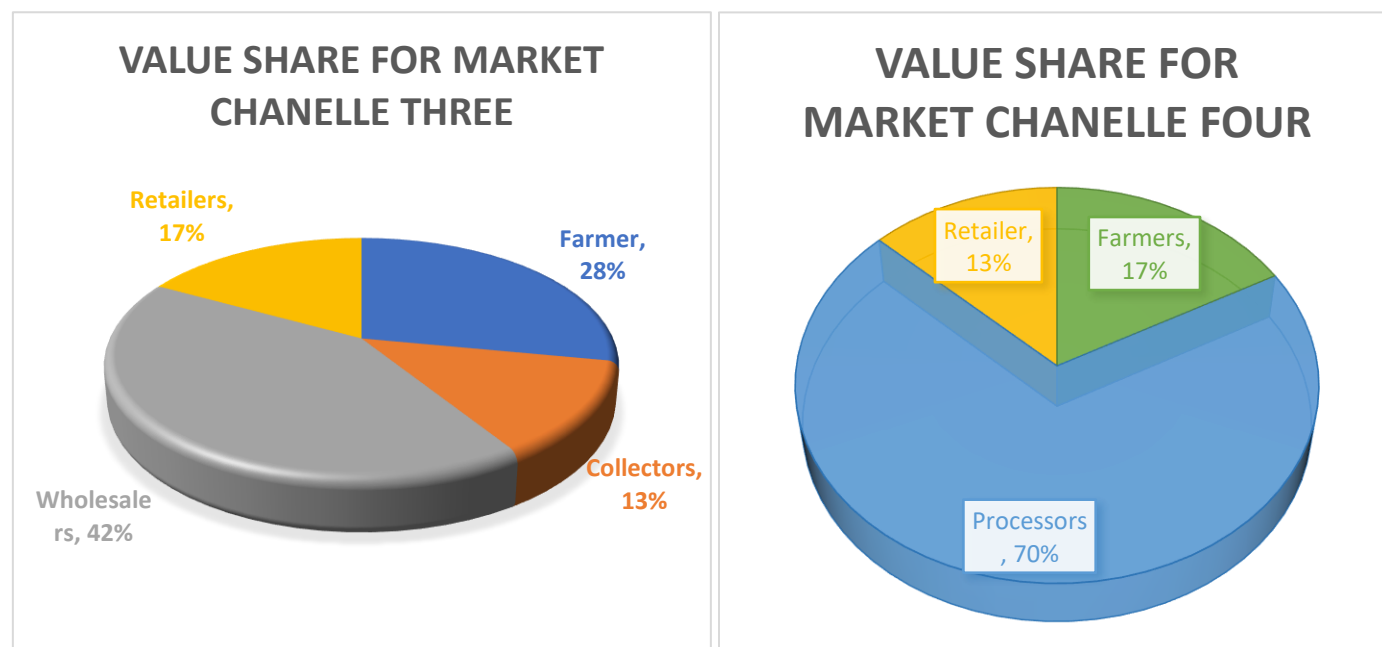
The gross margin and value share analysis result for Chanelle three shows that the highest gross income (operational profit) is 1.8 ETB/kg which is recorded by wholesaler whereas the lowest gross income 0.15 ETB/kg was for farmers. While the collector has 0.45 ETB/kg, retailer earns 0.65 ETB/kg. Similarly, the result shows that the wholesalers record the highest gross margin, the added value and the value share. It also shows that farmers have farmers has the highest value share and lowest gross margin.

On the other hand, the gross margin and value share of actors in the market Chanelle four shows that the added value, gross margin and value share of the processor. Whereas farmers have a high gross margin and low-value share in this market Chanelle.

Table 8: Gross Margin and Value Share of Cactus Pear Value Chain in Eastern Tigray

Actors	Variable Costs (VC)	Buying Price (BP)	Cost price (CP)= (VC+BP)	Sale price/kg (SP)	Gross income (GI)= (SP-CP)	Added value (AV)= SP2-SP1	Gross margin (%) (GM)= GI/SP*100	Value share (%) (VS)= AV/Retailer P*100
<b>Gross Margin and Value Share for Market Chanelle Three (Product goes to wholesaler via collector)</b>								
Farmers	1.55		1.55	1.7	0.15	1.7	9	28
Collectors	0.35	1.7	2.05	2.5	0.45	0.8	18	13
Wholesalers	0.7	2.5	3.2	5	1.8	2.5	36	42
Retailers	0.25	5	5.25	6	0.75	1	12.5	17
Total								100
<b>Gross Margin and Value Share for Market Chanelle Four (product goes through processor)</b>								
Farmers	1.55		1.55	4	2.45	4	61.25	17
Processors	3.5	4	7	20	13	16	65	70
Retailer	1	20	21	23	2	3	8.69	13
Total								100

Figure 13: Pie charts showing the Value share of actors in the two markets Chanelle's



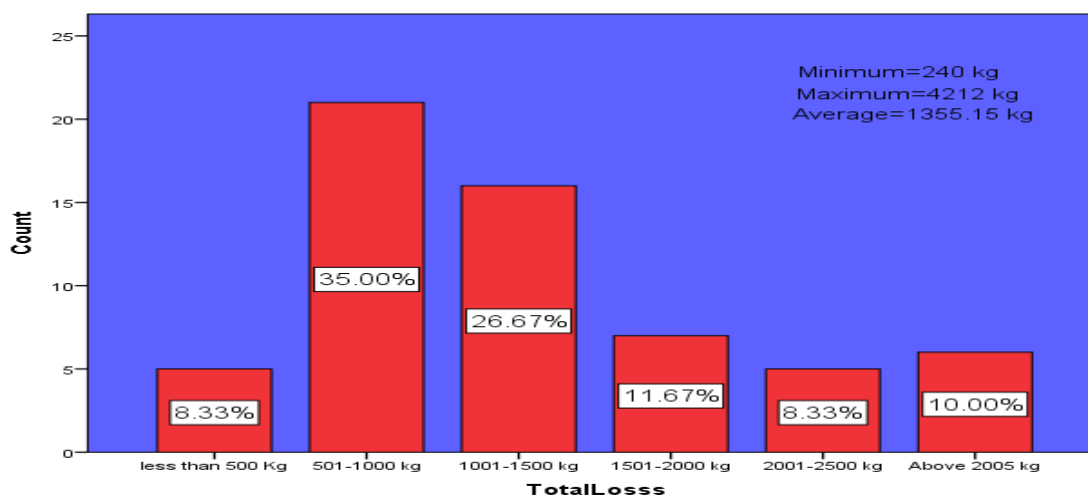


## 4.4. Post-Harvest Losses

### 4.4.1. The volume of Post-harvest loss at Producer Level

The total post-harvest loss had calculated as the sum of all losses that farmers encountered during harvesting, storage, sorting, packaging, transportation and selling. The maximum and minimum total loss of producers were 4,212 and 240 kilos per season respectively. As it is shown in the bar graph (figure 14), most (35 %) of the respondents had a loss between 501-1,000kg per season whereas around 10 % of the respondents had more than 2,005 kg total post-harvest losses.

Figure 14: Bar graph for the volume of post-harvest loss at the producer level



### 4.4.2. The effect of Post-harvest Losses on Smallholder Farmers Income

Based on the survey result, table 16 shows that the minimum and maximum profit of farmers in a season is 1000 and 9500 ETB respectively with a mean profit of 4061.28 ETB. The correlation result (Annex 8) also shows that when total post-harvest loss increases the profit of farmers in a season decreases. In another word, the relationship between the two variables is negative and significant.

Table 9: Descriptive Statistics showing a profit

	N	Min	Max	Mean	Std. Dev
Profit	60	1000.00	9500.00	4061.28	2100.95

### 4.4.3. Existing Post-Harvest Handling Practices of Farmers

#### 4.4.3.1. Harvesting

The survey result reveals that most (73%) of the farmers harvest their fruit from June to September while the rest 27% of the farmers harvest from May to September. More than half (52%) of the farmers do not have a specific time of harvesting whereas the rest 48% of them had a specific time of harvesting. Those farmers who had a specific time of harvesting prefers to harvest the fruit early in the morning and in the evening. According to the key informant interview with cactus pear institute director, the fruit should be harvested on cold time (morning, evening and when there is rain). From the personal observation result, though respondents said they are harvesting the fruit at the specific time of the day, they were found while they were harvesting at a mid-day. The independent sample t-test (Annex 9) shows that as there is a significant difference between a total post-harvest loss and the farmer's response on having a specific time of harvest. The bar graph (figure 16) also shows that the farmers who had a specific time of harvest has a lowest mean loss than those who do not have.

Figure 15: Bar graph showing seasons for harvesting

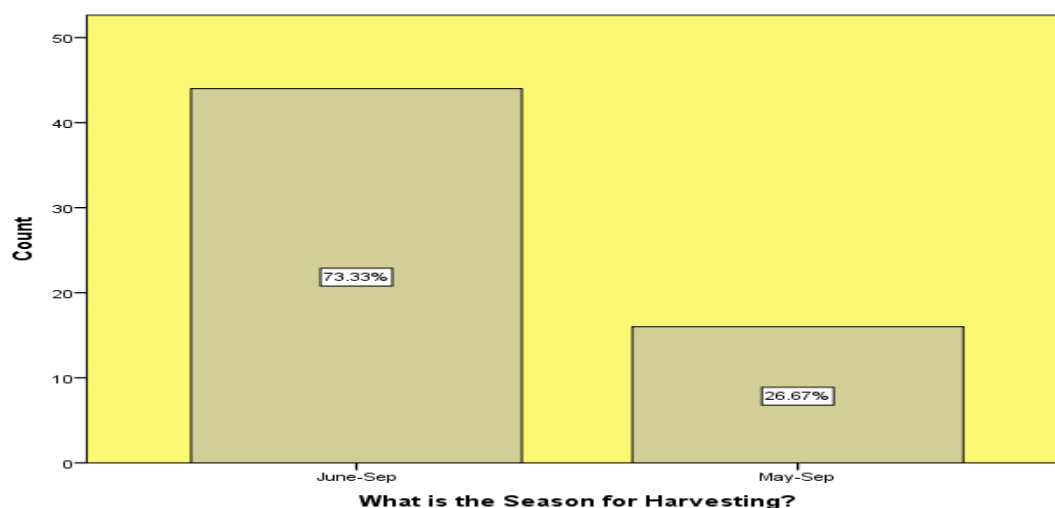
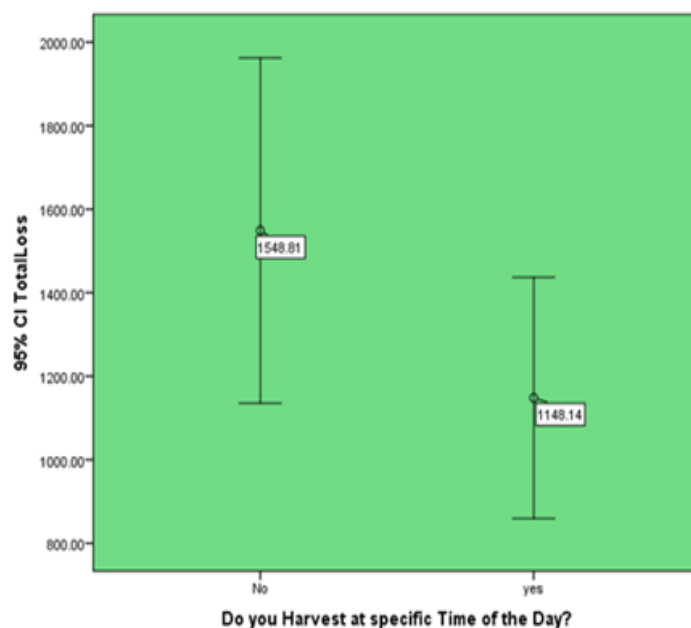


Figure 16: Error bar for harvest at specific time and loss

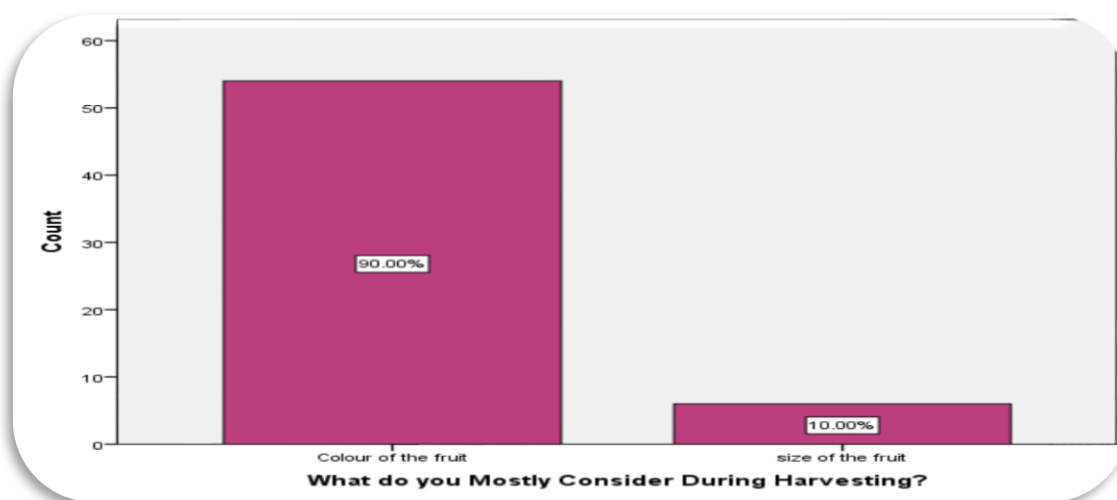
Table 10: Crosstab Between the specific time of harvest and time

the specific time of Harvesting		Time of Harvest		Total
		Morning/ Evening	Anytime	
No		0	31	31
yes		29	0	29
Total		29	31	60



As it is indicated in the bar graph (figure 17), most (90 %) of the surveyed farmers consider the color of the fruit during harvesting while the rest (10 %) considers size. The FGD result also indicates that harvest consideration of cactus depends on the buyer's demand. If the buyers are processor and collectors from regional and capital market, they prefer not ripened fruit to reduce the loss during transportation. Whereas the local retailers demand the ripened fruit.

Figure 17: Bar graph showing for criteria of harvest



From the survey result shown in the bar graph below (figure 18) most of the respondents from the two-peasant association (35% from Buket and 33% from Golea) uses a stick with a metal container which is locally called '*tanika*' while the rest uses a stick with top tin metal to harvest cactus fruit. The key farmers from the focus group discussion and the expert from Agriculture Office said that, since the top tin metal penetrates to the internal part of the fruit during harvesting, facilitates spoilage of the fruit. The metal container was much better for them to store the fruit for at least for 3 to 5 days. Moreover, the independent sample test in the (Annex 10) shows that as there is a significant difference between the two harvesting tools towards the total post-harvest losses. The error bar (figure 19) shows that the farmers use a stick with top tin metal as a harvesting tool have highest post-harvest loss as compared to the other farmers.

Figure 18: Bar graph showing harvesting tools

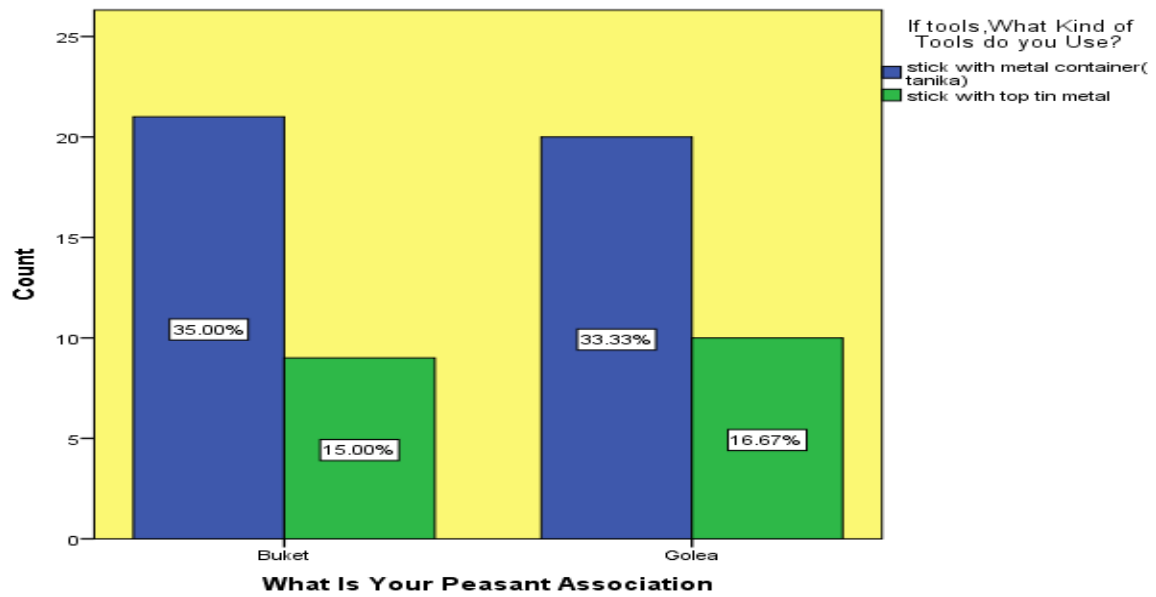
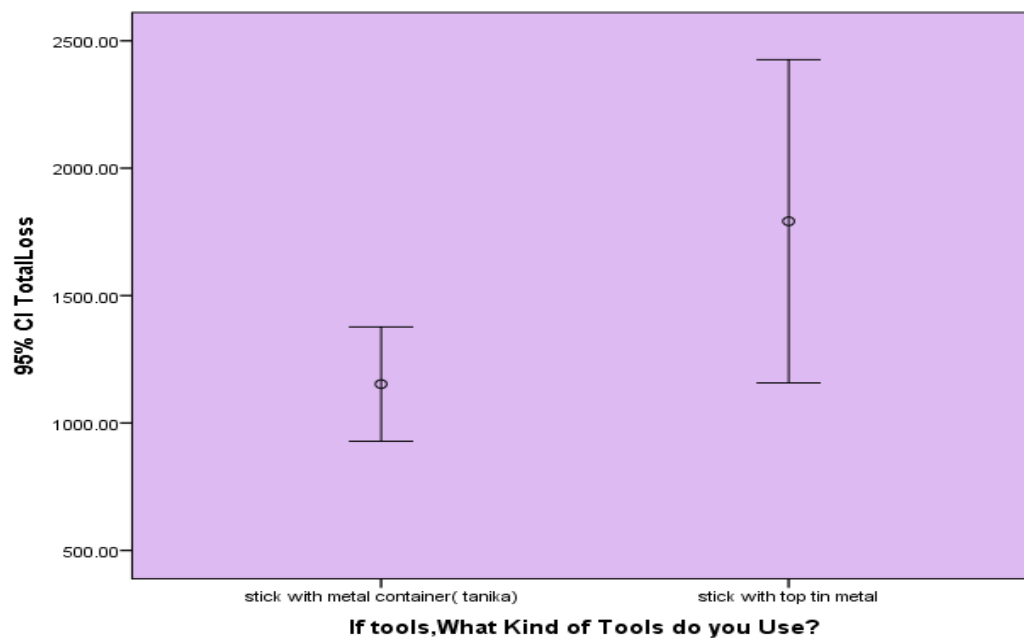


Figure 19: Error bar showing harvesting tools via loss



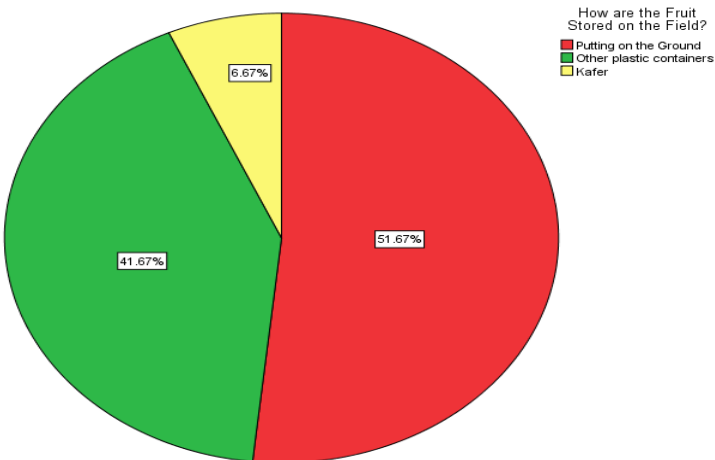
Pictures of field work to show harvesting tools and harvesting techniques



### Fruit treatment after Harvest on the Field

According to the survey result in the pie chart below (figure 20), more than half (51.6%) of the farmers put their cactus fruit on the ground. The main reason for putting the fruit on the ground was to remove the glochid spine on the fruit skin. The other 42 % of the farmers use plastic containers and the rest 7 % uses a traditional handmade container which is called 'cafer'.

Figure 20: Pie chart showing storage on the field



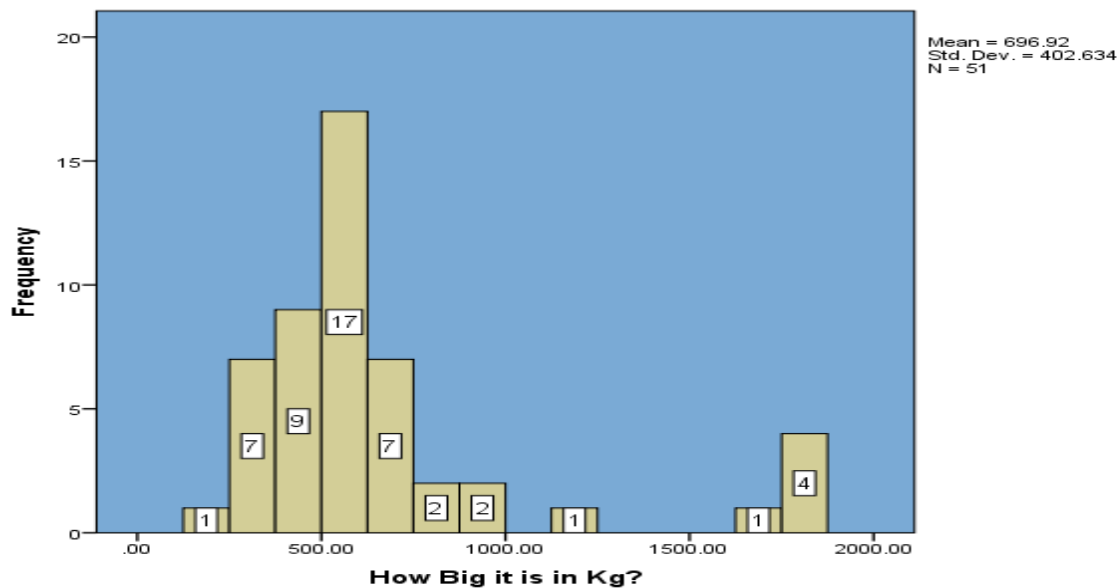
### Perception of Respondents on Causes of Harvesting Loss

As it is depicted in the table below (table 21), most (85%) of the sampled respondents faced loss during harvesting. Out of them, 29% of the respondents put their perception as a harvesting tool followed by lack of skill, unavailability of row plantation and over-ripening as a cause for harvesting loss. The histogram (figure 21) shows that most of the respondents had a loss between 500-1000 kg during harvest time.

Table 11: Crosstabulation between harvesting loss and causes

		Causes				Total
		Harvesting tools	Skill	plantation	Over-ripening	
Harvesting Loss	Yes	15	14	13	9	51
Total		15	14	13	9	51

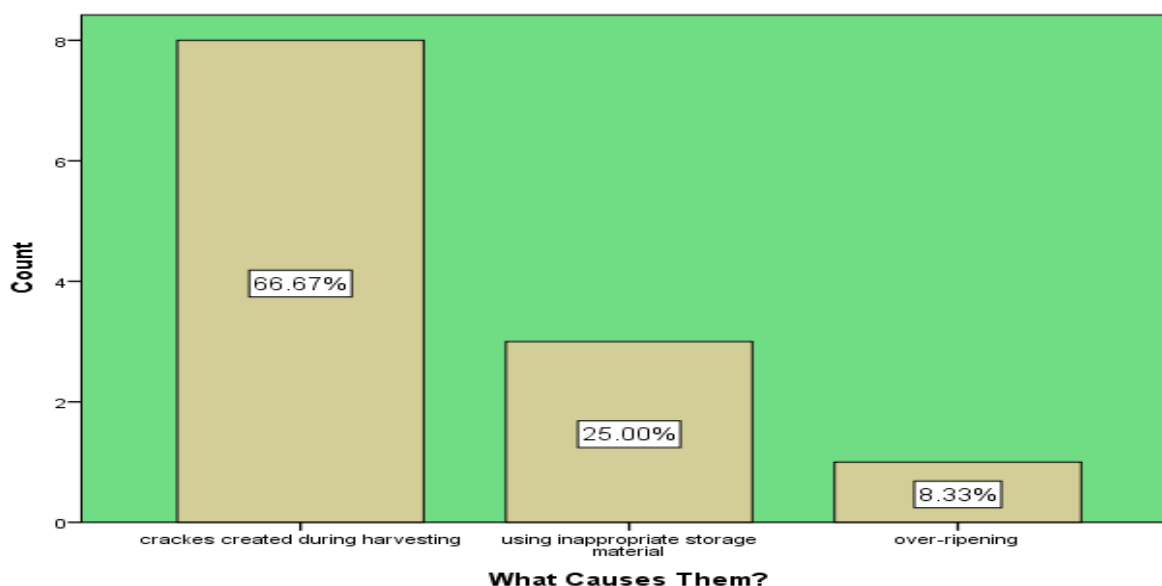
Figure 21: Histogram showing amount of loss during harvesting



#### 4.4.3.2. Storage

According to the survey, the focus group discussion and the key informant interview with different officials, the farmers were not using cold storage facilities so that around 45% of the surveyed respondents said there is storage loss. As it is shown in the bar graph below (figure 22), most (67%) of the surveyed farmers perceived that cracks created during harvesting were the leading cause for storage loss while 25% of them mentioned inappropriate storage facilities. The rest 8% mentioned over-ripening as a cause for storage loss. Though the respondents mentioned this, the key farmers from FGD said that the loss from storage is insignificant because most farmers are not storing cactus pear for more than one day. The key informant interview with agriculture experts, research centre, cactus pear institute director of Adigrat University shows that the awareness of farmers on how to preserve and storage is limited.

Figure 22: Bar graph showing the perception of farmers on storage loss



#### 4.4.3.3. Sorting

As it is shown in the table below (table 22), 50 % of the sampled respondents do sorting while others 50 % do not sort the fruit before they sell. From those farmers who do sorting, most (87 %) of the farmer's sort based on the criteria of ripeness and size while the others an insignificant number of farmers sort based on quality and market requirements.

Table 12: Crosstabulation between sorting and sorting criteria

	Sort criteria			Total
	ripped and big size	not cracked	depends upon the market distance	
Sorting	26	2	2	30
Total	26	2	2	30



#### 4.4.3.4. Packaging

According to the survey result, all respondents replied that they do packing using different packaging material before they sell the fruit. Most (53%) of the farmers use 'cafer' the rest 21% uses woody crates, and 18% of them use plastic containers. Insignificant number (5%) of farmers uses plastic crates. According to the experts from the bureau of agriculture and cactus institute director farmers are not washing the fruit before they pack and use plastic/sacks inside the other packaging materials to protect the fruit from damage during transportation. In the survey, the farmers asked if there was loss during sorting and packaging, 93% of them replied that no loss during sorting and packaging whereas 7% of them said there were losses.

Figure 23: Bar graph showing packaging materials

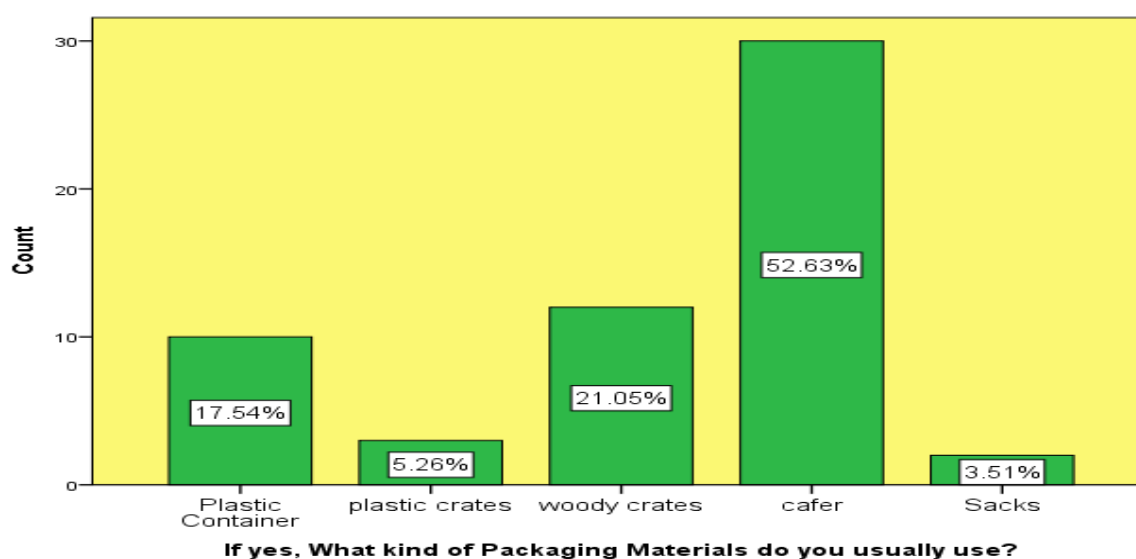


Table 13: Frequency table for losses during sorting and packaging

	Frequency	Percent
No	56	93.3
Yes	4	6.7
Total	60	100.0

Pictures showing packaging materials





#### 4.4.3.5. Transportation

Table 24 below shows that most (93 %) of the respondents transport the fruit using different ways of transportation whereas the rest 7% sell the fruit on the farm. From those who transport the fruit, 72 % of them uses human shoulder while the other 16 % of them uses animal back to transport the fruit to the marketplaces. There was also an insignificant number (7%) of farmers who use public transport.

Regarding loss during transportation, out of the total sampled respondents, more than half (68%) of the farmers said there is loss while the rest 32% said there was no loss during transportation (table 25). According to their perception in figure 24, most of the losses were due to overload and fruit vibration during transportation. Though poor in frustration was the least mentioned as a cause to fruit loss during transportation by the farmers, all the respondents from key informant interview and the key farmers from FGD mentioned poor infrastructure was the primary cause for fruit loss during transportation.



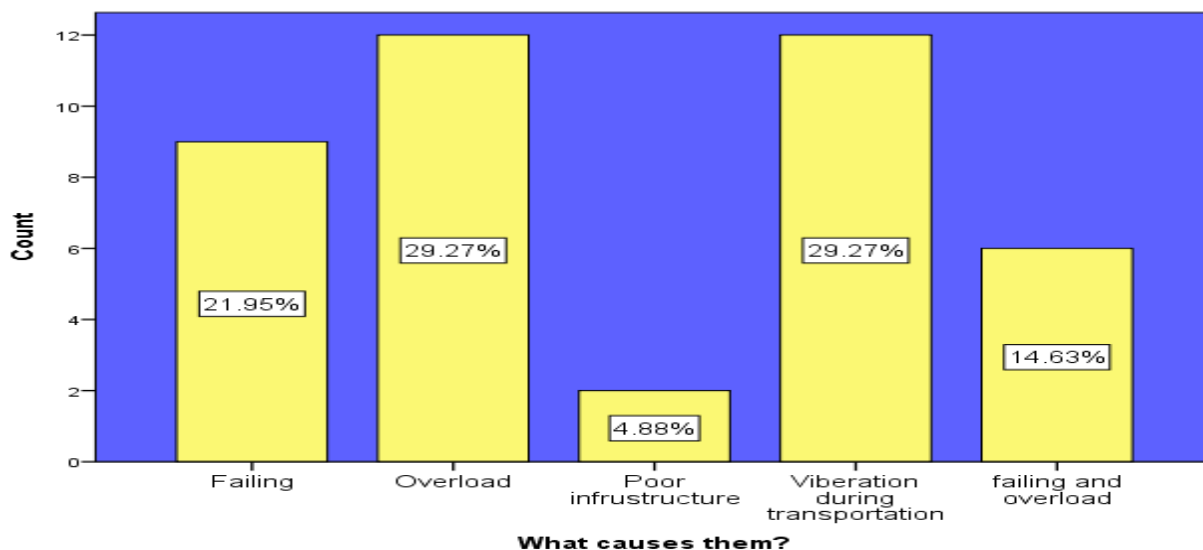
Table 14: Cross tabulation for transportation and ways of transportation

		Ways of transportation			Total
		Using Animal back	Using human Shoulder	Public transport	
Transporting the fruit	Yes	9	43	4	56
Total		9	43	4	56

Table 15: Frequency table for losses during transportation

	Frequency	Percent
No	19	31.7
Yes	41	68.3
Total	60	100.0

Figure 24: Bar graph showing the causes of transportation loss



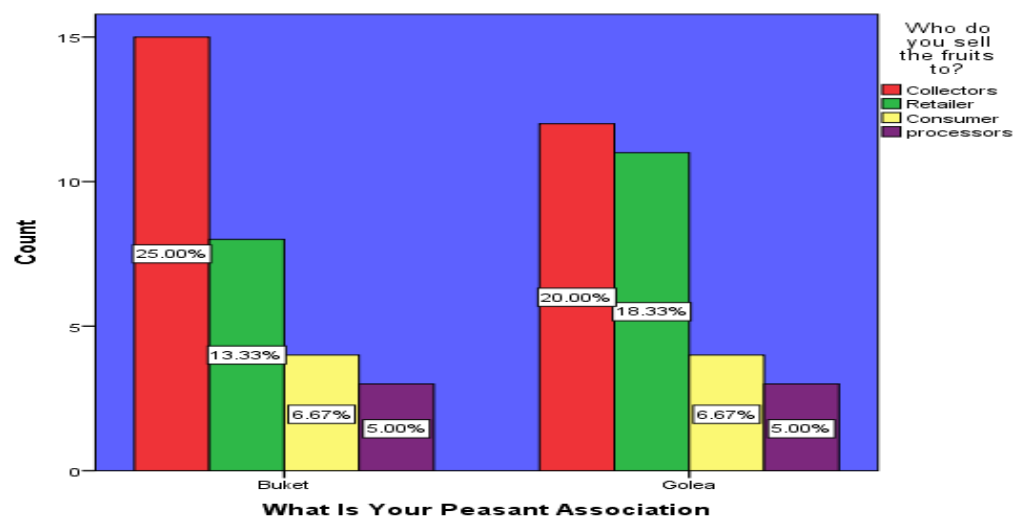
#### 4.4.3.6. Selling

The total sell of producers is calculated by subtracting total consumption and total loss from the total production per season. Table 26 shows that the minimum and maximum amount of sell of farmers from the total production per season was -600 and 16,906 kilos with an average sale of 5348.6 and standard deviation 4717.67. As it is indicated in the bar graph (figure 25) most (25%) of Buket and (20%) of Golea PA respondents sell their product to the collectors/middleman on the farm. Figure (25) also shows that only 5% of farmers from each peasant association sell their product to the fruit processor. According to them, they mentioned that the processor has a high-quality requirement. The result also shows that all of the respondents do not have a legal contract with buyers and every transaction made on the trust base.

Table 16: Descriptive Statistics Showing Amount of Sell from Total Production

	N	Min	Max	Mean	Std. Dev
Total sell	60	-600.00	16908.00	5348.63	4717.68

Figure 25: Bar Graph Showing Selling across PA



### Selling Price

According to the survey, the maximum and minimum market price of farmers is 3 and 1 ETB/Kg respectively with a mean value of 1.57 ETB/Kg. Based on the focus group, discussion result and interview with the processor, most farmers prefer to sell to collectors at a low price (1.5 ETB/Kg) rather than selling to the processor at a high price (4 ETB/Kg). According to the key farmers from group discussion, this was happening due to the high-quality harvest requirement of the processor. The processor prefers the cactus pear to be harvested by hand and small knife/cutter carefully without any damage on the fruit skin. However, they said the plantation does not allow them to use hand picking techniques of harvesting. Moreover, they also mentioned that it is difficult to pick the fruit without protective materials like gloves and eye cover because cactus pear has small glochid spines on the skin which is hurtful for the hand and eyes.

Table 17: Descriptive Statistics Showing Market Price

	N	Min	Max	Mean	Std. Dev
Market price per kg	60	1.00	3.00	1.5717	.51093

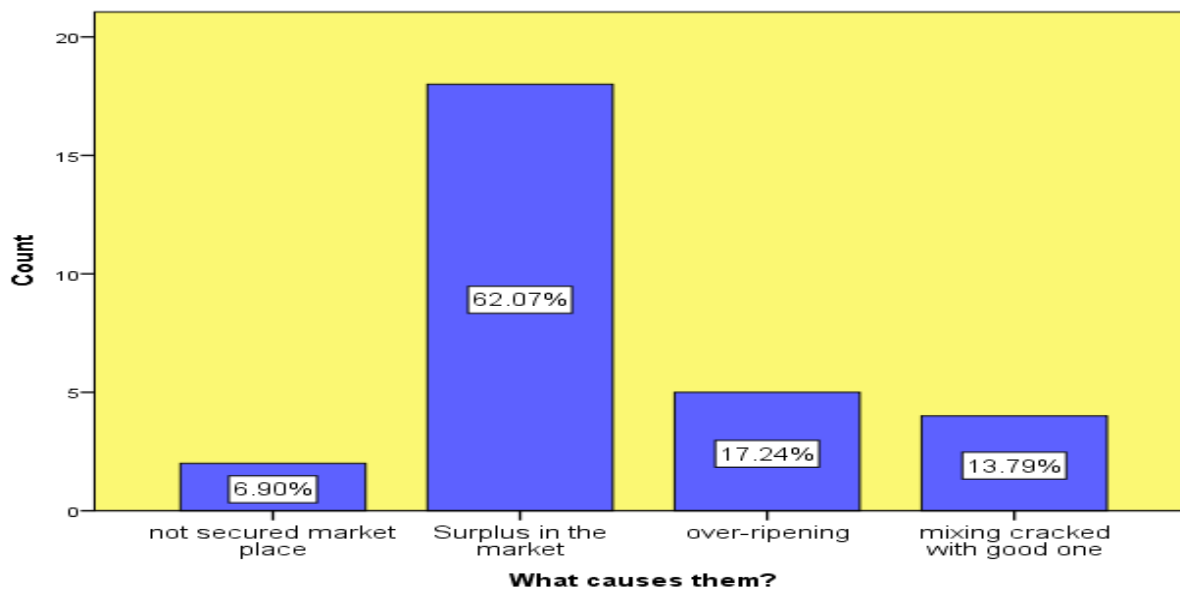
### Selling Loss and Perception of Farmers about Causes of Selling Loss

As it is indicated in the table below (table 28), out of the total respondents, while the 52% of them face loss during the transaction, 48% of them said there was no loss on the sale. From their perception on causes of loss in the market, 62% of them said surplus in the market, 17% over-ripening, 14% mixing well with bad and 7% due to unavailability of secured marketplaces. Moreover, the director of cactus pear institute in Adigrat University perceived that loss was farmers poor post-harvest handling techniques from harvesting to transportation, unavailability of well-structured marketplaces with good infrastructure and lack of well-functioning market were the main reasons which cause a loss on selling. According to the focus group discussion result, the key farmers indicated that sometimes the farmers take the retailer role, if the fruit gets spoiled they are forced to sell at a low price in the market.

Table 18: Frequency table showing availability of loss on selling

Loss during selling	Frequency	Percent
No	29	48.3
Yes	31	51.7
Total	60	100.0

Figure 26: Bar graph showing causes of losses on sell



Picture showing spoiled cactus at a retail market



## 4.5. Internal and External Factor Analysis

### 4.5.1. Stakeholder Analysis

Table 19: Stakeholders Matrix for Cactus Pear Value Chain in Eastern Tigray

Functions	Stakeholders	Basic Characteristics	Hindrance factors
Input Supply	No input supplier		
Production	Small-holder Producers	<ul style="list-style-type: none"> <li>- Small-scale production</li> <li>- low-income earner</li> </ul>	<ul style="list-style-type: none"> <li>- Low price</li> <li>- Unorganized farmer</li> <li>- No collection centres</li> <li>- Limited skill</li> <li>- Finance</li> </ul>
Collection	Collectors	<ul style="list-style-type: none"> <li>- local traders</li> <li>- Transporting fruits from farm to markets</li> </ul>	<ul style="list-style-type: none"> <li>- Traditional agreement (trust bases agreement)</li> </ul>
Wholesaling	Regional Wholesaler	- a large number of fruit buyers from the collectors and sell to retailers at the regional market	<ul style="list-style-type: none"> <li>- Informal communication</li> <li>- high post-harvest loss</li> </ul>
	Capital wholesaler	- a large number of fruit buyers from the collectors and sell to retailers in the capital city market	<ul style="list-style-type: none"> <li>- Informal communication</li> <li>- high post-harvest loss</li> <li>- the high cost of transportation</li> </ul>
Processor	Processing Unit (Agame Beles)	- Processing fresh fruit to sell to domestic and	<ul style="list-style-type: none"> <li>- Inadequate postharvest handling</li> <li>- Supply shortage from producer</li> <li>- The absence of a legal contract with buyers and producers</li> <li>-post-harvest losses</li> <li>- Financial shortage</li> <li>- Limited Skill</li> </ul>
Retailers	Local retailers (street vendors)	Small-scale individual business mainly by women and children	<ul style="list-style-type: none"> <li>- Inadequate infrastructures</li> <li>- lack of financial capacity</li> </ul>
	Regional retailer (street vendors)	Small-scale individual business mainly by women and children	<ul style="list-style-type: none"> <li>- Inadequate infrastructures</li> <li>- lack of financial capacity</li> </ul>
	Capital retailer (supermarkets and street vendors)	Private business and small-scale individual business mainly by teenagers	<ul style="list-style-type: none"> <li>- Inadequate infrastructures</li> </ul>
Supporters	HELVETAS	International NGO	<ul style="list-style-type: none"> <li>- a limited number of project involvement</li> <li>- lack of government support</li> </ul>
	Tigray agricultural research institute (TARI)	Research and extension	<ul style="list-style-type: none"> <li>- Skill</li> </ul>
	Agriculture Office	Government organisation	<ul style="list-style-type: none"> <li>- Limited skill</li> <li>- shortage of agricultural inputs</li> </ul>
	Adigrat University Cactus Pear Institute	Academic institution	<ul style="list-style-type: none"> <li>- budget constraint</li> <li>- Skill</li> </ul>
	DEDEBT	Financial support	<ul style="list-style-type: none"> <li>- lack of loan insurance/ recovery system</li> </ul>

#### 4.5.2. SWOT ANALYSIS

Table 20: SWOT Analysis for Internal and External Factor Analysis of the Cactus Pear Value Chain

STRENGTH	WEAKNESS
<ul style="list-style-type: none"> <li>• Potential production</li> <li>• Affordable price to the consumers</li> <li>• Women inclusiveness</li> <li>• Availability of domestic and international demand</li> </ul>	<ul style="list-style-type: none"> <li>• limited technical knowledge of farmers on farm management and harvesting</li> <li>• Limited research and extension services</li> <li>• Low market prices for farmers</li> <li>• Poor product agro-processing</li> <li>• poor transport systems</li> <li>• The absence of collection centres</li> <li>• Inadequate access to credit</li> <li>• The absence of a producer organisation</li> <li>• The absence of Improved variety</li> <li>• Using inappropriate packaging materials</li> <li>• Lack of storage facility</li> <li>• Poor infrastructure</li> </ul>
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> <li>• Availability of promotion</li> <li>• Establishment of the processing unit</li> <li>• Availability of agriculture-focused gov't policy</li> <li>• Being a common commodity on GTP II</li> <li>• Availability of microfinance institution</li> <li>• Availability of Agriculture expert at a regional level</li> <li>• Availability of cactus pear institute in Adigrat University</li> <li>• Availability of NGO initiatives</li> </ul>	<ul style="list-style-type: none"> <li>• Perishability/sensitivity of the fruit</li> <li>• The absence of quality control</li> <li>• Bureaucracy of offices</li> <li>• Lack of government support</li> <li>• Drought and natural hazard</li> <li>• Farmers illiteracy</li> <li>• Availability of illegal traders</li> <li>• Availability of child labor</li> </ul>

## 5. DISCUSSIONS

### 5.1. Factors Affecting the Cactus Pear Post-Harvest Losses

Cactus pear post-harvest loss is the primary constraint of the rural community in Tigray (GAFEIAS, 2012). Which is caused by the following factors:

#### 5.1.1. Pre-harvest Factors

##### Farm Management

FAO in 2013 reported that though the cactus plant is a perennial crop which is less dependent on external inputs, annual inputs such as fertilisers are essential, the timing may not be vital. However, as it is indicated in the result and analysis, there is no input supplier such as fertilisers and chemicals in the cactus pear value chain. The Focus group discussion also reveals that the farmers did not volunteer to invest their money in buying agricultural input for cactus production which is considered as a gift of nature. Moreover, the result from the FGD and key interview with cactus pear institute director of Adigrat University also show that there is no row plantation and the practices of weeding, pruning and irrigation for cactus pear production in the study area. This preharvest activities of farmers have a direct effect on the post-harvest losses of cactus fruit in the area. Different kinds of literature also support this. FAO 2008 reported that both the quantity and quality of the cactus produce is affected by planting density. For better harvesting and management of the stand, row plantation and appropriate spacing among the plantations are appropriate (GAFEIAS, 2012). According to FAO 2013 report, the planting density for cactus pear production should be 120 000–160 000 plants/ha, with beds width from 1.2–2.0 meters, 40–47 cm long and 1.0–1.5 meters spacing. Moreover, Waal et al. in 2015 added that applying irrigation for two to three times during the early stage of the cactus fruit development in the dry season and avoiding the top and side cladodes (Pruning) which shades the other parts of the plant increases production, fruit size, flesh percentage and ripening time.

#### 5.1.2. Post-harvest Factors

##### Harvesting

Regarding harvesting, the focus group discussion and the key informant interview with cactus pear institute show that the fruit should be harvested at the cold time (morning and evening). However, the survey result shows that most of the farmers from the survey do not have a specific time of fruit harvesting and they harvest the fruit any time of the day or when the time is convenient to them. The adverse effect of the harvesting time on post-harvest loss illustrated using independent sample test and error bar. This result was supported by FAO 2013 report that says the best time to start harvesting is at a lowest possible temperature to reduce fruit dehydration and infestation. Additionally, De Waal and his co-researchers in 2015 also added that harvesting of cactus pear should be started early morning when the spines are wet.

Moreover, the result shows that the farmers were using two traditional harvesting material locally called '*Tankia and Silki*'. While the *Tanika* leave an opening on the top part due to twisting and pulling during harvesting, the other one penetrates to the internal part of the fruit. According to the focus group discussion result, the fruit harvested using *Tanika* can be stored for some days (3 to 5 days) without using cold storage as compared to the other harvesting tool called '*silki*'. According to the independent sample test result, the farmers who use '*tanika*' have the lowest post-harvest loss as compared to the farmers who use '*silki*'. However, the result from the key informant interview with cactus pear institute director showed that fruit harvested manually using a small cutter has a most extended shelf life. De Waal et al., 2015 report, cactus fruit should be harvested manually, and the small piece of mother cladode should be on it to conserve the fruit for the more extended period.

## **Storage**

The result and analysis show that most of the surveyed respondents were put/store the fruit on the rough ground and use plant leaves to scrape or remove the glochid spines. The interview with agriculture office shows that this activity of farmers can create scratch and shorten the shelf life of the fruit. FAO 2013 report said that rough treatment of the fruit could shorten the lifespan of the fruit. Moreover, the report also added that to prolong the shelf life of the fruit; the fruit should be dry and laying out on the straw bed with plastic cover and brooms made from long tender brush should be used to remove the glochids.

Apart from it, neither the farmers nor the other actors have been using cold storage to prolong the shelf life of the fruit. The survey result shows that most of the farmers use shade to store their fruit. The interview with the processor revealed that even them they have not been using cold storage even for the exported fruit. Moreover, the result from the key informant interview with Adigrat University Cactus Institute Director also shows that farmers knowhow on how to store and conserve the fruit for more extended period is limited. The key informant interviewee added that unavailability of cold storage facilities and collection centres to collect and store the fruit in the area is the leading causes for cactus pear post-harvest losses in Eastern Tigray. According to the FAO 2008 report fruit, quantitative and qualitative losses of fruit can be significantly caused by high temperature and lack of cold storage. Moreover, FAO report in 2013 said that storing the cactus fruit without refrigeration led to micro- organism's infection and senesced. The report added that cactus could be stored for at least two months with refrigeration at a temperature level of  $0 \pm 0.5^{\circ}\text{C}$  and 85-90 % relative humidity.

## **Sorting and Packaging**

As it is shown in the result and analysis, half of the sampled respondents were sorting the fruit based on ripeness and size whereas the other was not sorting. The survey result shows that the farmers sell unsorted fruit for collectors. On the other hand, the interview with wholesalers and retailers reveals that though they are sorting the fruit before they sell, the sorting activity is done manually. The interview with processor indicates that most of the activity such as brushing, sorting and packaging is done with the help of machinery. However, the key informant interview from HELVETAS shows that one of the leading causes of fruit loss in the informal chain is due to unavailability of sorting and grading.

Regarding packaging, the survey result shows that though the farmers were using different packaging materials, most of them used the traditional handmade packaging material so-called 'cafer' to transport the fruit from place to place. The key farmers from the FGD said that since the fruit is transported using human shoulder and animal back, they put plastic and sacks inside the packaging materials to protect the fruit from damage during transportation. The key informant interview with the expert from the Bureau of Agriculture indicates that plastic and sacks used inside and hygiene of the packaging materials it self-facilitates spoilage at the producer level. The interview with the other actors reveals that most of the fruits at a collector, wholesaler and regional retailers' level are packed using woody crates whereas the local retailer uses both woody crates and 'cafer'. The result from the key informant interview with the focal person in HELVETAS shows that cactus pear is perishable produce so that it must be packed in the way the fruit adequately protected. However, most of the woody crates used by collectors are recycled and damaged this creates a defect to the fruit especially during long distance transportation.

## **Transporting**

The most vital thing in the value chain, to deliver high-quality product is transportation and marketing (FAO 2013). The result and analysis show that most of the farmers transport their fruit from farm to market using the human shoulder, animal back and public transport. Majority of them said they have a post-harvest loss during transportation. Farmers in the survey, the key farmers in the FGD and the interview with the the actors



and key informants, perceives that the causes of the post-harvest loss during transportation are; damage during harvesting and storage, using inappropriate packaging materials, overfilling of the packaging material during transportation, temperature and vibration of the fruit due to using traditional transportation system, and availability of poor infrastructure. FAO in 2008 reported that the significant loss of fruits during transportation is due to not using refrigerated transportation, mechanical damage, cold storage, inappropriate packaging materials and inadequate air flow and circulation.

### **5.1.3. Market Constraints**

#### **5.1.3.1. Value Share**

According to KIT 2008 report gross margin is the amount of a profit that each actor get from the chain whereas value share is the percentage of the final retail price that each actor achieves to get. In the gross margin and value share in the calculation of a market channel in which the collector has a significant role (Chanelle 3) indicated that the value share of farmers is high, but their gross margin is the lowest. On the other hand, the wholesaler has a significant value share and gross margin. Even the collectors were getting higher gross margin with lower value share (with insignificant value addition). This indicates that there is no fair profit distribution according to their contribution. The gross margin for farmers in the market channel four is quite high, and their value share is low. In this channel, the processor is adding more value to the product so that they are getting highest gross margin and value share. According to KIT 2008, in a perfect market, the gross margin shows that the cost (expenses) and risks of the actor; so that if the cost is high and the gross margin is high, it is called fair.

As it is discussed in the focus group discussion and key informant interviews, most of the product in eastern Tigray goes to regional and local markets, and the fruit is passing via collectors. The survey result shows that farmers are receiving the fixed price of 100 ETB/crates which fixed by the collectors. The farmers who are selling to the retailers and directly to consumer get a better price than via the collectors. According to Girma 2016 report banana farmers in southern Ethiopia got a higher price when they sell their fruit without the involvement of traders. However, the key farmers from focus group discussion said that instead of carrying the fruit by the shoulder to reach the market it was convenient to sell to collectors coming with big tracks even with low price. The key informants also added that all the cactus producer is smallholder farmers and they are not a member of cooperatives this hinder them to not negotiate on market price. Ampaire et al., 2013, reported that the collective action of the producer organisation enables smallholder farmers to be competitive in the agricultural market.

#### **5.1.3.2. Market Information**

On the other hand, regarding access to market information, the result from the survey, key informants and the focus group discussion show that most farmers do not have information about market price. Only those farmers who take the retailer role in the chain knows the exact price in the market. According to KIT 2006, Information is about knowing the prices and trends in the market which increases farmers bargain power with potential buyers (KIT, 2006).

#### **5.1.3.3. Market Demand**

The resulting analysis shows that as there is a market shortage due to surplus in the local market. However, the personal observation result shows that as there is a demand for cactus pear even in the international market. The result from the key informant with the cactus pear institute director shows that strengthen the chain through market linkage is the essential thing in the cactus pear value chain. Direct connection of smallholder farmers to formal buyers address the post-harvest inefficiency in the supply chain (USAID, 2013).

Picture showing the demand in the international market @ Lidl, Netherlands



### 5.2. Existing Strategies Implemented to Reduce Post Harvest Losses

According to the key informant interview with different officials, different stakeholders involved in reducing the post-harvest loss of cactus pear in Eastern Tigray. Those are HELVETAS, FAO, Tigray Agricultural Marketing Agency, Tigray Agricultural Research Center, Regional and District Bureau of Agriculture and Rural development and Adigrat University. The interview with the focal person of HELVETAS and Adigrat University shows that the contribution of the stakeholders in the cactus value chain was to facilitate the establishment of the processing unit (Agame Beles) to export fruit to Middle East (Israel), support the development of the value chain through via advertisement and market linkages and awareness raising of cactus producers. However, according to HELVETAS, this all was done by the initiative of NGOs without any governmental support. The establishment of the chain could not go further or be sustained due to the involvement of illegal traders in the cactus pear value chain. Moreover, the interview with cactus pear institute also reveals that the export market is not even becoming possible without quality control and Global Gap Certificate.

On the other hand, the result of the interview with the processor (Agame Beles) reveals that their enterprise is facing two problems which are related to supply and market. From the supply side, farmers are not willing to sell to them due to inadequate know-how on how to harvest manually. Even Though they provide a high price (4 ETB/Kg) to farmers, they prefer to sell at a lower price (1.7 ETB/Kg) to collectors. On the other hand, the processor mentioned that they are facing a market problem due to not having a legal agreement with buyers.

### 5.3. Suggestions to Improve the Current Post-Harvest handling practices

According to the focus group discussion and interview result with Adigrat university, HELVETAS, Research Institute and District Agriculture Office, to reduce the current post-harvest loss in Eastern Tigray, the following activities should be done from harvesting to marketing

- ❖ Awareness creation to farmers
- ❖ Harvesting at the cold time and manually to avoid mechanical injury.
- ❖ Establishing collection centres in each peasant associations
- ❖ Improving the infrastructure and transportation system
- ❖ Using appropriate packaging material

### 5.4. Sustainability Issues in the Cactus Pear Value Chain

According to the key informant interview with Adigrat University cactus pear institute director, HELVETAS and agriculture office, regarding people, the poor rural community in eastern Tigray is dependent on the cactus pear

production. It becomes the primary source of food and income for the rural poor. The key farmers from focus group discussion said that the cactus pear value chain engages a large number of women at a different level. Since men are mainly engaged in other common crops such as barley and wheat production that needs ploughing, the harvesting, transportation and marketing of cactus pear is mainly dominated by women and children. They also added that even though there are several women at the collector level, their number at retailer level is higher. The interview with the Bureau of Agriculture also shows that cactus pear is collected during school holiday time mostly June-September, children collect and sell to cover their school fee and school facilities. The interview with HELVETAS added that the price of cactus fruit is affordable even to the poor people especially in a local market so that the fruit has a more significant contribution to food security.

Picture showing retailing by children



According to them, cactus pear has environmental and biodiversity benefits. Cactus pear is a drought resistance plant it protects the soil from land degradation cactus has much environmental importance in Eastern Tigray including protecting the land from degradation and flooding. Moreover, the focus group discussion shows that during drought time the cladode (leave of cactus pear) and the residue from cactus fruit serves as animal feed.

Regarding profit, the result of the interview with cactus pear Institute shows that cactus pear is a source of income for smallholder income. So that if this post-harvest problem is solved it will improve the income of producers. The surveyed farmers and key farmers from FGD also said that since it has no cost of production, it has profit at least to cover their children school facilities.

## 6. CONCLUSION

The cactus pear value chain in Eastern Tigray encompasses different main actors such as producers, collectors, wholesaler, processor, retailers and consumers; and support giving organisations like ADU, TARI, DEDEBIT and BoARD. The producers are smallholder farmers and wild collectors, and their primary role is to produce and sell cactus fruit to the collectors and local market. Collectors were doing the collection from smallholder farmers at the farm and sell to regional/capital wholesalers and local retailer. Wholesaler, on the other hand, buy the fruit from collectors and sell to the regional and capital retailer. The retailer buys from wholesalers, processor, collectors and farmers; and sell it directly to the consumer.

The cactus pear value chain in eastern Tigray indicates how the product and information flow among the chain actors. While the cactus pear product flows upward among the chain actors, the information flow is both sides among actors. The cactus pear value chain has four market channels which show the product flow among actors. Since most of the fruit is consumed at the regional and local market, the product flow which involves collectors is most dominant. On the other side, the information flow in the cactus pear value chain is fragmented, and it is the concentration at a producer level is low. The information about the market situation, price and quantity are more concentrated at a collector level.

Regarding the gross margin and value share of actors in the chain, there is no fair distribution of profit among actors in the main cactus pear value chain in eastern Tigray. The gross margin of farmers is low with a high-value share of farmers in the cactus pear value chain which passes via collector compared to other actors. The highest value share recorded by wholesalers followed by collectors, retailers and farmers (11.8%). Therefore, it is concluded that the main market channel has an unfair price to farmers. On the other hand, the gross margin and value share of farmers in the market channel via the processor is high and low respectively.

The post-harvest loss in the cactus pear value chain is more at a producer, wholesaler and retailer level respectively. The volume of post-harvest loss at the producer level in the cactus pear value chain ranges from 240 to 4,212 kg per production season. The main causes of post-harvest losses are; availability of limited technical knowledge of farmers about farm management and harvesting, financial shortage, availability of illegal traders, inadequate market information, absence of research and extension service, low government attention to the sector, using traditional transportation, absence of collection centers in the nearby villages, absence of producer organization, absence of improved variety, using inappropriate packaging materials, lack of storage facility and poor infrastructure.

There is an adverse effect of post-harvest loss on farmers income. The Bivariate correlation shows that there is a negative relationship between the two variables. When post-harvest loss increases, the reverse happened to smallholder farmers income or vice versa. To solve this different stakeholders were involved through giving training, the establishment of the processing unit, promotion and market linkages. However, the chain is still informal and have many losses due to the reasons mentioned above.

## **7. RECOMMENDATIONS**

Based on the result of the findings, the possible areas of intervention were identified to reduce the cactus pear post-harvest losses at smallholder farmers level thereby improve their income. Though the recommendation is mainly given to the Cactus Pear Institute Director of Adigrat University, other recommendations were also made to the other stakeholders.

### **Cactus Pear Institute Director of Adigrat University**

- Strengthening the capacity of farmers through regular training on cactus pear production and post-harvest handling practices to improve farmers skill on production and harvesting of the fruit.
- Practical demonstration and popularisations of cactus pear row plantation, application of agricultural inputs, proper harvesting, removal of the glochid spines, using proper packaging material and other postharvest handling practices in collaboration with the research institute and Agriculture Offices to improve farmers attitude and show the difference between the previous and current post-harvest management practices.
- Facilitating governmental and non-governmental organizations to provide capacity building training for extension workers about the modern post-harvest handling practices and way of providing extension services to farmers.
- Facilitating governmental organisations in forming producer organisations to improve farmers access to different input and strengthening their bargaining power in the market.
- Facilitating governmental and non- governmental organisations on the construction of collection centres in the nearby villages.
- Facilitating the governmental and non- governmental organisations to strengthen the market linkages through promotion and stakeholder meetings thereby improving the gross margin of farmers via replacing the informal chain with the formal one.
- Initiating different researches on post-harvest management practices.

### **Bureau of Agriculture and Rural Development (Governmental Offices)**

- Assigning cactus pear experts at a district level to follow-up the progress of farmers
- Working on the successful Implementation of the government agriculture plan through the provision of advice and agricultural inputs
- Funding research projects on post-harvest management practices

### **Tigray Agricultural Research Institute**

- Releasing improved cactus pear variety
- Initiating different researches on post-harvest management practices.
- Demonstrating, popularisation and scaling-up of new post-harvest technologies

### **Non-Governmental Organizations**

- Providing training to farmers, development workers and other government officials
- Funding projects on post-harvest management practices
- Follow-up on the implementation of the projects in order to make the support sustainable

## The New Proposed Cactus Pear Value Chain in Eastern Tigray

Figure 27: New proposed cactus pear value chain

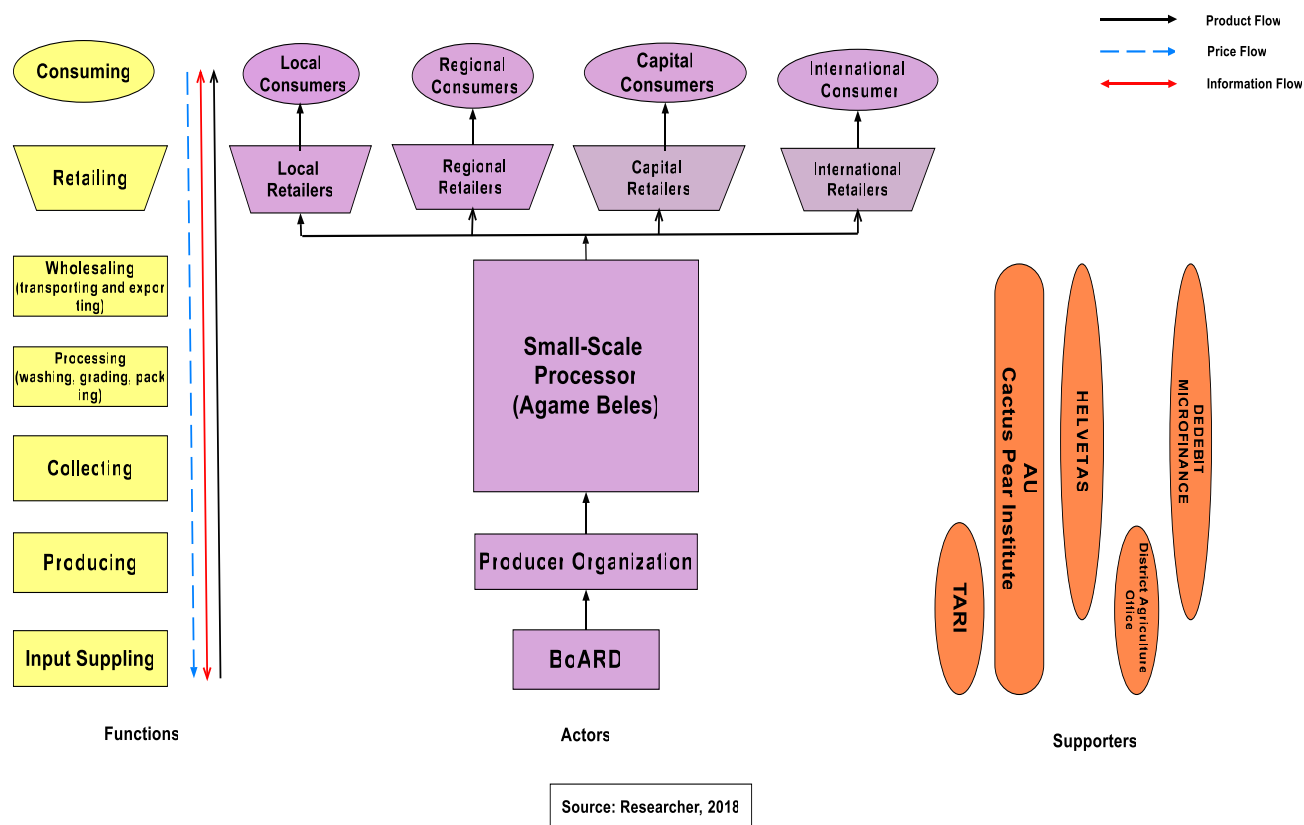


Table 21: Impact of the new chain in reducing post-harvest losses in theory of change format

Inputs	Activities	Output	Outcome	Impact
<ul style="list-style-type: none"> <li>Training manual and facilities</li> <li>Fund/budget</li> <li>Professional Staff</li> <li>Land</li> <li>Cladode</li> <li>Farm equipment's</li> <li>Agricultural Inputs</li> </ul>	<ul style="list-style-type: none"> <li>Forming producer organisations</li> <li>Capacity building training for extension agents</li> <li>Practical training (Demonstration and popularisation)</li> <li>Facilitating Credit access</li> <li>Construction of collection centres</li> <li>Improved cactus variety release</li> <li>Cold storage</li> </ul>	<ul style="list-style-type: none"> <li>Strong market linkages</li> <li>Improve bargaining power</li> <li>Reduce post-harvest losses</li> </ul>	<ul style="list-style-type: none"> <li>Improve Production</li> <li>High market price</li> </ul>	<ul style="list-style-type: none"> <li>Improve income</li> <li>Reduce food insecurity</li> </ul>

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## ANNEXES

### Annexe 1: Independent Sample test between household type and total losses

Table 22: Independent sample test between household type and total losses

	Levene's Test		t-test for Equality of Means						
	F	Sig.	T	Df	Sig. (2-tailed)	Mean	Std. Error	95% CI	
								Lower	Upper
Equal variances assumed	7.38	.009	-2.41	58	.019	-589.90	244.58	-1079.50	-100.30
Equal variances not assumed			-2.57	48.07	.013	-589.90	229.61	-1051.55	-128.25

### Annexe 2: Correlation between Age and Loss

Table 23: Correlation between age and loss

		Age	Total Loss
Age	Pearson Correlation	1	.179
	Sig. (2-tailed)		.172
	N	60	60
Total Loss	Pearson Correlation	.179	1
	Sig. (2-tailed)	.172	
	N	60	60

### Annexe 3: ANOVA result for Education Level and Total Post-harvest Loss

Table 24: ANOVA result for education level and total post-harvest Loss

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	10322734.329	4	2580683.582	3.061	.024
Groups	46371191.321	55	843112.569		
Total	56693925.650	59			

#### Annexe 4: Correlation between total loss and family size

Table 25 : correlations between total loss and family size

		Total Loss	Family Size
Total Loss	Pearson Correlation	1	-.114
	Sig. (2-tailed)		.386
	N	60	60
Total Family Size	Pearson Correlation	-.114	1
	Sig. (2-tailed)	.386	
	N	60	60

#### Annexe 5: Correlation between total loss and years of experience on cactus production

Table 26: Correlation between total loss and years of experience on cactus production

		Total Loss	Experience
Total Loss	Pearson Correlation	1	-.137
	Sig. (2-tailed)		.298
	N	60	60
Experience	Pearson Correlation	-.137	1
	Sig. (2-tailed)	.298	
	N	60	60

#### Annexe 6: Correlation between cactus land and loss

Table 27: Correlation between cactus land and loss

		Cactus Land	Total Loss
Cactus Land	Pearson Correlation	1	.273*
	Sig. (2-tailed)		.035
	N	60	60
Total Loss	Pearson Correlation	.273*	1
	Sig. (2-tailed)	.035	
	N	60	60

\*. Correlation is significant at the 0.05 level (2-tailed).

## Annexe 7: Independent Sample test for comparing production Between the Two PA

Table 28: Independent Sample test for comparing production Between the Two PA

		Levene's Test		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval	
									Lower	Upper
Production	Equal variances assumed	.310	.580	-.278	58	.782	348.53333	1253.51693	-2857.720	2160.65341
	Equal variances not assumed			-.278	57.2	.782	348.53333	1253.51693	-2858.457	2161.39062

## Annexe 8: Correlation between profit and Total Loss

Table 29: Correlation between profit and total loss

		Profit	Total Loss
Profit per season	Correlation	1	-.258*
	Sig. (2-tailed)		.047
	N	60	60
Total Loss	Correlation	-.258*	1
	Sig. (2-tailed)	.047	
	N	60	60

\*. Correlation is significant at the 0.05 level (2-tailed).

## Annexe 9: independent sample test for total loss across time of harvest

Table 30: independent sample test for total loss across time of harvest

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean	Std. Error	95% Confidence Interval	
									Lower	Upper
Equal variances assumed		4.370	.041	1.603	58	.114	400.66852	249.94013	-99.64101	900.97805
				1.624	52.845	.110	400.66852	246.77733	-94.33812	895.67516

**Annexe 10: Independent Samples test for comparing the mean value between harvesting tools across Loss**

Table 31: Independent Samples test for comparing the mean value between harvesting tools across Loss

	Levene's Test		t-test for Equality of Means						
	F	Sig.	T	Df	Sig. (2-tailed)	Mean	Std. Error	95% Confidence Interval	
								Lower	Upper
Equal variances assumed	9.945	.003	-2.02	58	.048	-497.7	246.77	991.66	-3.74
Equal variances not assumed			-2.02	41.652	.050	-497.7	246.77	995.82	.42198

## Annexe 11: Key Informant Interview with Agriculture office and Cactus Pear Institute



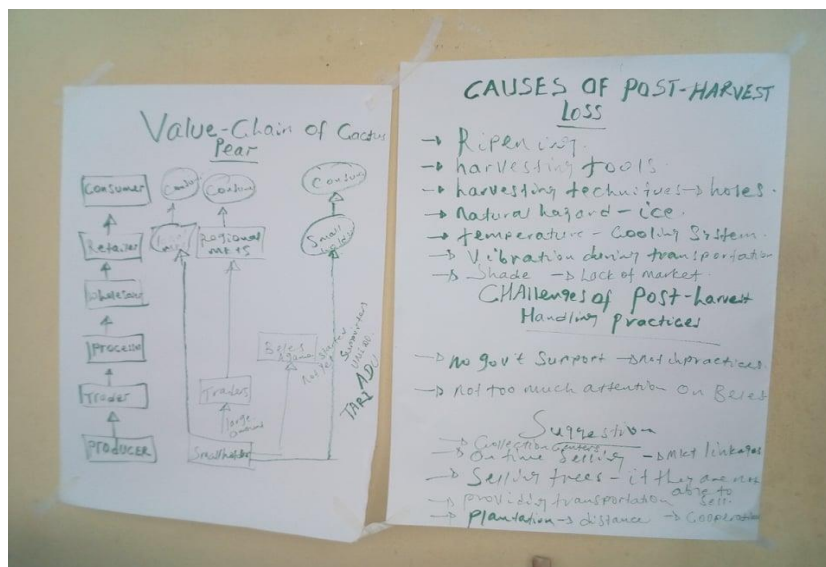


## Annexe 12: Field Survey and Interviews with Chain Actors





## Annex 13: Pictures of Focus Group Discussion with Participatory Method





## Annex 14: Questionnaire

1. Household Type      1= Female Headed      2= Male Headed
2. What is your Age? \_\_\_\_\_
3. What is your education level?  
1=Illiterate    2=Read and write    3=Primary    4=High School    5. Diploma & above
4. What is your marital status    1= single    2= married    3=divorced    4= widowed
5. What is your total family size \_\_\_\_\_; active labour force: M \_\_\_\_\_ F \_\_\_\_\_
6. what is your experience of cactus pear production \_\_\_\_\_ years
7. Do you own land?    1=Yes      0= No
8. If yes, what size of land do you have? \_\_\_\_\_ ha
9. What amount of it is allocated for cactus pear production? \_\_\_\_\_ ha
9. How many plants of cactus pear do you have? \_\_\_\_\_
10. Are your trees grafted or seeded?    0=Gifted    1= Seeded
11. What variety of cactus pea do you grow? \_\_\_\_\_
12. How much do you produce per year? \_\_\_\_\_
13. How much from it is consumed in kg? \_\_\_\_\_
14. Does the quality vary? \_\_\_\_\_ Why? \_\_\_\_\_
15. Do you have problems with any diseases and pests?    1= Yes      0= No
16. if Yes, how do you treat the diseases? \_\_\_\_\_
17. Are you a member of cooperative?    1= yes      2) No
18. If no, what is your reason \_\_\_\_\_
19. Do you have contacts with extension agents?    1= Yes      0= No
21. If yes, how frequent do you get extension service per month? \_\_\_\_\_
22. What service you get from extension agent? \_\_\_\_\_
23. Do you have any access to credit for cactus pear production?    1=Yes    0=No
24. If yes, where do you get credit?    1= bank    2= cooperative    3= traders    5= microfinance

## 25. Production and Marketing Costs

Table 32: production and marketing cost

No	Activities and inputs	Unit	Quantity	Number of days in years	Unit price	Total cost/year
1	<b>Cost of labours</b>	Nu				
	Land preparation	Nu				
	Planting	Nu				
	Weeding	Nu				
	Watering	Nu				
	Fencing	Nu				
	Harvesting	Nu				
	Transporting to market	Nu				
	Others, specify					
2	<b>Cost of fertiliser</b>					
	UREA	kg				
	DAP	kg				
	Compost	kg				

	Manure	kg				
3	<b>Cost watering materials</b>					
	Water pump - own	No				
	- Rent	No				
	Water pump fuel and oil	Litre				
4	<b>Farm/harvest equipment</b>					
	Plough	No				
	Hoe	No				
	Shovel	No				
	Spade	No				
	Pick axe	No				
	Other specify	No				
6	Pesticides	liters				
7	A tax on land cost	No				
8	Packaging material	No				
6	Others, specify					

### C) Harvesting

25. Do you harvest yourself or do you rent out your trees? \_\_\_\_\_
26. What is the season for harvesting? \_\_\_\_\_
27. Do you harvest at a specific time of the day? 1= yes 0= No
28. Which time do harvest? \_\_\_\_\_
29. What do you mostly consider during harvesting? \_\_\_\_\_
30. Do you harvest all fruit at the same time? 1= yes 0= No
31. How do you harvest the fruit? 1= Hand picking 2. Using harvesting tools
32. If tools, what kind of tools do you use? \_\_\_\_\_
33. How do you remove the glochid spine? \_\_\_\_\_
34. Does the fruit fall to the ground after picking? 1= yes 0=No
35. How are the fruit stored on the field? 1= putting on the ground 2= Plastic crates 3. Woody crates
36. Are there any losses during harvest? 1= Yes 0= No
37. What causes them? \_\_\_\_\_
38. How big are they in kg? \_\_\_\_\_

### C) Storage

39. Do you store them? 1= Yes 0= No
40. If yes, In what kind of facility? \_\_\_\_\_
41. How is the fruit packaged when stored? \_\_\_\_\_
42. How long do you store the fruit? \_\_\_\_\_
43. For how long can the fruit be stored without spoilage? \_\_\_\_\_
44. Do you cool the fruit during storage? 1= Yes 0= No
45. If yes, At what temperature, how long, how quickly after harvest? \_\_\_\_\_
46. Are there any losses during storage? \_\_\_\_\_
47. What causes them? \_\_\_\_\_
48. How much in kg? \_\_\_\_\_

#### **D) Sorting and Packaging**

49. Do you sort the fruit before selling? 1= Yes 0= No
50. How do you sort them? \_\_\_\_\_
51. Why you sort them? \_\_\_\_\_
52. Do you pack the them before you sell? 1=Yes 0=No
53. If yes, what kind of packaging materials do you usually use? \_\_\_\_\_
54. Are there any losses during Sorting and packaging? \_\_\_\_\_
55. What causes them? \_\_\_\_\_
56. How much in kg? \_\_\_\_\_

#### **E) Transport**

57. Do you transport the fruit? 1= yes 0= No
58. How do you transport? 1= Using animal driven cart 2= Using human shoulder  
3= Others, specify \_\_\_\_\_
59. Are there any losses during transport? 1= yes 0= No
60. What causes them? \_\_\_\_\_
61. what kind of loss/damage could happen during transportation? \_\_\_\_\_
62. How big are they in kilos? \_\_\_\_\_

#### **F) Marketing**

63. Where do you sell the fruit? 1= On farm 2= Market
64. If market, how long does it take to reach the market? \_\_\_\_\_
65. Who do you sell the fruits to? 1. Trader 2. Wholesaler 3. Consumer 4. Other \_\_\_\_\_
67. Do you have legal contract with buyers? 1= yes 0= No
68. If No, do you find the buyers, or they find you?
69. How much do you sell from the total produced per kg? \_\_\_\_\_
70. How often do you sell in a month? \_\_\_\_\_
71. Do you think it is profitable? 1=Yes 0=No
72. If yes, How much do you get in a month? \_\_\_\_\_
73. When do you receive the money? 1= Immediately 2= within two weeks 3. Other \_\_\_\_\_
74. At what price do you sell the fruits per kg? \_\_\_\_\_
75. Are there any losses related with selling? 1= Yes 0= No
76. What causes them? \_\_\_\_\_
77. How big are they in kilos per day? \_\_\_\_\_

#### **G) Suggestions on how to minimize the losses**

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**Thank You!**

## **Annex 15: Interview and FGD Checklist**

### **Checklist for Focus Group Discussion**

1. Perception about the post-harvest losses and its causes
2. The effect of post-harvest losses on income, production and marketing
3. The market linkages (the actors, supporters, product & information flow and market regulations)
4. Market related problems leading to post-harvest losses
5. Part of the chain the most post-harvest occurs and why
6. The common post-harvest handling practices employed to reduce post-harvest losses
7. Challenges encountered during the post-harvest handling processes
8. Any existing support from gov't and NGOs to improve production and reducing post-harvest losses
9. Any suggestion for improving the production and reducing post-harvest losses
10. Other issues .....

### **Checklist for Interview with traders, processors, wholesalers and retailers**

1. Source of cactus pear to buy, its amount and quality
2. Selling price and cost incurred during the process of buying and selling
3. Perception about the Post-harvest losses and source of post-harvest losses
4. Amount of post-harvest losses encountered from the total purchase
5. Any post-harvest handling practices employed to reduce post-harvest losses
6. Challenges encountered during the post-harvest handling practices
7. Any existing support from gov't and NGOs on production and reducing post-harvest losses
8. Any suggestion for improving the production and reducing post-harvest losses
9. Other issues .....

### **Checklist for key informant interview (BoARD, TARI, AGU and HELVETAS)**

1. Number of producers of cactus pear in the area
2. Who is involved as a supporter of the cactus pear value chain?
3. Awareness of post-harvest losses
4. The volume and causes of post-harvest losses
5. On which part of the chain the most post-harvest loss occurs
6. Available support to reduce cactus pear losses in the area (financial, extension etc.)
7. The opportunities and challenges to reduce post-harvest losses and implement post-harvest handling practices
8. Any suggestion for improving the production and reducing post-harvest losses
9. Other issues

## Annexe 16: List of key Informants and Actors

Table 33: List of the Key informant and chain actor's interviewee

Key Informant Interviewee List	
Name of Key Informants	Position
Yemane Kahesay	Cactus pear Institute Director of Adigrat University
Berhane Hailu	Project Manager of HELVETAS Swiss Intercooperation
Gebrselassie Gebru	Tigray Agricultural Research Institute
Desta W. Gabriel	Bureau of Agriculture and Rural Development
Netsanet Melaku	Extension Agent in BoARD
Chain actors Interviewee	
Alem G. Tsadik	Collector
Zemame Tekilu	Collector
Mohammed Ali	Wholesaler (Capital city)
Akelil Gebray	Wholesaler (Regional city)
Girum W. Tensae	Processor (Agame Beles)
Abadit kiros	Retailer(local)
Kidan Temesgen	Retailer(regional)
Kiflu Amanual	Retailer (capital city)
Eyerusalem	Consumer (local)
Belen Haile	Consumer(regional)