



Addis Ababa University  
College of Development Studies  
Center for Rural Development

Growers' Indigenous Knowledge and the Contribution of  
Neglected and Underutilized Tuber Crops to the  
Household Food Security in Southwestern Ethiopia

By  
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November 2019  
Addis Ababa, Ethiopia

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Neglected and Underutilized Tuber Crops to the  
Household Food Security in Southwestern Ethiopia

A Dissertation Submitted to the Center for Rural Development in Partial  
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By

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November 2019

Addis Ababa, Ethiopia

## Dedication

Dedicated to the memory of my heavenly mother Tiru Hunde, who is no longer with us since 1999.

**DISSERTATION APPROVAL**  
**ADDIS ABABA UNIVERSITY**  
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This is to certify that, the thesis prepared by Abebe Olkeba entitled ‘Growers’ indigenous knowledge and the contribution of neglected and underutilized tuber crops to household food security in southwestern Ethiopia’ submitted in fulfilment for the requirements of the Degree of Doctor of Philosophy (Rural Development) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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This dissertation has been submitted for examination with my approval as a University supervisor.

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## Abstract

*Neglected and underutilized crop species that have huge potential for addressing the food and income needs of the farmers have been found in different parts of Ethiopia. Among the others, *Plectranthus edulis* and anchote (*Coccinia abyssinica*) are native to Ethiopia and important tuber crops widely cultivated for their food, medicinal, and cultural values. Despite the importance of the two tuber crops in supporting the livelihood of growers, limited research has been conducted. Hence, this Ph.D. dissertation aimed to bridge the existing knowledge gap related to the two tuber crops indigenous production practices together with associated constraints and their contribution to household food security in southwestern Ethiopia. A cross-sectional survey of 434 households, FGD, individual case studies, key informant interviews and field observations were used to collect the data. EpiData and STATA computer software were used to manage and analyze the data, respectively. Descriptive statistics, PCA, Multidimensional food security indicator (MFI) and logit model were used to analyze the data. Out of studied farmers, 45.8% in Chenchu and 39.0% in Jima Arjo district have participated in *P.edulis* production. All growers produce the crop primarily for food. Besides food, the crop helps them to get small cash income, and to reduce risk in case other crops fail. The study documented six local varieties of *P.edulis* in Chenchu and two local varieties in Jima Arjo district. Across the study areas, the growers consider several plant traits to select the best performing local varieties. The harvested tuber maximum storage life is not more than two days in both study areas; while in situ or leaving in the ground is the only available storage facility in the study area. *P.edulis* production trend is decreasing, and the growers are producing it less as compared to other crops. Notwithstanding its importance and long period farmers' growing experience, the crop is mostly produced on a small plot of land around the homestead for home consumption due to low market demand, low price, and lengthy maturity. The current study identified some 13 *P.edulis* production constraints; and the top three according to the growers' perception are lack of government attention, lack of improved varieties and lack of tuber seed. Some 66.4% of households in Chenchu district were food secure and 33.6% were food insecure. The corresponding figures in Jima Arjo district were 82.1% and 17.9%, respectively. The logit regression model showed seven explanatory variables namely location of the study area, age of the household head, total crop production, total livestock owned, engagement of household head in off-farm activities, farmland size and total annual income were determining factors of the household food security.*

*Overall, 39.5% of studied farmers in Gimbi and 82.9% in Ayira district participated in growing of anchote. The growers produce the crop primarily for food, to get additional cash income, cultural and medicinal values. Anchote production trend has been increasing over the past 10 years. This study identified two local varieties of anchote (white and red) in both study areas. The available storage facility in the study area is leaving in the ground and protecting from animals reach. Ten major anchote production constraints were found in both study areas. According to the growers' perception, lack of improved variety and lack of government attention are the top ones.*

*Some 75.4% of households in Gimbi and 78.6% in Ayira district were food secure, while 24.6% and 21.4% were food insecure, respectively. The logit regression model showed that the age of the household head, total crop production, growing anchote, dependency ratio, market distance, and total annual income were statistically significant in determining the household food security. It was learned that growers have a wealth of knowledge about the two tuber crops management, protection from wild animals, local variety selection practices, indigenous storage, and food processing practices that could be useful for further tuber crop improvement. Despite their benefits, however, the crop lacks attention from research and extension systems in the country. Therefore, regional and federal research institutes and higher education institutions should give more attention to improving and promoting the best performing local varieties of anchote. Considering its untapped potential and significant contribution of anchote to household food security, its production needs due attention in any on-going and future tuber crops development plan to enhance food security of the farmers that are dependent on it.*

*Keywords: growers, indigenous knowledge, tuber crops, *Plectranthus edulis*, anchote, food security, Ethiopia.*

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Abebe Olkeba Gutema

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## Acronyms and Abbreviations

CSA	Central statistical agency
CSI	Coping Strategies Index
DAs	Development agents
FAD	Food Availability Decline
FAO	Food and Agricultural Organization
FCS	Food Consumption Score
FED	Food Entitlement Decline
FGD	Focus Group Discussions
GFSI	Global Food Security Index
HDDS	Household Dietary Diversity Scale
HFIAS	Household Food Insecurity and Access Scale
HHS	Household Hunger Scale
IBC	Institute of Biodiversity
IK	Indigenous Knowledge
IPGRI	International Plant Genetic Resource Institute
KIIs	Key Informant Interviews
Km	Kilometer
LCOT	Livelihoods Change over Time
LR	Likelihood Ratio
m.a.s.l.	Meter above sea level
MFI	Multidimensional Food Security Indicator
mm	Millimeter
NGOs	Non-governmental organizations
NUCS	Neglected and underutilized crop species
P.edulis	Plectranthus edulis
rCSI	Reduced Coping Strategies Index
SAFS	Self-assessed Measure of Food Security
SNNPR	Southern Nations, Nationalities, and Peoples Region
UN	United Nations
USAID	United States Agency for International Development
VIF	Variance Inflation Factor
WFP	World food program
WFS	World Food Summit

# Table of Contents

<b>DEDICATION</b> .....	<b>III</b>
<b>DECLARATION</b> .....	<b>V</b>
<b>ABSTRACT</b> .....	<b>VI</b>
<b>ACKNOWLEDGMENTS</b> .....	<b>VIII</b>
<b>ACRONYMS AND ABBREVIATIONS</b> .....	<b>X</b>
<b>LIST OF TABLES</b> .....	<b>XIV</b>
<b>LIST OF FIGURES</b> .....	<b>XV</b>
<b>LIST OF BOXES</b> .....	<b>XVI</b>
<b>LIST OF ANNEXES</b> .....	<b>XVI</b>
<b>CHAPTER 1 INTRODUCTION</b> .....	<b>1</b>
1.1. BACKGROUND.....	1
1.2. STATEMENT OF THE PROBLEM .....	3
1.2.1. <i>Research Questions</i> .....	4
1.2.2. <i>Objectives</i> .....	5
1.2.2.1. General Objective .....	5
1.2.2.2. Specific Objectives .....	5
1.3. ETHICAL CONSIDERATION .....	5
1.4. SIGNIFICANCE OF THE STUDY .....	5
1.5. SCOPE AND LIMITATIONS OF THE STUDY .....	6
1.6. ORGANIZATION OF THE DISSERTATION .....	6
<b>CHAPTER 2 LITERATURE REVIEW</b> .....	<b>8</b>
2.1. CONCEPTS AND DEFINITIONS OF FOOD SECURITY .....	8
2.2. THEORETICAL PERSPECTIVES ON FOOD SECURITY .....	10
2.2.1. <i>Food Availability Decline (FAD) Approach</i> .....	10
2.2.2. <i>Food Entitlement Decline (FED) Model</i> .....	12
2.2.3. <i>Food Security as Sustainable Livelihood Approach</i> .....	14
2.3. DEFINITIONS AND CONCEPTS OF INDIGENOUS KNOWLEDGE.....	19
2.3.1. <i>What is Indigenous Knowledge?</i> .....	19
2.3.2. <i>The Role of Indigenous Knowledge in Agriculture</i> .....	20

2.4. EMPIRICAL EVIDENCE ON NUCS CONTRIBUTION TO HOUSEHOLD FOOD SECURITY .....	22
2.5. ANALYTICAL FRAMEWORK.....	26
<b>CHAPTER 3 STUDY AREAS SETTING AND METHODOLOGY .....</b>	<b>30</b>
3.1. INTRODUCTION .....	30
3.2. DESCRIPTION OF THE STUDY AREA.....	30
3.3. RESEARCH PARADIGM .....	33
3.4. RESEARCH DESIGN .....	36
3.5. SAMPLE SIZE AND SAMPLING PROCEDURE .....	36
3.6. DATA COLLECTION.....	38
3.6.1. <i>Cross-sectional Household Survey</i> .....	38
3.6.2. <i>Focus Group Discussion (FGD)</i> .....	41
3.6.3. <i>Individual Case Studies</i> .....	42
3.6.4. <i>Field Observation</i> .....	42
3.7. DATA ANALYSIS .....	43
3.7.1. <i>Growers Indigenous Production Practices of the Two Tuber Crops</i> .....	44
3.7.2. <i>Constraints of the Two Tuber Crops Production</i> .....	44
3.7.3. <i>Contribution of the Two Tuber Crops to the Household Food Security</i> .....	45
<b>CHAPTER 4 GROWERS INDIGENOUS PRODUCTION PRACTICES AND SOCIO-ECONOMIC IMPORTANCE OF THE TWO TUBER CROPS .....</b>	<b>58</b>
4.1. INTRODUCTION .....	58
4.2. GROWERS INDIGENOUS PRODUCTION PRACTICES AND SOCIO-ECONOMIC IMPORTANCE OF PLECTRANTHUS EDULIS .....	59
4.2.1. <i>Farmers Participation in Plectranthus Edulis Production</i> .....	59
4.2.2. <i>Growers Reasons for Plectranthus Edulis Production</i> .....	60
4.2.3. <i>Traditional Foods and some Expressions on the Importance of P.edulis</i> .....	61
4.2.4. <i>Why Growers Produce Less Plectranthus edulis?</i> .....	62
4.2.5. <i>Local Varieties of Plectranthus Edulis and Growers Selection Criteria</i> .....	64
4.2.6. <i>Cropping Pattern of Plectranthus Edulis</i> .....	66
4.2.7. <i>Plectranthus Edulis Production Trend</i> .....	73
4.2.8. <i>Growers Marketing Participation</i> .....	74
4.3. GROWERS INDIGENOUS PRODUCTION PRACTICES AND SOCIO-ECONOMIC IMPORTANCE OF ANCHOTE .....	75
4.3.1. <i>Farmers Participation in Anchote Production</i> .....	75
4.3.2. <i>Growers Reasons for Anchote Production</i> .....	76

4.3.3. <i>Traditional Foods and Expressions about the Importance of Anchote</i> .....	78
4.3.4. <i>Why Growers Produce Anchote Less as Compared to Other Crops?</i> .....	80
4.3.5. <i>Local Varieties and Growers Selection Criteria</i> .....	82
4.3.6. <i>Cropping Pattern of Anchote</i> .....	84
4.3.7. <i>Perception of Growers about Anchote Production Trends</i> .....	91
4.3.8. <i>Growers' Marketing Participation</i> .....	92
4.4. SUMMARY.....	94
<b>CHAPTER 5 CONSTRAINTS OF THE TWO TUBER CROPS PRODUCTION.....</b>	<b>99</b>
5.1. INTRODUCTION .....	99
5.2. PLECTRANTHUS EDULIS PRODUCTION CONSTRAINTS.....	100
5.3. ANCHOTE PRODUCTION CONSTRAINTS .....	106
5.4. SUMMARY.....	111
<b>CHAPTER 6 CONTRIBUTION OF THE TWO TUBER CROPS TO THE HOUSEHOLD FOOD SECURITY .....</b>	<b>112</b>
6.1. INTRODUCTION .....	112
6.2. CONTRIBUTION OF PLECTRANTHUS EDULIS TO THE HOUSEHOLD FOOD SECURITY .....	112
6.2.1. <i>Household Food Security Status</i> .....	112
6.2.2. <i>Relationship between Food Security and Household Characteristics</i> .....	116
6.2.3. <i>Parameter Estimates of Determinants of Household Food Security</i> .....	118
6.2.4. <i>Growers Perception about Plectranthus edulis Contribution to the Household Food Security</i> .....	124
6.2.5. <i>Household Coping Strategies during Food Shortage Period</i> .....	126
6.3. CONTRIBUTION OF ANCHOTE TO THE HOUSEHOLD FOOD SECURITY .....	128
6.3.1. <i>Household Food Security Status</i> .....	128
6.3.2. <i>Relationship between Food Security and Household Characteristics</i> .....	130
6.3.3. <i>Parameter Estimates of the Determinants of the Household Food Security</i> .....	132
6.3.4. <i>Household Coping Strategies during Food Shortage Period</i> .....	138
6.4. SUMMARY.....	139
<b>CHAPTER 7. CONCLUSIONS AND RECOMMENDATIONS .....</b>	<b>142</b>
7.1. CONCLUSIONS.....	142
7.2. RECOMMENDATIONS.....	147
<b>REFERENCES.....</b>	<b>149</b>
<b>ANNEXES .....</b>	<b>159</b>

## List of Tables

Table 1 Algorithmic classification techniques of the household food security according to their response.....	45
Table 2 MFI category calculation.....	46
Table 3 Prevalence of different levels of household multidimensional food security calculation	46
Table 4 Explanatory variables and priori hypothesis.....	50
Table 5 Farmers participation in <i>Plectranthus edulis</i> production by district.....	59
Table 6 Household reasons for growing of <i>Plectranthus edulis</i> (Multiple responses is possible)	60
Table 7 Growers reasons for less production of <i>P.edulis</i> (Multiple responses is possible).....	63
Table 8 Farmers reasons for not growing <i>P.edulis</i> (Multiple responses is possible).....	64
Table 9 Local varieties of <i>P.edulis</i> and growers preference (Multiple responses is possible) .....	64
Table 10 Growers local variety selection criteria (Multiple responses is possible) .....	65
Table 11 Growers planting site selection practice .....	66
Table 12 Land preparation period (Multiple responses is possible).....	67
Table 13 Land preparation frequency .....	67
Table 14 Sources of <i>Plectranthus edulis</i> planting material (Multiple responses is possible) .....	69
Table 15 Growers fertilizer application practice .....	70
Table 16 Cultivation and earthing up practices .....	70
Table 17 <i>Plectranthus edulis</i> harvesting practice.....	71
Table 18 <i>Plectranthus edulis</i> growers marketing participation.....	74
Table 19 Farmers participation in production of anchote.....	76
Table 20 Growers' reasons for anchote production by district (Multiple responses is possible).	76
Table 21 Farmers reasons for less production of anchote (Multiple responses is possible).....	80
Table 22 Farmers reasons for not growing anchote (Multiple responses is possible).....	81
Table 23 Local variety selection criteria (Multiple responses is possible).....	83
Table 24 Growers anchote planting site selection practice.....	84
Table 25 Land preparation practice (Multiple responses is possible).....	85
Table 26 Sources of anchote planting materials (Multiple responses is possible) .....	86
Table 27 Fertilizer application practice .....	87

Table 28 Cultivation and earthing up practices .....	88
Table 29 Harvesting practice .....	89
Table 30 Growers' marketing participation .....	93
Table 31 Explained variance by components for <i>Plectranthus edulis</i> constraints .....	101
Table 32 Perception of growers on <i>Plectranthus edulis</i> production constraints .....	103
Table 33 Explained variance by components .....	106
Table 34 Severity of anchote production constraints.....	108
Table 35 Multidimensional household food security status (N=250).....	113
Table 36 Number of months the household consumes from their own produce by district (N=250) .....	115
Table 37 Household annual food requirements meeting from their own farm production .....	115
Table 38 Relationship between the household food security status and their characteristics ....	117
Table 39 Parameter estimates of the binary logit model with their marginal effects .....	121
Table 40 Household coping strategies during food shortages period (Multiple responses).....	127
Table 41 Multidimensional household food security status .....	128
Table 42 Number of months the household consume from their own produce (N=184).....	129
Table 43 Household annual food requirement meeting from their own farm production .....	130
Table 44 Relationship between the household food security status and their characteristics ....	131
Table 45 Parameter estimates of the binary logit model with their marginal effects .....	134
Table 46 Growers perception on anchote contribution to the household food security .....	136
Table 47 Household coping strategies during food shortages period.....	138

## List of Figures

Figure 1 Sustainable livelihood framework for analyzing household food security .....	27
Figure 2 Description of the study area.....	31
Figure 3 Growers perception on production trend of <i>Plectranthus edulis</i> .....	73
Figure 4 Local varieties of anchote and growers preference .....	82
Figure 5 True seed harvesting season .....	90
Figure 6 Anchote production trend.....	92
Figure 7 Anchote marketing channel in western Ethiopia.....	94

Figure 8 Household major sources of food in <i>Plectranthus edulis</i> growing area .....	114
Figure 9 Growers perception about <i>P.edulis</i> contribution to the household food security.....	125
Figure 10 Household major sources of food (Multiple responses is possible).....	129

## List of Boxes

Box 1 Reflection of the case study household from Chenchu district about <i>P.edulis</i> contribution to the household food security .....	126
Box 2 Reflection of the case study household from Gimbi district on the contribution of anchote to food security .....	137
Box 3 Reflection of the case study household from Ayira district regarding the contribution of anchote to food security .....	137

## List of Annexes

Annex 1 Cross-sectional household interview questionnaire .....	159
Annex 2 General checklist for FGD, Individual case studies and Key informants .....	167
Annex 3 Logit regression analysis in <i>P.edulis</i> growing area .....	173
Annex 4 Marginal effects after logit in <i>P.edulis</i> growing area .....	173
Annex 5 Logit regression analysis in anchote growing area .....	174
Annex 6 Marginal effects after logit in anchote growing area .....	174
Annex 7 Summary of goodness-of-fit model assessment.....	174

# Chapter 1 Introduction

## 1.1. Background

Poverty, inequality and food insecurity are the most critical and persistent problems facing the less developed countries of the world. Despite the growing global acceptance of an individual's right to adequate food and nutrition, and the state's obligation to ensure that all its citizens are free from hunger, the number of undernourished people in the world increased to an estimated 815 million in 2016 (FAO et al., 2017); and the majorities of these live in developing countries (Astou, 2015; FAO, 2015). Although progress continues in the fight against hunger, unacceptably large numbers of people still lack the food they need for an active and healthy life. For example, in sub-Saharan Africa one-third of the population is estimated to be undernourished and this figure increased from 31.1 percent in 2015 to 33.9 percent in 2016 (FAO, 2015). Although there are several challenges that have kept Africa from achieving food security, inadequate attention to agriculture is one of the main reasons for food insecurity in the continent (Astou, 2015). Hence, there is a need to address the issue of how to feed and ensure the food security of the population including addressing of malnourishment.

The struggle to achieve food security at the household level has dated long in Ethiopia, but it has still remained a challenge (Ayalneh & Abebaw, 2009). According to the Global Food Security Index report (2013) Ethiopia was among the developing countries that made the greatest progress in achieving food security. In line with this, Cochrane (2018) also indicated that in Ethiopia amid rapid population growth, climatic and land pressures, commodity price spikes and other challenges, significant progress has been made on food security. However, the drought that has been exacerbated by the effects of El Niño, the successive years of crop failure resulted in deteriorating agricultural, livestock, food security and nutrition conditions (USAID, 2015 as cited in Hana & Dereje, 2016). Recently, FAO et al. (2018) also reported that though Ethiopia has experienced large increases in national cereal production in recent decades, acute and localized food insecurity and malnutrition crises, often associated with droughts has remained the challenge. This highlights the need to utilize untapped resources to feed the population of the country all year round.

Historically, human beings made use of around 7,000 cultivable plant species for food, fiber, forage, fuel, health security and other needs (IPGRI, 2002; Williams & Haq, 2002). However, agricultural research has concentrated on a few crops and breeds. Over 50% of humankind's requirements for protein and calories are met with three crops (maize, wheat and rice), while 95% of the world's food energy needs are provided by 30 plant species (Bizimana, 2007; Williams & Haq, 2002), suggesting that most of the potential food crops are underutilized. With the modernization of agricultural practices, many species were neglected due to their being held in low esteem (Williams & Haq, 2002). The focus is purely on the productivity of current major food crops that cannot meet the challenge of food insecurity (Mayes et al., 2011). Hence, diversification of food crops should be one important option in achieving food security of the country; among the others, utilization of untapped resources including neglected and underutilized tuber crops can help to that end.

There are a number of diverse indigenous crops, often defined as the 'orphans' of research and development, nowadays called as neglected and underutilized crop species (NUCS) in different parts of the world (Baena et al., 2012). These species are often considered as minor crops because they are less important than staple crops in terms of global production, market value, and research attention. However, from the standpoint of the rural poor who depends on many of these species for their food security, nutrition and income, they are not really minor (IPGRI, 2002). Nowadays, it is argued that these crops are instead called future crops, which was clearly reflected in the International Science Forum 2016 held in Addis Ababa (personal observation). Producers and consumers are using these crops less because they are in some way not competitive with other crop species in the same agricultural environment (Padulosi et al., 2006). Recently, in many countries, knowledge and interest in the nutritional composition of food products and recognition of the need for better diet diversity as a health prevention strategy are increasing (Gruere et al., 2006). Their ability to adapt to agro-ecological niches and marginal areas makes such plant species ideal for expanding the existing food basket for poor people (Williams & Haq, 2002). Among these, roots and tubers form an essential component of food security for many poor and undernourished people in the developing world, particularly, in Sub-Saharan Africa contributing a significant amount to overall caloric consumption (Bizimana, 2007).

Ethiopia has diversified agro-ecological conditions that are suitable for the production of various types of crops (IBC, 2008). Farmers in Ethiopia, like many other developing countries, have developed and maintained a number of diverse and locally adapted varieties of crops because no single variety can satisfy their basic needs (Yeshitila, 2007). Noticeable among these are, root and tuber crops like potato, sweet potato, *enset* (*Ensete ventricosum*), *anchote* (*Coccinia abyssinica*), *Plectranthus edulis* and yams are widely cultivated in southwestern parts of Ethiopia (Girma & Hailu, 2007; IBC, 2007). Overlooked and underdeveloped indigenous food items that have huge potential for addressing the food and income needs of the farmers have been found in many parts of Ethiopia. Among the other tuber crops, *Plectranthus edulis* and anchote are native to Ethiopia and essential tuber crops widely cultivated for their edible tuber in a substantial amount in southwestern Ethiopia (Abera, 1995; IBC, 2012; Mulugeta, 2008). Despite these facts, little research and development attention has been given and their potential has not been exhaustively exploited in the fight against hunger (Dandena, 2010). Hence, giving attention to these potential crops is timely in helping the country's effort toward achieving food security.

## 1.2. Statement of the Problem

### Why *P.edulis* and Anchote?

The available literature shows that the two tuber crops are some of the little known but potentially useful crop species in Ethiopia (Abera, 1995; IBC, 2012; Mulugeta et al., 2007; Yosef & Tileye, 2013). Despite the availability of various underutilized and neglected crop species, chronic and acute food insecurity is prevalent among smallholder farmers in Ethiopia (Endalew et al., 2015). Baena et al. (2012) pointed out that current food systems need to be reshaped because they are unsustainable. The authors further indicated that neglected and underutilized crops can play an important role to that end. In line with this, Dukpa (2012) emphasized the importance of analysis of the potential of NUCS in achieving food security and generating livelihood.

Currently, Ethiopia's agricultural research and development strategy are mainly focusing on major crops for improving food security in the nation. This scenario needs to be changed and appropriate attention needs to be given to tuber crops in particular and NUCS in general. So far, the available information on the two tuber crops broadly focused on: *P.edulis* and anchote genetic diversity

(Abreham et al., 2014; Tilahun et al., 2014; Weyessa et al., 2013); response of anchote to organic and inorganic fertilizer rates (Girma & Hailu, 2007); effects of anchote boiling methods on anti-nutritional factors (Habtamu, 2014); phenotypic variation and local customary use of *P.edulis* (Yeshitila, 2007; Yeshitila & Weibull, 2012); nutritional composition of anchote (Habtamu et al., 2013); yield and growth performance of anchote (Daba et al., 2012); morphology and taxonomic classification of *P.edulis* (Mulugeta et al., 2012); indigenous multiplication practice of *P.edulis* (Mulugeta et al., 2007); and physiology of *P.edulis* (Mulugeta, 2008).

Among the available literature, the work of Abera (1995) in particular has significant contribution in explaining about anchote and its importance, however, Turner (1988) points out that cultural significance can change over time. Rao (2006) argues that the basis of any society's knowledge system is built on indigenous knowledge. People with indigenous knowledge have long associations with nature and a deep understanding of it (Kazmi et al., 2014). Knowledge of how and why farmers undertake different cultural practices and information on the production constraints are essential. Knowing these practices would enable one to properly grow the crop, understands yield gaps and associated constraints and make the necessary investigations (Mulugeta et al., 2007). By and large, despite the efforts made by different researchers on the topic listed above related to the two tuber crops, yet little information are available on the farmers' indigenous production practices; associated constraints and their contribution to household food security. These are areas the researcher outlines as key knowledge gaps. This study was thus aimed to narrow the existing knowledge gap in this regard. Given the existing research gaps identified in the preceding paragraphs, this study has tried to address the following major research questions:

### 1.2.1. Research Questions

1. What are the different activities carried out by the growers to produce the two tuber crops?
2. What are the inputs required to produce these crops?
3. Why growers produce these crops less as compared to other crops?
4. Why do not all farmers participate in growing of the two tuber crops?
5. What are the criteria considered by growers to select the best performing local varieties?
6. Who is doing what in relation to the two crops tuber production-related activities?
7. What are the constraints of the two tuber crops production?

8. Do the two tuber crops significantly contribute to the household food security?

## 1.2.2. Objectives

### 1.2.2.1. General Objective

To investigate the growers' indigenous production practices of *Plectranthus edulis* and *anchote* (*Coccinia abyssinica*), associated constraints and their contribution to the household food security and thereby contribute to the crops future improvement, wider production and utilization.

### 1.2.2.2. Specific Objectives

1. To explore the growers' indigenous knowledge of the two tuber crops production, storage, marketing, processing and utilization in southwestern Ethiopia (Chapter Four);
2. To identify constraints associated with the two tuber crops production, storage, marketing, processing and utilization in southwestern Ethiopia (Chapter Five); and
3. To examine the contribution of the two tuber crops to the household food security in southwestern Ethiopia (Chapter Six).

## 1.3. Ethical Consideration

Prior to commencing the fieldwork, permission was sought from all concerned bodies following all necessary procedures. Meetings were held with local government officials, agriculture and rural development bureau staff and respective *kebeles* administrative officials to explain the purpose of the study in order to obtain permission and necessary cooperation. Data were collected from individual respondents and FGD participants with the consent obtained by explaining the purpose of the research and protecting the confidentiality and personal information of the study subjects.

## 1.4. Significance of the Study

This research has generated information on growers' indigenous knowledge related to the two tuber crops production (cultivation, variety selection, harvesting, storage, processing, and utilization), marketing and associated constraints. This study also tried to contribute knowledge on the understanding of the relationship between the two tuber crops and household food security. In general, this study provides information on areas of the two tuber crops improvements (like agronomic, storage and improving local variety), which will further enhance their production and

productivity and thereby contribute to the household food security in the study area. It was also anticipated that the results obtained would add to the wealth of information currently available on the determinants of household food security in Ethiopia, particularly the predictor variables, growing the two crops was a unique variable in this regard. This study informs the policymakers to consider the incorporation of anchote into the existing extension system. Moreover, the study will also serve as a reference document for higher education institutions, research centers and individual researchers to embark further research on similar or related topics in the study area or elsewhere in the country.

### 1.5. Scope and Limitations of the Study

The data was produced from surveying a sample of 437 randomly selected households from 12 *kebeles* in Chench, Jima Arjo, Gimbi, and Ayira districts where *P.edulis* and anchote are widely produced and used. This research due to physical accessibility, time, and resource constraints, it was limited to the mentioned four districts. Therefore, the findings of this research are not generalizable beyond the two crops growing areas. Multidimensional food security indicators used in this study have been recently developed, and the researcher has not seen so far other research conducted using this tool and have not yet further verified. Some MFI questions do not wholly mirror the context of rural communities, which may lead to misclassification of the household food security status. Hence, the researcher believes that the tool has a deficiency in classifying the farm households according to their food security status, which may not reflect the household food security status in reality. Though this research is supported partly by the project it was not sufficient to undertake the FGD and individual case studies in each kebele, and this may put its own impact on generating the necessary information. The challenges faced during data collection was that during proposal development stage it was planned to undertake the preliminary survey, however due to security reason it was not conducted in western Oromia.

### 1.6. Organization of the Dissertation

This thesis is composed of seven chapters. Chapter One provides the background of the study, research questions and objectives, significance of the study, and the scope and limitations of the study. Chapter Two provides a review of the literature including concepts and theories of food

security, definitions, and concepts of indigenous knowledge, definitions and characteristics of root and tuber crops, empirical evidence related to NUCS contributions to household food security and analytical framework that guides this research. Chapter Three introduces study area settings, the research paradigm that guides the research, research design, data collection techniques, and analysis.

Chapter Four presents the major findings of the study including growers' indigenous knowledge of the two tuber crops productions; growers reasons for production; traditional foods prepared and some expressions on the importance of the two crops; the reasons why growers produce the two crops less as compared to other crops; the reasons why not all farmers participate in growing of the two crops; acquisitions of planting materials; available local varieties of the two tuber crops and selection criteria; cropping pattern; the two crops production trends; gender division of labor in relation to the two crop production; and the final subsection discusses about growers marketing participation. Chapter Five provides constraints associated with the two crops productions. Chapter Six presents the household food security status; parameter estimates of the determinants of the household food security and the perception of growers on the contribution of the two crops to household food security. The final chapter, Chapter Seven, summarizes the main findings of the research and draws general conclusions and implications for research and policy.

## Chapter 2 Literature Review

### 2.1. Concepts and Definitions of Food Security

Food security is a dynamic concept originated in the 1940s during the historic Hot Spring Conference of Food and Agriculture held in 1943 (Gross et al., 2000). In this conference the concept of a 'secure, adequate, and suitable supply of food for everyone' was accepted internationally. At that time, food insecurity was mainly looked upon as a problem of food supply at national and global levels. As indicated in Baro & Deubel (2006) the earliest definition of food security emerged from the World Food Conference of 1974, fundamentally due to the 1972-74-world food crisis, the definition was focused on 'the availability at all times of adequate world supplies of basic foodstuffs to sustain a steady expansion of food consumption'. Hence, early definitions of food security were focused on aggregate food supply at national and global levels, and analysts advocated the production for self-sufficiency as a strategy for nations to achieve food security (Ashenafi, 2008). Again, after the incidence of the mid-1980 African food crisis, attention moved from global and national levels to the household and individual levels (Maxwell, 1996). This paradigm shift occurred after Sen's influential work on poverty and famine in 1981 where he argued that famines were caused not by low food production and lack of availability, but because of the lack of access to food (Sen, 1981). In this case, the distribution of the available food is critical (Pinstrup-andersen, 2009).

As a matter of this fact, in 1983 FAO redefined food security by focusing on food access and the balance between food demand and supply, which is stated as 'ensuring that all people at all times have both physical and economic access to the basic food that they need' (Astou, 2015). The well-established and widely accepted definition of food security was adopted by World Food Summit in 1996, which states: 'Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life' (WFS, 1996 as cited in Simon, 2012). In this definition, the addition of 'safe and nutritious' highlights food safety and nutritional composition while the addition of 'food preferences' changes the concept of food security from mere access to enough food, to access to the food preferred. This implies that people with equal access to food, but different food preferences, could show different levels of food security (Pinstrup-andersen, 2009).

This definition provides four main dimensions of food security: the first component is the availability, it is a concept that explains the availability or quantity of food in a given households/regions/nations. It is a function of local food production, stock levels and net trade, food importation or food aid, and other demand and supply factors in food production (Asayehgn, 2016; Oni & Fashogbon, 2013). The second dimension is access, the concept of access to food was first introduced by Amartya Sen in the early 1980s. Food access is a function of income and purchasing power of households (Oni & Fashogbon, 2013); and this varies in relation to market integration, price policies, and temporal market conditions (Webb et al., 2006). It is the ability of the household/nation to obtain the food needed to maintain nutritional balance. It encompasses physical, economic, social and sustainability accesses. It is the access to food by households through purchases from the market, from their own stock/home production, gift or borrowing (Abera et al., 2011).

The third dimension relates to food utilization, the World Food Summit's definition of utilization is 'safe and nutritious food, which meets their dietary needs', i.e., the actual processing and absorption capacity of the supplied nutrients by the body (Napoli et al., 2011). It is not sufficient that food be available and accessible to the households to ensure that people will have a 'safe and nutritious' diet. In this case, food has to be of good quality and safe (Simon, 2012). More importantly, the food consumed has to provide sufficient energy to enable the consumer to carry out routine physical activities. Webb and his colleagues pointed out that availability, access, and utilization are hierarchical in nature: food availability is necessary but not sufficient for access, and access is necessary but not sufficient for utilization (Webb et al., 2006). The fourth dimension is stability; the World Food Summit says that stability must be present 'at all times' in terms of availability, access, and utilization for food security to exist. Based on the stability dimension of food security, the literature distinguishes between chronic/permanent food insecurity that describes a long-term lack or persistent inability of access to sufficient food and transitory food insecurity (for example seasonal/cyclic food insecurity), where the time period is more temporary (Maxwell & Frankenberger, 1992; Pinstруп-andersen, 2009).

In general, historically, the concept of food security originated as a result of the global food crisis that occurred during the mid-1970s and 1980s. During these decades, food security mainly focused

on the status of the supply of food availability and attempted to incorporate the effect of price stability with food security. Around 1994, a broader perspective of food security was adopted by the United Nations Development Program (UNDP) to include food security as a necessary element of human rights (Asayehgn, 2016). Starting in 2001, the concept of food security was further expanded to include food and nutrition status (food availability, food access, food utilization) and stability (vulnerability and resilience).

## 2.2. Theoretical Perspectives on Food Security

This section intends to review different theories or approaches of food security. Any aim to understand the unknown or partially known world will make use of existing theories as a starting point. In this case, the theory may guide researchers in investigating problems and in generating new knowledge (Degefa, 2005). A clear understanding of the theory of food security is an essential element to better understand the sustainability of household food security status and its determinants (Meskerem & Degefa, 2015). There are many theoretical orientations for food security analysis, which have progressively developed and expanded over time. Hussein (2006) highlights that it is impossible to employ a single theory to best analyze the whole aspect of food security as each and every theory has its own weakness in light of the multidisciplinary nature of food security. Cognizant of this act, this study used three existing theories of food security to explain the food security situation of the study area. These theories are Food Availability Decline (FAD), Food Entitlement Decline (FED), and Food Security as Sustainable Livelihoods Outcome. The theories are presented on a chronological order moving from the oldest to the recent ones, in such a way that they will support each other to reflect the food security picture.

### 2.2.1. Food Availability Decline (FAD) Approach

The theories of famine are divided into two categories: the first view explained that famines result from an overall decline in food availability in a region or a country. This view, according to Tauger, believes that famine mainly occurs because of natural disasters that destroy crops, and in the context of overall low food production. The second category view famines result from a variety of economic, social and political factors and contexts that reduce or deny access to food for certain people and groups in the country (Tauger, 2003). Because of the occurrence of the food crisis in Africa in the early 1970s, the concern of the international donor community in the 1970s was the

national and international food security, defined in terms of guaranteeing the availability of food as well as attempting to ensure price stability both nationally and internationally through increased food production and the use of food surpluses (Maxwell & Frankenberger, 1992; Napoli et al., 2011). Due to this fact, the first 1974 World Food Conference adopted the Universal Declaration on the Eradication of Hunger and Malnutrition. The declaration proclaims that: ‘Every man, woman, and child has the inalienable right to be free from hunger and malnutrition in order to develop fully and maintain their physical and mental faculties’ (UN, 1975 as cited in Shaw, 2009).

Following the First World Food Conference, the main emphasis of the world nations was on increasing or expanding domestic food production where the potential exists, as well as on creating a favorable situation under which nations can easily import food to bridge the gaps. Hence, during this time food security was defined as: ‘Availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices’ (UN, 1974 quoted in Burchi & De Muro, 2016). According to this definition, a nation that can make sufficient food available from either domestic production, import or a combination of the two was regarded as attaining food security (Degefa, 2005). During this time, the main issue was how enough food made available to eradicate hunger. This question has indeed attracted academic efforts to identify and understand predicaments that hinder nations to produce sufficient food and enable each person to access adequate food. Thus, the issue of food security has therefore become central to academic research; and the outcome of these efforts resulted in the emergence of the theory of the FAD.

The FAD approach focuses on agricultural supply and considers that famines are largely caused by a sudden decline in food availability in a particular geographic region following war or exogenous shock (epidemics, climatic shifts, etc.) (Clément, 2012; Lin & Yang, 2016). The FAD is mainly concerned about the balance or imbalance between population and food. This approach to famine analysis goes back to the writings of Malthus, who claims that famines are primarily caused by a sudden decline in food availability (Lin & Yang, 2016). Malthus (1978) argues that population growth takes place geometrically, while production and means of subsistence increase only exponentially; due to this fact the FAD approach is also known as the Malthusian approach (Burchi & De Muro, 2016). According to Malthus, the growth rate of food availability should not

be lower than the growth rate of the population. The Chinese famine of 1959–1961 is effectively associated with a significant decline in agricultural production (Clément, 2012). However, a recent study conducted by Lin & Yang (2016) on Chinese famine gives an account to the food entitlement decline approach which will be discussed in the subsequent section.

In general, the traditional approach of FAD argues that anything, which disrupts food production (like drought, flood, or war) can cause famine. However, a modified version of FAD acknowledges the first of these flaws (FAD is not a sufficient condition for famine) and can be expressed simply as ‘FAD + isolation = famine’. The logic here is that food production disruption causes FAD, while poor infrastructure links (transport, communication, and markets) make compensating trade and aid flows impossible. Hence, in this case, a local FAD becomes a local famine if the region is effectively isolated, and so cannot call on food supplies from elsewhere (Devereux, 1988). Though the Green revolution of the 1960s delivered some of its promise and levels of food production increase; the problem of famine did not go away and it was realized that the underlying cause was not so much food supply as the purchasing power of specific social groups (Napoli et al., 2011). Finally, the criticism over FAD ended up in the alternative model of ‘Entitlement’ developed by Amartya Sen in 1981, which will be discussed in the following section.

### 2.2.2. Food Entitlement Decline (FED) Model

In 1970s commentators increasingly focused on the relationship between poverty and famine, emphasizing that it is the poor who starve during food crises - not the rich who invariably survive (Devereux, 1988). However, the food crisis that plagued Africa in the mid-1980s was accompanied by a paradigm shift in the way famines were conceptualized (Sen, 1981). Sen in his book, “Poverty and famines: An essay on entitlement and deprivation”, published in 1981, offered a new paradigm of famine studies by rejecting food availability decline. According to Sen, starvation occurs when a person does not have access to enough food, often despite the availability of food for those who can afford it. He further indicated that food availability decline is not sufficient to explain how famines occur, added to that many famines have occurred without FAD. Instead, Devereux (1988) showed that famine affects specific groups of people following the collapse of food entitlement, named as FED of those identifiable groups. Hence, Sen defined entitlement as ‘the set of alternative commodity bundles that a person can command in a society using the totality of rights

and opportunities that he or she faces' (Sen, 1984 quoted in Devereux, 2001).

Sen points out that starting from a situation in which an individual has just enough means of subsistence, a decline in endowments can obviously lead the person to starvation. However, with the same endowments, a person can still fall into the hunger trap because of a decline in exchange entitlement mapping; for instance, a sharp reduction in the price of the commodity that the individual produces, due to external causes, reduces her/his capacity to buy food (Sen, 1981). Entitlement involves how much food the households actually have access to from their own production, income, wild foods, community support (claims), assets, and migration (Maxwell & Frankenberger, 1992).

The strong point of the FED approach when compared with FAD is that the FED has the potential capacity to identify which group of people are affected by various threats of availability or access to food, differentiation depending on the degree of vulnerability (Maxwell & Smith, 1992). By examining a large entitlement set, one can see that issues such as drinkable water and health care are as important to food security as food per se (Burchi & De Muro, 2016). In general, FAD concentrates on the total availability of food in a geographical region, while FED focusses on the distribution of available foods between different groups of people. FAD operates at macro (national or regional) level, while FED operates strictly at the micro (household or socioeconomic group) level. The Chinese famine of 1959-61, the Bengal famine of 1943, the Ethiopian famines of 1973 and 1984, and the Bangladesh famine of 1974 are some of the evidence provided by Sen for his argument. In relation to 1972–1974 famine of Ethiopia, Baro & Deubel (2006) point out that absence of a significant reduction in overall food output, and the people succumbed to starvation while food prices remained fairly stable, this typical example is explained in terms of both FAD and FED (Devereux, 1988). Recently, Lin & Yang (2016) also analyzed the Chinese 1959-61 famine and aligned it to Sen's entitlement approach. In general, the most valuable contribution of the entitlement approach to famine theorizing is that it shifts the analytical focus away from food supplies - FAD on to the inability of groups of people to acquire food (Devereux, 2001).

However, the FED model is criticized for its failure to take into account the intra-household distribution of food; exclusion of relief entitlement (food aid); concentration on proximate causes of famine (such as market prices) rather than addressing underlying causes; heavy focus on food deprivation, and presumption that famine mortality is induced by starvation; and omits all non-legal transfers of resources. Hence, the role of violence and social disorder leads to entitlement collapse; failure to give attention to the significance of cultural preferences and tastes in determining voluntary under-consumption when entitlement is adequate; and no temporal dimension and the analysis is historical and cannot account for changing vulnerability to entitlement failure (Maxwell & Smith, 1992; Devereux, 1993 as cited in Degefa, 2005).

### 2.2.3. Food Security as Sustainable Livelihood Approach

The concept of Sustainable Livelihood (SL) approach was indeed used previously, however, the emphasis on livelihood was given in the 1980s by Chambers who introduced the basic elements of this approach, with a focus on rural development and poverty. Subsequently, the approach has been elaborated and expanded by Chambers himself and by other scholars (Chambers & Conway, 1991; Ellis, 2000; Scoones, 1998); and livelihood as a theoretical framework to understand poverty and food security emerged in the late 1990s and at the beginning of the 21<sup>st</sup> century (Degefa, 2005). Livelihood is a comprehensive concept that involves access to resources, activities that households undertake in order to secure their means of living, and strategies that they pursue under both normal or abnormal/crisis situations (Scoones, 1998).

According to Chambers & Conway (1991) livelihood is defined as:

*A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable, which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets and provide sustainable livelihood opportunities for the next generation, and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term.*

Nowadays, it has been recognized that food, especially short-term nutritional intake, is only one of the objectives people pursue. In this regard, de Waal (1989) conducted research into the 1984/85 famine in Darfur, Sudan, and provided an account stating that people chose to go hungry to

preserve assets and future livelihood. He further explained that “people are quite prepared to put up with considerable degrees of hunger, in order to preserve seed for planting, cultivate their own fields or avoid having to sell an animal”. This is an indication that people prefer going hungry now in order to avoid going hungry later.

The SLF puts considerable emphasis on individual and household endowments (social, tangible and intangible assets) people possess (Mensah, 2012; Scoones, 1998). Accordingly, SLF identifies five broad categories of resources from which individuals determine their production possibilities, within the context of shocks, trends, and seasonality of their livelihood and in the light of the institutional structures and processes that they confront. The pentagon of assets is the core concept of the SL framework (Burchi & De Muro, 2016), and the assets are termed as capitals – mainly human capital, social capital, physical capital, financial capital and natural capital, which together enable households to pursue a sustainable livelihood (Abera et al., 2011). Details of each category of capital are discussed below.

Natural capital: refers to the land/soil, water and biological resources (flora and fauna) as well as their environmental services that people make use of it to generate their means of survival (Ellis, 2000). Crop production at home depends on access to arable land and its size, and the availability of pasture and water determines livestock rearing. Some segments of poor populations also directly rely on natural vegetation for their livelihood through selling firewood and charcoal. Thus, the linkage between access to natural capital and food security for rural people is direct (Scoones, 1998). Social capital refers to social resources including networks, social claims, social relations, affiliations, associations, community, culture, informal networks, membership of formalized groups and relationships of trust that facilitate co-operation when pursuing different livelihood strategies (Scoones, 1998). Human capital is the labor available to the household and other qualities embedded in it, i.e. education, skills and knowledge base, information, adaptive strategies and good health and physical capability, which are important for the successful pursuit of different livelihood strategies.

Financial capital is the financial resources available to people, including savings, supplies of credit, or regular remittances which provide them with different livelihood options (Carney, 2003); and

other economic assets including basic infrastructure, production equipment and technologies that are essential for the pursuit of any livelihood strategy (Scoones, 1998). Available stocks comprising cash, bank deposits, or liquid assets such as livestock and jewelry, regular inflows of money comprising labor income, pensions, or other transfers from the state, and remittances are the main sources of financial capital available to the household (Kollmair & Juli, 2002). Among the five categories of capitals, financial capital is the most versatile because it can be converted into other types of capital or it can be used for direct achievement of the livelihood outcomes (e.g. purchasing of food to reduce food insecurity). However, it is the asset the least available for the poor, which makes other capitals important as substitutes.

Physical capital comprises the household level property ownership (crop, livestock, etc.) and the basic infrastructure such as transport/roads, shelter and irrigation works, water, energy, schools as well as the production equipment which enable people to pursue their livelihoods (Scoones, 1998). In order to create livelihoods, people must combine the capital endowments that they have access to and control over. In general, livelihood analysis seeks to explain how a person obtains a livelihood by drawing upon and combining five types of capital (Ben et al., 2003).

There are two distinctive features that give SLF some advantages in the analysis of food security. The first advantage is its long-term perspective and the second is its focus on the context (political, economic, physical, social, cultural, etc.) (Burchi & De Muro, 2016). Livelihood activities are influenced by shocks and trends that are in a varying degree exogenous to the household and to local circumstances (Ellis, 2000). According to Scoones (1998), the well-known shocks that have been affecting people's livelihood include recurrent drought, flooding, pests, livestock diseases, etc. The trend of biophysical resources, demographic variables, and technical changes in production practices and the economy of people in a given area are other important contextual aspects, which affect the livelihood activities. The household reacts to exogenous shocks that lead to declining food availability through different coping strategies (Burchi & De Muro, 2016), these include involvement in productive activities, investment strategies and reproductive choices (Haider, 2009). Those households who are unable to cope or adapt are inevitably vulnerable and unlikely to achieve sustainable livelihoods (Scoones, 1998).

Institutions are one of the mediating or influencing elements of the SLF approach. North (1991) defines institutions as ‘the rules of the game in a society or are the humanly devised constraints that shape human interaction’. These include laws, land tenure arrangements (property rights), policies, and the ways markets work in practice. Hence, formal and informal institutions mediate and influence access to livelihood resources. In the same way, livelihood activities and strategies are other detrimental elements of the SLF approach. Livelihood strategies consist of activities that generate the means of household survival (Ellis, 2000). Depending on the level of endowments, individuals construct and identify possible livelihood strategies that would yield optimal returns on welfare outcomes such as increased income and well-being, reduced vulnerability to economic shocks and natural disaster, improved food security and sustained use of available natural resources. Within the SLF, households either gain more of their livelihood from agriculture through processes of intensification (more output per unit area through capital investment or increases in labor inputs) or extensification (more land under cultivation). According to Haider (2009), the choice of strategies is a dynamic process in which people combine activities to meet their changing needs – including off-farm activities in order to diversify income and meet the household needs. Migration is also a very important element, by which people move away and seek a livelihood, either temporarily or permanently, elsewhere, or receive remittance from their relatives (Scoones, 1998).

According to Ellis (2000), necessity and choice are the two main reasons for individuals and households to pursue diversification as a livelihood strategy. Necessity refers to involuntary and desperation reasons (like drought, floods, or civil war) for diversifying. Choice refers to voluntary and proactive reasons (mixed cropping, intercropping and planting non-staple root crops) for diversifying (Ben et al., 2003); and seeking out seasonal wage-earning opportunities and saving money to invest in non-farm businesses. The authors further identified seasonality, risk strategy, response to labor and credit market failure, accumulation strategy and coping behavior and adaptation as reasons for income diversification.

In SLF as indicated in Figure 2, livelihood outcome is an end result of the interaction of various elements in a system. Livelihood outcomes are the achievements of the livelihood strategies. The outcome can be either desirable or undesirable. Poverty and food insecurity are undesirable

outcomes. Whereas, a household whose life is established on a sustainable livelihood base is often food secure, which is a desirable outcome. Livelihood outcomes directly influence the assets and change dynamically their level - the form of the pentagon, offering a new starting point for other strategies and outcomes (Kollmair & Juli, 2002). In general, whether the household livelihood is sustainable or vulnerable, or food secure or not, depends on the interaction between access to various forms of assets, the existing context (trends and vulnerability/shock), the mediating processes, and the resulting livelihood strategies that the household pursues (Ellis, 2000; Scoones, 1998). Mensah (2012) put in a nutshell that ‘the welfare of the household group is hypothesized to be a function of the household assets, the trends, conditions and the context of the livelihood formation processes, as well as the institutional and policy environment that condition the economic and social exchanges’.

Despite the comprehensiveness of the SLF approach in food security analysis, it is not without shortcomings. In line with this, Burchi & De Muro (2016) indicated freedom and agency issues are overlooked because they further elaborate that they play an important role in the analysis of food security. The variable relationship between people and food is also not analyzed thoroughly, and therefore the utilization dimension of food security is neglected; finally, since the unit of analysis of this approach is the household or the community but not the person, intra-household inequalities in the distribution of and access to food that often affect women and children may be overlooked.

To summarize, the household food security situation in the rural area is whether the household can produce enough food from own production or sell livestock and purchase food grain of the right quality in the marketplace. This implies the availability of enough food and the capacity of the household to acquire it determines the household food security. The FAD model is directed towards understanding the main hindrances for increased agricultural production, which in turn would lead to a decline in food availability. The central argument of the model is that anything that disturbs food production, such as drought and flooding by reducing the availability of food for an extended period causes famine. The FED model argues that the mere presence of food in the economy or in the market does not entitle a person to consume and famine could persist without aggregate availability decline. Hence, according to FED, it is access to food that plays a crucial

role in securing command over food (Meskerem & Degefa, 2015). SL approach enables us to identify and understand a multiple of natural, cultural, social, economic, and political factors that enhance or constrain peoples living situation in general and household food security in particular; and it offers more attention and priority on the human environment. It is used to understand the sustainability of the quality of life and food security of the poor and recognizes the complexity, diversity, and continuous change of people's activities and their strategies over time. The approach also helps to holistically address how context interacts with various forms of assets in affecting the livelihoods and strategies that households depend on (Degefa, 2005).

## 2.3. Definitions and Concepts of Indigenous Knowledge

### 2.3.1. What is Indigenous Knowledge?

Indigenous knowledge (IK) is unique to a particular culture and society. It is the basis for local-level decision-making in agriculture, food preparation, education, natural resource management, and a host of other activities in rural communities (Warren, 1991). Such knowledge is passed down from generation to generation, in many societies, orally, or transmitted through imitation and demonstration (Senanayake, 2006). IK is a key element of the social capital of the poor; their main asset to invest in the struggle for survival, to produce food, to provide for shelter or to achieve control of their own lives (World Bank, 1998). IK is tacit knowledge that is difficult to codify and embedded in community practices, institutions, relationships, and rituals (Warren, 1991). It is a consequence of practical engagement in everyday life and is constantly reinforced by experience, trial, and error (Senanayake, 2006). Herbal medicine is a good example of IK, which has affected the lives of people around the globe (World Bank, 1998).

IK contrasts with the international knowledge system generated by universities, research institutions and private firms (Warren, 1991). Warren reveals that IK is a set of perceptions, information, and behavior which is used by local community in order to guide them in terms of land use and the use of natural resources. In other words, IK is created by a local community to meet their daily needs in terms of food and health. According to Abdullah & Hassan (2015) IK is locally based knowledge instead of knowledge which is used across a wider range. It is experiential in terms of being based on what people have preserved in their surroundings, and what is passed

down through generations. It is not knowledge about making grand statements and being applied universally, rather, it is local knowledge intensively built on what can actually be done regarding real situations in the real world. It is generally orally preserved rather than being written down in journal articles.

IK is scientific and is repeatedly resource-conserving, environment-friendly, and a ready tool for the attainment of self-reliance and sustainability. It is a tested and accepted local knowledge that is easily adaptable (Wahab, 2018). In Ethiopia, the local farmers use the enormous amount of indigenous knowledge that has been transferred from parents till this point of time. Farming knowledge has been the major key value in the agriculture sector in Ethiopia, these include seeding, production practice, and selling (Tewodros & Workshet, 2014). Ethiopia is also very rich in indigenous knowledge of architecture, medicine and cottage industry. For example, in Bale administrative zone, farmers prepare a trench around a potato plot to protect it from a porcupine (Sumner & Wossenu, 2002).

### 2.3.2. The Role of Indigenous Knowledge in Agriculture

Investigating first what local communities know and have, can improve understanding of local conditions and provide a productive context for activities designed to help the communities (Nnadi et al., 2013; World Bank, 1998). According to the 1998/99 World Development Report as cited in World Bank (1998) the key to sustainable social and economic development is not capital, rather it is knowledge. Building on local knowledge, the basic component of any country's knowledge system, is the first step to summon such capital. World Bank emphasized that the development partners need to recognize the role of IK in the context of the local communities, and integrate systematically the most effective and promising practices into the development programs they support.

According to Escobar (1995) cited in Briggs (2005) the remaking of development must start by examining local constructions, to the extent that they are the life and history of the people, that is, the conditions for and of change. It is not a big step to imagine that development can only emerge from the application of western knowledge and that indigenous knowledge itself has little to offer. In this regard, Senanayake indicated that indigenous knowledge offers the foundation for

grassroots decision-making (Senanayake, 2006). The study conducted by Rankoana (2017) in South Africa showed that the farming community continues subsistence farming in their home-gardens and plowing fields through indigenous farming practices and rainfall prediction. The other study conducted by Maroyi also showed that farmers produce indigenous crops through knowledge of environmental conditions and seasonal change without access to external inputs, capital, and modern scientific knowledge (Maroyi, 2012). Rankoana (2017) shows that the farming community have ample knowledge of the types of crops that do well on particular soil types and mulching practices to maintain soil fertility. For centuries, farmers have planned agricultural production and conserve natural resources with the mechanisms of indigenous knowledge (Akullo et al., 2007).

Farmers carry out various indigenous crop production practices most of which were cross-cutting among the crops grown. In this regard, early planting is one of the pillars for both indigenous and improved farming methods. Farmers take advantage of early rains, which help them to reduce the incidences of pests and disease that leads to high yields (Akullo et al., 2007). World Bank (1998) report shows that in some countries, local crop varieties are conserved in a gene bank. The gene bank preserves the genetic information of indigenous varieties in hope that genetic traits of these species may corroborate instrumental in future breeding programs against pests and disease. Similarly, Akullo et al. (2007) indicated that farmers in Uganda use rudimentary post-harvest handling techniques. Due to the fact that many root crops are highly perishable when harvested, for instance, when farmers harvest cassava and not immediately used for consumption or selling, the fresh tubers are buried in moist soil. In agreement with the findings of the current study as the growers use in situ or ground for preserving *P.edulis* and anchote tubers.

World Bank (1998) indicated that IK should be seen as complementing rather than competing with scientific knowledge in food production. For instance, many small-scale farmers in Kenya utilize indigenous knowledge system because it is cheaper compared to modern techniques. They are also available locally and are easy to adapt and use. Indigenous knowledge systems prefer the less risk to most profit. However, despite their importance neglected and underutilized food crops are not usually subject to agricultural policy, research and extension activities (Maroyi, 2012). Hence, paying attention to these crops and bringing to the attention of policymakers is timely to help the farmers who are depending on these crops for their food, health, and other benefits.

In general, the generation, adaptation, and use of IK are prominently influenced by culture, economic, social, political and geographical contexts. Consequently, IK shows great diversity among ethnic groups and locations (Rao, 2006). IK related to various fields such as agriculture, medicine, or water supply is a valuable resource that can utilize for even to the modern development initiatives and processes (Panampitiya, 2018). Abioye and his colleagues show that farmers adopt a wide range of indigenous agricultural practices based on generations of experience, informal experiments and intimate understanding of their environments (Abioye et al., 2011). In line with this, Warren (1991) indicated that IK has made a remarkable contribution to crop production by poor farmers. In view of this, the current study tried to assess the IK of farmers about the two tuber crop production practices in southwestern Ethiopia. This research has given valuable insights into how farmers use their own locally generated knowledge in the production of two tuber crops reflected in indigenous land preparation, local variety selection, harvesting and storage, weeds and pests control, food preparation and coping mechanisms during food shortage period.

#### 2.4. Empirical Evidence on NUCS Contribution to Household Food Security

This section presents definitions and characteristics of root and tuber crops, and the research done so far by various scholars in sub-Saharan countries with major emphasis on Ethiopia. Root crops are edible energy-rich underground plant structures developed from modified roots while tuber crops are those crops in which the edible carbohydrate-rich storage organs developed wholly or partly from underground stems (Okigbo, 1989 quoted in Iyagba, 2010). In various parts of the world, many indigenous crops including root and tuber crops are often referred as minor and NUCS. NUCS is defined by the International Plant Genetic Resources Institute (IPGRI) as ‘those plant species that have been overlooked by scientific research and development workers, and yet play a crucial role in food security, income generation and food culture of the rural poor’ (Bizimana, 2007). Nowadays some argue that these crops need to be called future crops - this was clearly reflected in the International Science Forum 2016 held in Addis Ababa (personal observations). It was emphasized that due to their ability to adapt to different climatic conditions and stress resistance ability these crop species are the future prospects in fighting malnutrition and achieving food security in developing countries. Underutilized is commonly applied to refer to

species whose potential has not been fully realized (Padulosi et al., 2006). The term minor implies these species have a small commercial value in production and trade compared to major agricultural commodities.

These plant species have a remarkable ability to adapt to different agro-ecological niches and marginal areas and semi-subsistence production systems (Gruere et al., 2006). These characteristics make such plant species ideal for expanding the existing food basket for poor people, providing a significant contribution to diet and nutrition, and thereby to their livelihood improvement (Williams & Haq, 2002). Anchote is a plant endemic to Ethiopia, which is grown for its edible tuberous roots (Bekele et al., 2014). The consumable parts of anchote including root, leaf, and fruit are rich in protein, calcium, iron, potassium, and utilizable carbohydrate. Hence, anchote is best in terms of nutrient content as compared to some root crops grown in anchote growing areas and fourth after *enset*, sugar beet and potato in energy content (Abera, 1995). The practices of anchote cultivation and utilization have been passing orally from generation to generation with very little recorded information (Wondimu, 2012; Abera, 1995). Similarly, *P.edulis* is a small hairy, ancient tuber crop cultivated on a small-scale basis in mid and high altitude areas in the north, south, and southwest of Ethiopia. It is locally known under different names depending on the place where it grown such as *Oromo dinich* (in Oromia), *Wolaita dono* (in Wolaita zone), *Gamo dinich* or *Gamo Dono* (in Gamo Gofa zone), *Gurage dinich* (in Gurage zone), *Agaw dinich* (in Awi zone, Amhara region), Ethiopian potato, etc. (Mulugeta, 2008).

Bizimana (2007) conducted research on underutilized crop diversity, seed systems, management, and their implications on food security: the case of roots and tubers in southwestern Rwanda. The study was aimed at finding the composition of neglected and underutilized indigenous root and tuber crops and practices that maintain crop diversity via informal seed systems in smallholder farms. The study showed the heavy dependency of farmers on their own farm-saved seeds. The author further revealed that due to small landholdings, the farmers tended to intercrop and practice leveled land preparation. This practice significantly reduced the risk and/or increased resilience of the system for roots and tuber crops. Bizimana indicated that new varieties developed by research hardly reach the end-user. The author further highlights that indigenous root and tuber crops are good, needed all the time, eaten on a daily basis, and have good taste. In general, the author found

out that yam and taro have been playing a major role, be it for home consumption, income generation, and animal feeding.

Yeshitila & Weibull (2012) conducted the research entitled ‘phenotypic variation and local customary use and management of *Plectranthus edulis* in Sodo Zuria Woreda, southern Ethiopia’. The research was composed of field experiments and household surveys, with the aim of studying the phenotypic diversity of the accessions and assessing the morphological diversity with respect to collection regions and ethnobotanical study in relation to the use and management of the crop. The findings of the field experiment indicated that the existence of wide overall diversity, involving a number of traits across different regions and different accessions. They also tried to reveal the traditional management practice of producers and customary use of the crop. However, management practice might vary from place to place and from one community culture to the other. Similarly, Abreham et al. (2014) studied the genetic diversity of anchote, with the aim of assessing the genetic diversity within and among 12 populations of anchote using ISSR markers. The findings showed the existence of immense genetic diversity in some collection sites and regions. Tilahun et al. (2014) also conducted research on ‘Variability and association of quantitative traits in anchote’, and the findings were not far from Abraham and his colleagues’ work.

Similarly, Yeshitila & Temesgen (2016) conducted research on ‘exploration and collection of root and tuber crops in the East Wollega and Ilu Ababora zones’. The authors collected a total of 76 root and tuber crop germplasms and conserved in the cold room and field gene bank of the Ethiopian Biodiversity Institute. *P.edulis* and anchote were among the other collected root and tuber crops. The findings of the survey indicated that production and the number of local varieties of root and tuber crops maintained on individual farms have been declining for the past decade. They identified major factors limiting the production and sustainable use of root and tuber crops including displacement by other crops, little research attention, drought, short shelf life, shortage of planting materials and limited knowledge of youth and pests.

Girma & Hailu (2007) conducted research on the response of anchote to organic and inorganic fertilizer rates and plant population density in western Oromia. The aim was to compare the response of anchote to different levels of organic and inorganic fertilizer. The researchers finally

recommended the optimum level of fertilizer application. Habtamu (2014) also studied the effects of boiling methods on anti-nutritional factors of anchote tubers, with the aim of determining the effect of traditional processing methods on anti-nutritional factors of anchote. The findings showed that raw anchote contains low levels of anti-nutrients compared to other roots and tubers crops. The effect of harvesting dates on yield and nutrient concentration of the crop and in-situ storage was conducted by Girma & Dereje (2015) to investigate its yield and nutrient concentration. Nutrient analysis showed that anchote tuber contains 19 g N, 122.6 g K, 7.4 g P, 5.1 g Ca and 316 mg Fe kg<sup>-1</sup> of dry weight, which highlights that the crop contributes equal or more nutrients than equal amounts of Irish potato tuber and cassava roots, and also its nutrient content is much higher than the indigenous root crops. The findings also showed that the tuber yield of anchote was 2.7 to 3.3 times higher than the average national yield of 5.8 t ha<sup>-1</sup> when harvested in the 7<sup>th</sup> month. Daba et al. (2012) also conducted research under the topic growth and yield performance of anchote in the contracting environment. It was experimental research and mainly focused on growth and yield of the crop.

Twenty-four years ago, Abera (1995) conducted a research on the topic ‘anchote: an endemic crop’ and explored the existing farmers’ indigenous knowledge related storage, processing, utilization, and its cultural and social values. His work was exhaustive in explaining the crop and provided information on anchote culture starting from site selection for cultivation, harvesting, processing, utilization, and marketing. He has also reviewed the nutritional content of anchote. His work also tried to address the labor division related to anchote production activities. The author also described the morphology of the crop and taxonomic classification and its vernacular name in different parts of the country. Due to the fact that the study undertaken two decades ago, the existing farmers’ indigenous knowledge, the crop’s utilization and the level of the contribution of the crop to the household food security might be changed over time. Hence, it is timely to conduct research on farmers’ indigenous knowledge and the crops’ contribution to household food security. Mulugeta et al. (2007) also conducted the research under the topic ‘indigenous multiplication and production practices of *P. edulis* in Chench and Wolaita, southern Ethiopia’. The researchers tried to establish traditional cultural production practices, constraints and the reason for the decline of crop production in the study area. The current study tried to fill the endeavors of knowledge gap with regard to farmers’ indigenous production practices, constraints associated with the two crops

and their contribution to the household food security in the study area.

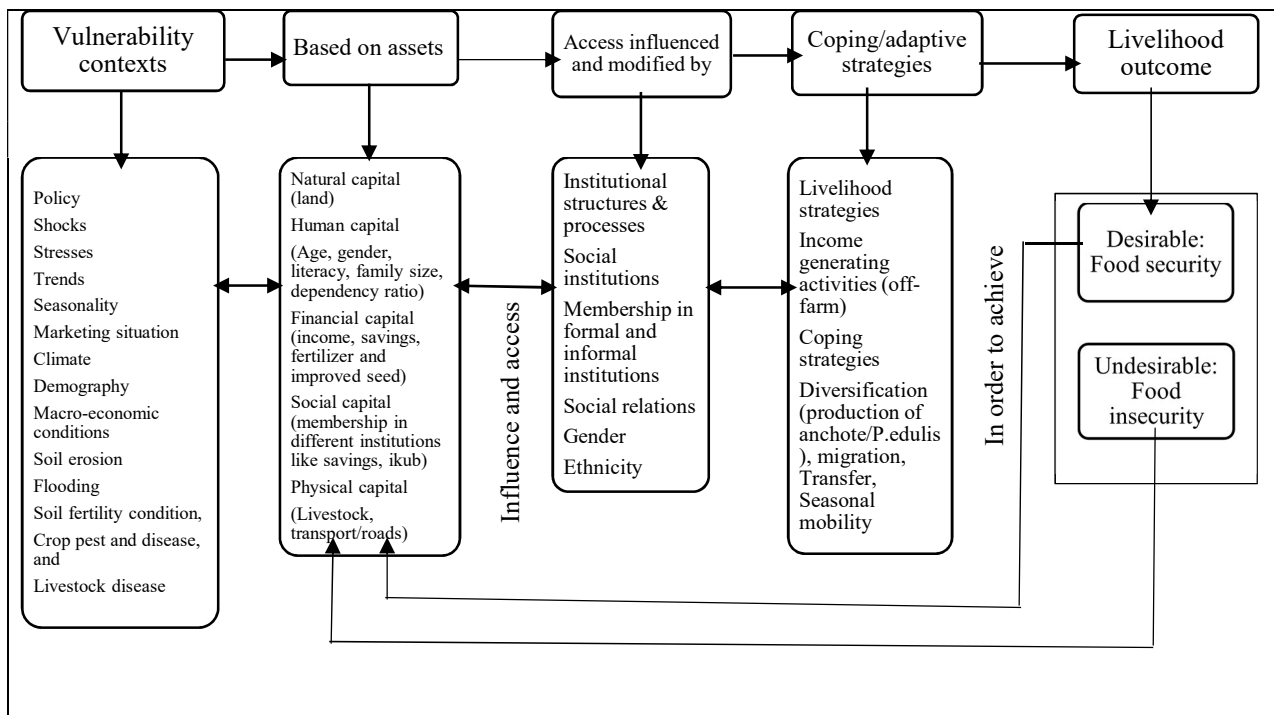
## 2.5. Analytical Framework

Sustainable livelihood framework (SLF) guided this research as an analytical framework. Analytical framework in scientific research is essential for the systematic evaluation of complex phenomena (Mensah, 2012). As presented in Figure 1, the SLF puts considerable emphasis on individual and household endowments (social, tangible and intangible assets), offers a holistic and integrated view of the processes by which people achieve or fail to achieve sustainable livelihoods (Burchi & De Muro, 2016; Scoones, 1998; Abera et al., 2011; Mensah, 2012). SLF constitutes five components: context, assets, mediating process (institution and organization), activities and strategies, and outcomes. Interaction of the first four components determines the outcome. Assets are further categorized into five: natural capital, social capital, human capital, financial capital, and physical capital. These assets are from which individuals determine their production possibilities, within the context of shocks, trends, and seasonality of their livelihood and in the light of the institutional structures and processes that they confront (see details in section 2.2.3). Ben et al. (2003) indicated that in order to create livelihoods people must combine capital endowments that they have access to and control over.

Livelihood activities are influenced by shocks and trends that are in a varying degree exogenous to the household and local circumstances (Ellis, 2000). Assets can be destroyed or created as a result of the trends (such as economic trends, resource trends), shocks (such as conflict, economic shocks, health shocks and natural shocks such as drought) and seasonality (seasonal fluctuations in prices, production, health, employment opportunities) in the vulnerability context within which people live (Haider, 2009). Context determines the extent to which the households are vulnerable to various disasters/risks, which has direct implications for asset capitals possessed (Degefa & Tesfaye, 2008). Shocks and stress have an impact on people's livelihoods (activities, assets, and entitlements); then the household starts to respond to exogenous shocks that lead to declining food availability through designing different livelihood coping/adaptive strategies (Burchi & De Muro, 2016). While this, coupled with productive activities, reproductive choices, intervention in policy, governance, investment strategy, and technology will lead to sustainable livelihood/food security (Haider, 2009). Conversely, those households who are unable to cope or adapt are inevitably

vulnerable and unlikely to achieve sustainable livelihoods (Scoones, 1998).

Figure 1 Sustainable livelihood framework for analyzing household food security



Source: Adapted from (Scoones, 1998; Degefa, 2005; Woller, 2011; Mensah, 2012)

The trend of biophysical resources, demographic variables, and technical changes in production practices and the economy of people in a given area are other important contextual aspects, which affect the livelihood activities. In addition, policies, institutions, and processes can have a great influence on access to assets (Haider, 2009). Institutions (formal and informal) are one of the mediating or influencing elements of SLF approach. Livelihood activities and strategies are other detrimental elements of SLF approach. Livelihood strategies consist of activities that generate the means of household survival (Ellis, 2000). Depending on the level of endowment, individuals construct and identify possible livelihood strategies that would yield optimal returns in welfare outcomes such as increased income and well-being, reduced vulnerability to economic shocks and natural disasters, improved food security and sustained use of available natural resources.

Within the SLF the household either gain more of the livelihood from agriculture (crop production, livestock rearing, aquaculture, etc.) through processes of intensification (more output per unit area through capital investment or increases in labor inputs) or extensification (more land under

cultivation). According to Haider (2009), the choice of strategy is a dynamic process in which people combine activities to meet their changing needs – including off-farm income-earning activities in order to diversify income and meet the household needs. Migration is also very important, people move away and seek a livelihood, either temporarily or permanently, elsewhere, or receive remittance from their relatives (Scoones, 1998). In SLF, livelihood outcome is an end result of the interaction of various elements (context, assets, mediating process and livelihood activities and strategies) in a system. The outcome can be desirable or undesirable, depending on how households under an existing context combine different forms of capital, and how these combinations are enhanced, or constrained by organizational and institutional frameworks in place. Among other things, poverty and food insecurity are undesirable outcomes. Whereas those households whose lives are established on a sustainable livelihoods base are often food secure, that is a desirable livelihood outcome. If the outcome is desirable, then feedback contributes to building up the five capital assets; where they are undesirable, they reduce the asset base.

In this study within the framework those important factors that determine the households' food security was incorporated. These variables included demographics, biophysical, productive asset/resources, infrastructural and socio-cultural factors (Figure 1). The outcome of the study provided an understanding of whether the households in the study area are food secure or not. Some of the hypothesized factors that determine the household food security were: land from the natural asset, the household characteristics (such as family size, educational level, dependency ratio, age and gender of the household head) from the human capital asset. Membership in different institutions/associations like traditional revolving savings and credit associations locally called *iqub*, which indicates both social and financial capital endowment. In addition to providing financial sources, membership in local associations offers households an opportunity to build connections with other households resulting in social capital on which the households could count in times of food or financial shortages (Abera et al., 2011). The household income obtained from different sources (like on/off-farm, remittance, credit, etc.), use of fertilizer and improved seed, savings (formal and informal) from financial assets; and distance to the nearest market, and livestock ownership from physical assets are considered from the components of SLF as the determinants of the household food security. Coping/adaptive strategies of the household (income-generating activities including non/off-farm employment), migration, and transfer are considered

to have the full picture of the household food security status in the study area. This study incorporated from the context: biophysical condition – soil erosion, soil fertility condition, crop pests and disease, and livestock diseases. The central objective of this study, growing the two tuber crops in their respective study area were considered as one means of the household livelihood diversification strategies to sustain their livelihood.

## Chapter 3 Study Areas Setting and Methodology

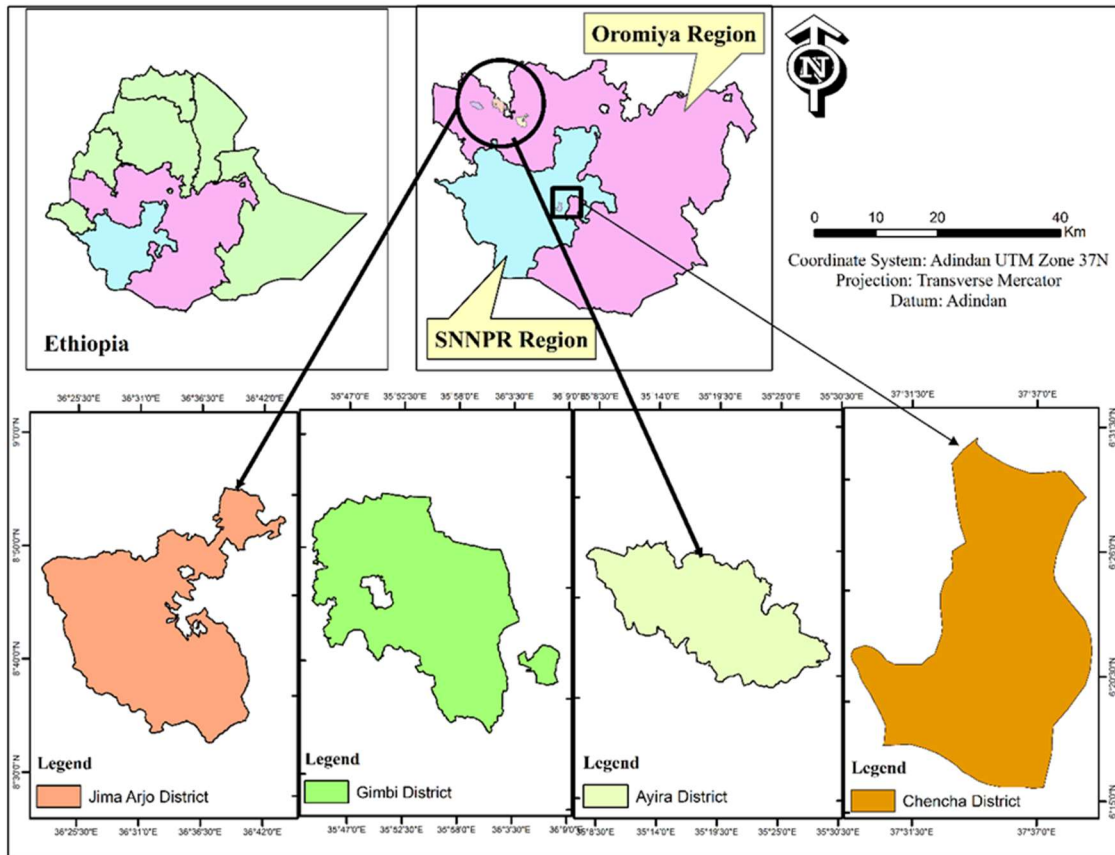
### 3.1. Introduction

The purpose of this chapter is to provide an account of the methodological framework that guided this study. This research was intended to study the growers' indigenous knowledge, constraints associated with and the contribution of the two tuber crops to the household food security in southwestern Ethiopia by taking the case study *P.edulis* and anchote (*Coccinia abyssinica*). This requires appropriate philosophical and methodological underpinnings that guide the whole research process, which in turn needs predetermination of the type of data that would be employed. In the following subsection, description of the study area, a brief account of the research paradigm that guides this research, research design, sampling procedure, data collection procedures, and the penultimate section deal with data analysis techniques.

### 3.2. Description of the Study Area

The survey was conducted in Chench district, Gamo Gofa zone, Southern Nations, Nationalities, and People's Region (SNNPR); Jima Arjo district, East Wollega zone; Ayira and Gimbi districts, West Wollega zone, Oromia Regional State, Ethiopia (Figure 2). Chench and Jima Arjo districts were selected for their *P.edulis* production potential; while Gimbi and Ayira districts were selected for their anchote production potential. Chench district is located between 1300 and 3250 m.a.s.l; between 37° 29' 57" East to 37° 39' 36" West and between 6° 08' 55" North and 6° 25' 30" South in the Gamo Gofa zone, SNNPR (Gezahagn, 2008). It is located at about 480 km southwest of Addis Ababa, the capital city of Ethiopia and bounded on the east by Lake Abaya and Lake Chamo. The rainfall pattern is bimodal, the first rainy season locally called *gabba* occurs from March to June; and the second season, known as *silla*, occurs from August to November (Engdawork, 2012; Mulugeta et al., 2007). The annual rainfall distribution varies between 667.0-1706.8 mm, and the mean annual temperature ranges from 15.0-27.7°C (NASA, 2018). Following the seasonal patterns, there are two cropping seasons in the area, locally referred as *silla* and *gabba*. *Silla* is the dominant agricultural season; which accounts for 65-75% of the total yield in the area (Engdawork, 2012). The mean annual temperature ranges from 11 to 23°C (Gezahagn, 2008).

Figure 2 Description of the study area



Source: Own construction based on points obtained from GPS reading during survey work

In Chenchu district the household landholding is within the range of 0.1 to 0.5 ha. Ecologically 82% of the total area considered as Dega and the remaining 18% is Weyna Dega (Fassil & Elias, 2016). Chenchu district has 45 rural kebeles and 5 rural small towns. The district has a total population of 111,686 of which 98,382 were rural population and 13,304 were urban population (CSA, 2007). The major crops grown in Chenchu district include maize, wheat, barley, Irish potato, peas and beans, *enset*, *P. edulis*, vegetables, sweet potato, *teff*, apple, and onion. *Enset* is the staple food in the area and central to subsistence agriculture. Raising livestock is also an integral part of the economy. Off-farm activities constitute weaving locally called *shimena* and small-scale trading. The locally-made traditional clothing has been seen on the roadside being displayed on the market day in the area. The traditional house is made from the stems and leaves of bamboo and appears like an upturned basket (Engdawork, 2012).

Jima Arjo district is located in the east Wollega zone of Oromia Regional State, 378 km west of Addis Ababa (Gadisa et al., 2014). The district shares boundaries with Leka Dulecha in the north and northwest, Guto Wayu in the north, Nunu Kumba in the east and Bedelle (Ilubabor zone) district in the south and southwest. The district is bounded by 8033' to 8055'N latitudes and 36022' to 36044'E longitudes and has a total area of 773 km<sup>2</sup> (77,258 ha) (Muleta, 2009). Based on the agro-climatic classification of Ethiopia, the lowland covers 30%, mid-altitude 58% and highland 12% (Shayaq et al., 2017). Generally, the area is located at an altitudinal range from 1200-1816 m.a.s.l (Gadisa et al., 2014; Shayaq et al., 2017). The area receives an average annual rainfall ranging from 974.1-2699.3 mm and the mean annual temperature ranges from 13.3-27.4<sup>0</sup>c (NASA, 2018)(Gadisa et al., 2014; Shayaq et al., 2017). The rainfall in the study area is unimodal with monthly rainfall rising steadily from March to a peak in August. Months from May to September are when the area receives 76.3% of the total rain (Muleta, 2009).

Jima Arjo district has a total population of 86,329 of which 77,157 were rural population and 9,172 were urban population (CSA, 2007). The farming system is a mixed crop and livestock production system and employs more than 88% of the total economically active population in the area. Agriculture is characterized by small and dispersed cropland holdings with traditional farming practices (Muleta, 2009). Barley, wheat, teff (*Eragrostis teff*), maize, peas, coffee, *P.edulis*, selit (*Sesamum orientale L*), Irish potato, noug (*Guizotia abyssinica*), anchote, and oats are the major crops grown in the area.

Gimbi district is located in the west Wollega zone, Oromia Regional State, 441 km southwest of Addis Ababa. It has an estimated area of 1,183.44 square km bounded by the east Wollega zone in the east, Lalo Assabi district in the west and Guyi district in the south and Amhara Regional State in the North, and Benishangul-Gumuz Regional State in the southeast (Degneh et al., 2010; Fikru, Efa, & Hailu, 2017). The district is located at 07°02'N and 38°28'E (Degneh et al., 2010). The district receives an average annual rainfall of 619.0-2183.0 mm and the average annual temperature is between 14.4 and 29.6<sup>0</sup>c. The area is covered with a variety of vegetation patterns of cultivated land, bushland, savannah grassland, and patches of dense forests and strips of riverine forests along the riverbanks (Degneh et al., 2010). The district has a total area of 1172 km<sup>2</sup>; and a total population of 105,604 of which 74,623 were rural population and 30,981 were urban

population (CSA, 2007). The major rainy season includes spring (May), summer (June-August), and autumn (September-October). Rural people in the district lead their lives in crop production and livestock rearing (Abera, 2014).

Ayira district is part of the west Wollega zone, Oromia Regional State. The district was separated from the former Ayra Guliso district in 1999. Guliso district bounds Ayira district in the north, Yubdo district in the southeast and Kelem Wollega zone in the south and west. The district is located at 9.1°N and 35.3°E. Agro-ecologically, 85% of the district is Midland and 15% is lowland, with an annual average temperature range from 14.6-29.1°C (NASA, 2018). According to the information obtained from Ayira district agricultural and natural resource management office, Ayira district has 18 kebeles. Out of which 15 are rural kebeles and the rest are urban kebeles. The mean annual rainfall ranges from 680.6-2211.2 mm (NASA, 2018); and the altitude ranges from 1500-1750 m.a.s.l. (Debela et al., 2014). According to the 2007 national census report, Ayira district has a total population of 47,537 in 9,293 households, 12.79% of its population were urban dwellers (CSA, 2007). The population's livelihood in the district, 80-90% depends on agriculture.

### 3.3. Research Paradigm

Philosophically, this study was guided by a pragmatic research paradigm. Guba and Lincoln (1994) define a paradigm as a basic set of beliefs or worldview that guides research action or an investigation. Paradigm constitutes the abstract beliefs and principles that shape how a researcher sees the world, and how s/he interprets and acts within that world. Paradigm is the lens through which a researcher looks at the world and defines a researcher's philosophical orientation (Kivunja & Kuyini, 2017). There are two main philosophical dimensions, ontology and epistemology, which distinguish the existing research paradigms. Ontology is related to the nature of knowledge; it is the view of how one perceives reality. While epistemology is related to the development of that knowledge. It is the belief in the way to generate, understand and use the knowledge that is deemed to be acceptable and valid (Wahyuni, 2012). Additionally, axiology and methodology are the two basic beliefs that affect the way to investigate reality. Axiology is concerned with ethics, encompassing the roles of values in the research and the researcher's position in relation to the subject studied. Methodology refers to a model for undertaking a research process in the context of a particular paradigm. Philosophically, researchers make claims about what is knowledge

(ontology), how we know it (epistemology), what values go into it (axiology), how we write about it (rhetoric), and the processes for studying it (methodology) (Creswell, 2009).

There are divergent opinions on how to ensure research quality. Some scholars argue that different methodological approaches are underpinned by particular philosophical assumptions and that researchers should maintain consistency between the philosophical starting point and the method they adopt (Degefa, 2006). By contrast, according to the same author, others believe that the methods associated with a range of philosophical positions each have something to offer. Due to this fact, the debate over the relative advantages of quantitative and qualitative methodology has gained considerable impetus over the last many decades. Quantitative methodology is routinely depicted as an approach that used to conduct social research by applying natural science, and in particular a positivist approach to social phenomena (Bryman, 1984). For positivists, the world is measurable, controllable and explainable (Knox, 2004 quoted in Degefa, 2006). The proponents of positivism perceive that there is a single reality. The existence of this reality is external and independent of social actors and their interpretations of it, and that its properties should be measured using objective methods, i.e. methods that result in essentially numerical evidence. This means that only observable knowledge is valid. For positivism non-measurable world data are invalid, and as a result, research underpinned on the philosophy of positivism does not give room to accommodate methods from the qualitative approach (Degefa, 2006). This highlights that for positivists there is no place for individual values, opinions, attitudes or beliefs in the knowledge accumulation process (Muthuma, 2011).

Alternatively, constructionists or qualitative methodology or subjectivist adopter theory believes that reality is dependent on social actors and assumes that individuals contribute to social phenomena (Bryman, 1984). Constructionists stress the importance of interpretation as well as observation in understanding the social world. In this regard, the job of a researcher becomes simply to understand the meaning from which social reality is constructed (Degefa, 2006). Similar to the positivists, the qualitative method is linked to the constructionists. Concerning the logic of inference, according to the same author positivists focus on deduction (proof or disproof of a predetermined hypothesis), while constructionists are interested in induction (constructing theory from observations – grounded theory).

According to Tashakkori and Teddlie (1998) quoted in Wahyuni (2012), pragmatism is another philosophical stance that refuses to join the ‘paradigm war’ between the positivist and interpretivist research philosophies. Pragmatic paradigm arose among philosophers who argued that it was not possible to access the ‘truth’ about the real world solely by virtue of a single scientific method as advocated by the positivist paradigm, nor was it possible to determine social reality as constructed under the interpretivist paradigm (Kivunja & Kuyini, 2017). Pragmatism believes that objectivist and subjectivist perspectives are not mutually exclusive, and believes that a mixture of ontology, epistemology, and axiology is acceptable to approach and understand social phenomena. Here, the emphasis is on what works best to address the research problem at hand; it places the research problem as central and applies all approaches to realize the problem (Creswell, 2003). Pragmatist researchers favor working with both quantitative and qualitative data because it enables them to better understand social reality (Wahyuni, 2012). Pragmatism rejects the either/or choices associated with the paradigm tension, and instead advocates the application of mixed methods in research (Degefa, 2006). The movement of researchers to mixed model approaches used the mixing aspects of the quantitative or qualitative approach at multiple phases of the research i.e. design, collection, and analysis (Creswell, 2003).

Pragmatism is treated as a new orthodoxy built on the belief that not only it is allowable to mix methods from different paradigms of research but it is also desirable to do so because good social research will almost inevitably require the use of both quantitative and qualitative research to provide an adequate answer (Denscombe, 2007). Gray (2004) revealed that selecting approaches to research involves adopting a research philosophy, and an appropriate research approach and methodology. The author further indicated that in practice, research often necessitates the use of multiple methods to achieve triangulation. Therefore, considering the mentioned virtues, this study aimed to generate knowledge in the lens of the pragmatic research approach. This research mainly adopted pragmatic research paradigm to substantiate/triangulate the data collected through formal household survey. The qualitative aspect was involved the growers production practices of the two tuber crops; identification of associated production constraints; types of traditional foods prepared from the two tuber crops; sayings that express the importance of the two tuber crops; perception of growers toward production trend and the perception of growers toward the contribution of the two tuber crops to the household food security. While, the quantitative part involved household

characteristics, household income, quantity of food crops produced, production constraints, household food security status, and coping strategies during food shortage period, etc.

### 3.4. Research Design

This study employed descriptive and exploratory research designs. The reason for using mixed research design was that the research included several research questions; hence, a research method appropriate for one question may not be appropriate for another; and to apply triangulation. In an exploratory survey, we usually use open-ended questions (qualitative). An exploratory design is flexible design and involves non-probability sampling design, and unstructured instruments for collection of data. Hence, the exploratory research design covers the qualitative parts that involve FGD, case studies, and key informant interviews. Alternatively, the descriptive research design is a rigid design, usually employs probability or random sampling, pre-planned design for analysis and involves structured instruments for data collection (Kirshenblatt-Gimblett, 2006). In this case, the answer was sought for questions such as: is the production of the two crops increasing or decreasing over the last 10 years? How many food secure and insecure households are there in the study area? Are the two tuber crops significantly contributing to household food security? This design covers the formal household survey part. In general, a mixed-methods research design was used for collection, analysis, and integration of quantitative and qualitative data. Therefore, the overall study design aimed to understand the growers' indigenous knowledge regarding production practices of the two tuber crops, associated constraints and the contribution of the two tuber crops to household food security.

### 3.5. Sample Size and Sampling Procedure

A multi-stage sampling technique was used to select the respondents. At the first stage, four districts were selected purposively based on their potential for *P.edulis* (Chencha and Jima Arjo) and anchote (Gimbi and Ayira) production. In the second stage, a representative sample size of the household was determined using sample size determination formula developed by (Yamane, 1967):

$$n = \frac{N}{1 + N(e^2)}$$

Where  $n$  is the sample size,  $N$  is the total number of households and  $e$  is the level of significance,

i.e. fixed at 5%, and 1 is the probability of the event occurring. In the study area, empirical studies that show the proportion of the two crop growers and non-growers was not found. Hence, to overcome this shortcoming equal proportion of growers and non-growers (0.5 or 50%) was assumed. This assumption yields 397 households. When 10% added for contingency due to non-response, the total sample size becomes 437 households. In the third stage, 12 *kebeles*<sup>1</sup> (3 kebeles from each district) were selected purposively based on their potential for the two crops production. In the fourth stage, the list of household heads was obtained from each *kebele* and the sample size was proportionally allocated to each *kebele*. Accordingly, a total of 250 households from *P.edulis* growing area (155 from Chenchu and 95 from Jima Arjo district) and a total of 187 households from anchote growing area (114 from Gimbi and 95 from Ayira district) were selected. Finally, a simple random sampling technique was employed to draw the household head from each kebele for interview. However, the statistical analysis was limited to 434 households as the remaining households did not fulfill the requirements.

In addition, purposive sampling was used to determine the participants for FGD and case studies. The non-probability sampling technique allows the investigator to rely on his/her expert judgment to determine representative units. Focus groups are labor-intensive in recruitment, transcription, and analysis; therefore, where possible, numbers should be kept down to the bare minimum (Bloor et al., 2001). The authors further explained that since the interaction between participants is a key feature of the focus group method careful consideration of group composition is vital. Accordingly, a group of nine participants from each district consisting of three farmers from each kebele (two men and one woman), encompassing elderly growers who are known to have a better knowledge of the present and past social and economic status of the study area to have a diverse idea of the subject matter. The group members were a group of farmers who at the time involved in growing *P.edulis* and anchote in their respective locations. In the same way, four case study households (one from each district) were selected purposively. The case study respondents were the farmers who at the time involved in growing *P.edulis* and anchote in their respective locations. Participants were identified with assistance from development agents (DAs) and *kebele* administrators.

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<sup>1</sup> Kebeles are the lowest administrative unit of Ethiopia that is larger than a village but smaller than a district.

### 3.6. Data Collection

As the issues addressed in the study are of quantitative and qualitative in nature, both quantitative and qualitative data collection methods were used to collect the data. Prior to commencing the fieldwork, ethical issues were considered. Meetings were held with respective district agriculture and rural development bureau staff and respective *kebele* administrative officials to explain the purpose of the study in order to obtain necessary cooperation. Data was collected from individual respondents and FGD participant with consent obtained by explaining the purpose of the research and participant rights prior to their participation. To achieve the proposed objectives of the study different data collection tools were employed to generate adequate and reliable first hand data. The methods used include cross-sectional household surveys, FGDs, individual case studies, key informant interviews (KII) and field observation in the crop farms, major market areas, hotels and restaurants (anchote growing areas). Gary shows that all methods have their own strengths and weaknesses; hence, the use of multiple methods not only assist in data triangulation but also helps to balance out any of the potential weaknesses in each data collection method (Gray, 2004). This approach from a different methodological standpoint is usually known as triangulation (Gillham, 2000). In addition, secondary data was collected from published and unpublished research reports and respective district agricultural offices. The subsequent sections present the details of each data collection technique.

#### 3.6.1. Cross-sectional Household Survey

The comprehensive mix of structured and semi-structured questionnaire was prepared and administered among the randomly selected *P.edulis* and anchote growers and non-growers located in respective study areas. The questionnaire was designed to gather the data pertaining to socioeconomic and demographic characteristics of the household, resource endowments, farm inputs use, growers knowledge related to the two crops production, storage, marketing, processing, utilization, purposes of the two crops production, perception of farmers on the crops production trend, the reason why farmers produce less, and the reason why these crops are not consumed beyond their traditional production area despite the farmers' long period production practice, sources of income and amount from different sources, and constraints associated with the two crops production, storage, marketing, processing and utilization, household multidimensional food

security, and the household coping strategies during food shortage period, etc. (Annex 1).

Scoring technique was used to collect the data on the two crops production constraints. Prior to the individual scoring exercise, 25 production constraints were identified based on preliminary FGD (with growers and key informants) and a review of related literature (Annex 1). Scoring data arises from activities where precise numerical measurement is inappropriate, including a range of qualitative work (Marsland et al., 2001). Scores have a numerical meaning and scoring data can be dealt with relatively standard statistical methods (Abeyasekera, 2001; Marsland et al., 2001). For the purpose of this study, a fully open scoring method was used to collect production constraints during the formal survey period. Fully open scoring is a technique where each item to be scored can be given any value within a particular range (for instance 1-5) is the most flexible since it leads to observations that are independent of each other - a requirement for most simple statistical analysis procedures (Maxwell & Bart, 1995). While doing so, the sample respondents were asked to rate the weight of the two crops production constraints in their respective study areas by giving 1 (no constraint), 2 (low constraint), 3 (medium constraint) and 4 (high constraint) adopted from (Almaz et al., 2014).

In order to determine household food security status and thereby look into the relationship between the two crops production and household food security, Multidimensional Food Security Indicator (MFI) questionnaire developed by Maxwell et al. (2013) was adopted. Frequently available and utilized indicators that measure food security include actual food consumption at the household level by a 24-h recall; coping strategies index; proxy indicators such as caloric intake, household income, productive assets, anthropometric measures of nutritional status, dietary diversity, and household food insecurity access scale (HFIAS). Though these indicators reasonably capture and designate a small portion of the problem, they do not provide a comprehensive picture. Per-capita caloric intake was considered as the gold standard for access to food at the household level for many years (Gorstein et al., 1994). Per-capita caloric intake reflects current consumption and focus on the quantity aspect, and fails to address many other elements of food security, like quality (dietary diversity and micronutrient sufficiency), vulnerability and risks, and fluctuations and trends in consumption over time (Maxwell et al., 2013). However, understanding food security requires not only food quantity entitlement but also the quality of entitlement. This is to mean that

food security requires not just secure, stable access to a sufficient quantity of food, but also access to nutritionally adequate quality food, culturally acceptable, procured without any loss of dignity and self-determination (Maxwell & Frankenberger, 1992). Food security/insecurity is a multi-dimensional issue which cannot be adequately recorded by a single indicator (Napoli et al., 2011), and this immediately raises the question of measurement - how are these different dimensions to be measured and weighted?

In response to this question, Maxwell et al. (2013) developed MFI using seven measures. The seven measures used in MFI were (1) Coping Strategies Index (CSI); (2) Reduced Coping Strategies Index (rCSI); (3) Household Food Insecurity Access Scale (HFIAS); (4) Household Hunger Scale (HHS); (5) Food Consumption Score (FCS); (6) Household Dietary Diversity Scale (HDDS); and (7) Self-assessed Measure of Food Security (SAFS). This approach will help the researcher to explore whether or not farming households are self-sufficient in food from their own production or not through their own self-assessment. The authors developed the MFI based on HFIAS. In their findings, they revealed that relying on CSI, HFIAS, or FCS alone would result in the misclassification of a substantial proportion of the households as either food secure or food insecure by the measurement of the other indicator. In their work, the authors found out that nearly 27 percent of households would be misclassified by using only one indicator rather than the combination of both (CSI/HFIAS and FCS). Hence, looking into the stated advantages over the other indicators MFI was adopted as appropriate to assess the multidimensional household food security status.

MFI contains 24 questions composed of different measures representing: 7 FCS/HDDS, 1 SAFS, 6 CSI, 3 HFIAS/HHS, 3 CSI/rCSI, and 4 HFIAS. With the exception of SAFS, each question has four response options, borrowed from HFIAS: often, sometimes, rarely, and never, with the exact meaning of these responses differing by the question. The difference between MFI and HFIAS is that the latter constitutes nine 'occurrence' questions, if the respondent answers 'yes' to an occurrence question, then the frequency question follows (Castell et al., 2015; Maxwell et al., 2014), but in case of MFI, Maxwell and his colleagues combined both occurrence and frequency questions together. For SAFS, the responses correspond to severely food insecure (4 or worst), moderately food insecure (3), mildly food insecure (2), and food secure (1). Each of the 24 MFI

questions was asked with a recall period of four weeks (30 days) similar to HFIAS. The questions were directed to the household head along with other questions.

### 3.6.2. Focus Group Discussion (FGD)

FGD helps in bringing out the group's perspective on the issues being discussed. The main advantage of FGD is that it assists in the understanding the significance of data generated by participants from their interpersonal communication of daily interactions (Dukpa, 2012). Group discussion can also facilitate greater critical comments from the participants than interviews can (Bloor et al., 2001). As indicated in the previous section, each group comprised 9 participants, including elderly and female household heads. During proposal development stage preliminary field visit were also made in all districts. During this time discussion was made with respective Zone and District Agriculture and Rural Development office experts and Development Agents.

The information obtained from preliminary survey and the first round FGD was used in the design of questionnaires for the formal household survey, particularly to identify crop production constraints, and explore the growers' indigenous production practices related to the two tuber crops. In this case the final outcome of the FGD, which summarizes constraining factors that affect the two crops production, storage, marketing and utilization, reasons for less production of the crops were presented to the participants for pairwise ranking exercise. Then, the same list were presented to participants for their approval. Finally, the approved list was included in the formal survey questionnaire in order to gain further insights from the individual household interview.

Then again an open-ended checklist was prepared and four FGDs (one FGD per each district) were conducted. During the course of FGD, the questions governed the discussions were emphasized mainly on general situation of the study area; pairwise ranking exercise of growers preference of local varieties and their selection criteria; identification of the two crops production constraints and prioritizing them according to their importance; available income source in the area; indigenous production practices of *P.edulis* and anchote; uses of the two tuber crops; participants perception toward the production trend of the two crops; the reason why growers produce less as compared to other crops; the growers perception regarding the contribution of the two crops to the household food security. The output of the FGD was used to substantiate/triangulate the

information collected through individual household interview.

### 3.6.3. Individual Case Studies

In a case study that involves seeking in-depth opinions and perspectives of a small number of respondents, constructing an interview schedule containing open-ended questions is appropriate (Gray, 2004). According to the same author the research design may plan for a wide-scale survey using questionnaires, to be followed up by in-depth interviews or observations. The informal and flexible nature of the interviews enables the participants and the researcher to discuss a variety of issues in a comfortable atmosphere, which offers opportunities to pursue issues that emerged in the course of the discussions in an unrestricted way (Tuettemann, 2003). Hence, an open ended checklist was prepared and four case study households (one per each district) were conducted.

The interview provided the researcher an opportunity to probe the respondents into the matters under discussion. This gave the researcher the chance to get deep understanding of the indigenous knowledge of farmers related to the two crops production and constraints, the reason why farmers produce less and the reason why these crops are not widely consumed beyond their traditional production area despite the farmers long period production practices; and their perception toward the contribution of the two tuber crops to the household food security. In addition, it helped the researcher to have a clear picture with regard to overall situation of the study area. The interviewees were those growers who are known to have better knowledge on the present and past social and economic status of the study areas to get deep information about the subject matter. Check list was also prepared and Key Informant Interviews (KIIs) was conducted with agricultural and rural development officials. The points governed the interview were opportunities and major constraints associated with the two crops production; the reasons for less production of these crops by the farmers; and food security situation of the community in the study area.

### 3.6.4. Field Observation

Observation is a complex combination of sensation and perception (Gray, 2004). Observation has three main elements: watching what people do; listening to what they say; sometimes asking them clarifying questions (Gillham, 2000). The overwhelming validity of observation is that it is the most direct way of obtaining data. It is not what people have written on the topic (what they intend

to do, or should do). It is not what they say they do. It is what they actually do (Gillham, 2000). Observations in the field assist with data collection for both quantitative and qualitative studies (Creswell, 2009). Observation is an important tool for validating the collected data during analysis phase as observations help in expanding a researchers' understanding of what one learns from interviewing; and people in their natural setting are less likely to change their behavior (Bernard, 2006). This study demanded understanding of the indigenous management practice of the two tuber crops, marketing situation, storage facilities and overall situation of the target communities. Hence, the researcher observed and kept a note of observations in a field diary. Recording the reality as it takes place has become one of the approaches of documenting evidence in social research, photography is a way to visualize the reality as it is (Degefa, 2005). Hence, during field work the researcher took digital photograph throughout the study period in order to better understand the study area that helped the researcher during the interpretation of the findings.

I myself conducted the FGD and case studies. During the FGD exercise, I introduced objectives of the study and its topic, asked the prepared questions, controlled digressions and stops breakaway conversations. In doing so, I took note of the discussion gained in the journal and flip chart. The interviews were carried out with enumerators, which were graduates from a college and proficient in the local languages. The questionnaire was translated in to Amharic language and Afan Oromo to make the respondents easily understand the questionnaire and to get accurate information. They were trained in respective districts on the purpose of the study, on how to contact respondents, contents of the questionnaire, procedures and conducting interviews. The data was collected between March and May 2017.

### 3.7. Data Analysis

Both qualitative and quantitative techniques were used to analyze the data in a mixed-methods fashion. The computer software EpiData was used for data entry and cleaning, and STATA 13.0 version computer software program was used to analyze the data. The quantitative data were analyzed using descriptive statistics (percentages, means, frequencies, Chi-square test, and t-test), Principal Component Analysis (PCA), food security model (MFI) and logit regression model. The next sections present the details of each data analysis technique under each objective.

### 3.7.1. Growers Indigenous Production Practices of the Two Tuber Crops

The quantitative data generated from the household survey were analyzed following the descriptive statistics including percentages, Chi-square test, and t-test. Descriptive statistics were used to assess the purpose of the two crops production, their uses and benefits, production trend, the reasons why they produce the two crops less, the reasons why not all farmers participate in the production of the two crops, the two crops management practices, identification of local varieties and the growers selection criteria, and marketing situation of the two crops. The qualitative data from FGDs, individual case studies and key informant interviews were partly processed on the spot during the data collection period to avoid forgetting and to get feedback from participants. Finally, the qualitative data were carefully transcribed, classified and presented in narrations.

### 3.7.2. Constraints of the Two Tuber Crops Production

The qualitative data from the FGDs, individual case studies and key informant interviews related to the two crops production constraints were carefully transcribed, classified and presented in narrations. The quantitative data generated from the household scoring exercise was analyzed following PCA, descriptive statistics procedure (such as frequencies and percentage) and chi-square test. PCA was used to reduce the dimensionality of the number of constraints. Descriptive statistics were used to analyze the growers' perception of the severity of the two crops production constraints. As already indicated in the previous section, the production constraints were identified based on the review of related literature and preliminary FGD with growers and key informants. Accordingly, 25 constraints of the two crops production were presented to the household head for scoring exercise during the survey period (Annex 1).

In order to reduce the dimensionality of the number of listed constraints, the following PCA formula was employed:

$$PC_i = A_1X_1 + A_2X_2 + \dots + A_nX_n$$

Where,

$PC_i$  = the subject's score on the principal component of the  $i$ 's constraint'  $i=1, \dots, n$

$A$  = Constraint weight for the observed variable  $n$

$X$  = Component loading on observed variable  $n$ .

### 3.7.3. Contribution of the Two Tuber Crops to the Household Food Security

Both qualitative and quantitative techniques were used to analyze the data in a mixed-methods fashion. The quantitative data were analyzed using descriptive statistics (percentages, means, frequencies, Chi-square test, and t-test), food security model (MFI) and binary logit regression model. The MFI was used to ascertain the multidimensional food security status of the households, while the descriptive statistics were used to analyze the relationship between food security and household characteristics. Chi-square and t-test were used to compare the associations of attributes and household food security status. The binary logit regression model was used to ascertain the determinants of the household food security status and thereby the impact of the two crops to the household food security. For this to happen, first the household food security status was determined following an algorithmic classification technique that was adapted from the Household Food Insecurity Access Scale (HFIAS) by Maxwell and his colleagues (Maxwell et al., 2013). The techniques categorized the multidimensional food security status of the household into food secure, mildly food insecure, moderately food insecure, and severely food insecure (Table 1).

Table 1 Algorithmic classification techniques of the household food security according to their response

Indicator	Name	Food security dimension	1(best)	2	3	4 (worst)
HFIAS/HHS	NOEAT	Rare and severe behaviors/Quantity				
HFIAS/HHS	SLPHUN	Rare and severe behaviors/Stability				
HFIAS/HHS	NOFOOD	Rare and severe behaviors/Quantity				
CSI	SKIPEAT	Rare and severe behaviors/Quantity				
CSI	SENDBEG	Rare and severe behaviors/Quantity				
CSI	SENDEAT	Rare and severe behaviors/Quantity				
FCS/HDDS	PULSE	Daily foods/Quality/Diversity				
FCS/HDDS	GRAIN	Daily foods/Quality/Diversity				
CSI	EATSEED	Food-increasing behaviors/Quantity				
CSI	WILD	Food-increasing behaviors/Quantity				
CSI	FDCRED	Food-increasing behaviors/Quantity				
CSI/rCSI	BORROW	Food-increasing behaviours/Quantity				
HFIAS	NOTWNT	Dietary change preferences/Acceptability				
HFIAS	LIMVAR	Dietary change preferences/quality				
HFIAS	PREFER	Dietary change preferences/Acceptability				
CSI/rCSI	FWRMEAL	Rationing strategies/Quantity				
CSI/rCSI	LMTPORT	Rationing strategies/Quantity				
HFIAS	WORRY	Stability				
SAFS	SAFS	Stability				
FCS/HDDS	DAIRY	High value foods/Quality/Diversity				
FCS/HDDS	EGGS	High value foods/Quality/Diversity				
FCS/HDDS	MEAT	High value foods/Quality/Diversity				
FCS/HDDS	FRUIT	High value foods/Quality/Diversity				
FCS/HDDS	VEGET	High value foods/Quality/Diversity				

As shown in Table 2, the MFI category variable was calculated for each household by assigning a code to ensure that households are classified according to their response to multidimensional food security.

Table 2 MFI category calculation

MFI Category	<p>Calculation of each Household Multidimensional Food Security category. 1=Food Secure, 2=Mildly Food Insecure, 3=Moderately Food Insecure, 4=Severely Food Insecure</p> <p>MFI Category 1-Food secure: If [Q1-Q6 response is never (worst), Q7 and Q8 response are often, and Q9-Q13 response is never, and Q14-Q18 response is never or rarely, and Q19 response is food secure or mildly food secure, and Q20-Q24 response is rarely or sometimes or often].</p> <p>MFI Category 2-Mildly food insecure: If [Q7 or Q8 response is sometimes, and anyone of Q9-Q13 is rarely, or anyone of Q14-Q18 response is sometimes, or Q19 response is moderately food secure, or anyone of Q20-Q24 response is never].</p> <p>MFI Category 3-Moderately food insecure: If [any one of Q1-Q6 response is rarely, or Q7 or Q8 response is rarely, or anyone of Q9-Q13 response is sometimes, or anyone of Q14-Q18 response is often].</p> <p>MFI Category 4-Severely food insecure: If [any one of Q1-Q6 response is sometimes or often, or Q7 or Q8 response is never, or anyone of Q9-Q13 response is often].</p>
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Table 3 Prevalence of different levels of household multidimensional food security calculation

MFI Prevalence	<p>The percentage of households that fall in each MFI category (category 1, category 2, category 3 and category 4) can be calculated according to the following formula:</p> <p>Category 1: Food secure</p> $\frac{\text{Number of households with MFI category} = 1}{\text{Total number of households with an HFIAS category}} \times 100$
	<p>Category 2: Mildly food insecure</p> $\frac{\text{Number of households with MFI category} = 2}{\text{Total number of households with an HFIAS category}} \times 100$
	<p>Category 3: Moderately food insecure</p> $\frac{\text{Number of households with MFI category} = 3}{\text{Total number of households with an HFIAS category}} \times 100$
	<p>Category 4: Severely food insecure</p> $\frac{\text{Number of households with MFI category} = 4}{\text{Total number of households with an HFIAS category}} \times 100$

Once the household food security status is known, the binary logit regression model was used to identify the determinants of the household food security status and thereby the relationship between the two crop production and household food security.

A variety of statistical models can be used to establish the relationship between household characteristics and food security. To measure the outcome of such discrete output, a variety of multivariate statistical techniques can be used to predict a binary dependent variable from a set of independent variables. Multiple regression and discriminant analysis are the two techniques for this purpose. However, these techniques pose difficulties when the dependent variables have only two values, 1 if the event occurs and 0 if it does not. In such cases, logit and probit models are the two most frequently used applications in explaining socio-economic phenomena, especially for analyzing the relationship between dependent discrete variables and explanatory. Due to this fact, the use of a logit or probit model is recommended as a solution to the drawback of the linear regression model (Gujarati, 2004). Which model to choose between logit and probit is difficult because of their similarities in most applications, the only difference is that the logistic distribution has slightly fatter tails. That means the conditional probability  $P_i$  approaches zero or one at a slower rate in logit than in probit. This indicates that there is no compelling reason to choose one over the other but for its comparative mathematical and interpretational simplicity, many researchers tend to choose the logit model (Hosmer & Lemeshow, 2000).

The assumptions required for statistical tests in logistic regression are less restrictive than those for ordinary least squares regression (Hosmer & Lemeshow, 2000). There is no formal requirement for multivariate normality, linearity of relationship between dependent and independent variables and normality of the error distribution. Logistic regression can handle nonlinear relationships between dependent and independent variables because it applies a non-linear log transformation of the linear regression (Park, 2013).

However, the following assumptions still apply to the logistic regression model. Logistic regression requires the dependent variable to be discrete mostly dichotomous; hence, it is necessary to code the dependent variable accordingly (i.e. the desired outcome should be coded to be 1). Inclusion of all relevant and exclusion of all irrelevant variables in the regression model and low error in the explanatory variables; whilst logistic regression does not require a linear relationship between the dependent and independent variables, it requires that the independent variables are linearly related to the log odds of an event. Independent sampling (each observation to be independent), no outliers, and the model should have little or no multicollinearity. The large

sample size is also required because maximum likelihood estimates are less powerful than the ordinary least squares used for estimating the unknown parameters in a linear regression model (McCullagh and Nelder, 1983 quoted in Park, 2013). For its comparative mathematical and interpretational simplicity, many researchers tend to choose the logit model. Therefore, this study employed the logit model to examine the determinants of the household food security following the footsteps of these researchers.

### Logit Model Specification

As the dependent variable is a dichotomous (food secure or insecure households), a binary logistic regression was used to scrutinize the household food security determinants. Maxwell et al. (2013) while developing multi-dimensional food security measurements, they converted the HFIAS classification system (food secure, mildly food insecure, moderately food insecure, and severely food insecure) into binary categories of food secure and food insecure. Following the authors' footstep, this classification was adopted to fit into the binary logit model to examine the impact of the explanatory variables on the dependent or outcome variable (food security). Food security as a dependent variable, thus, assumes the value of Y=1 if the household is food secure, 0 otherwise.

The independent variables  $X_1, X_2 \dots, X_n$  can take on any form since logistic regression makes no assumptions about the distribution of independent variables. The dependent variable Y is dichotomous taking on a value of 1 with a probability of success  $\theta$  or 0 with a probability of failure  $(1 - \theta)$ . Thus, a logistic regression model was specified to identify the determinants of the household food security status. Following Gujarati (2004), the functional form of the logistic regression model was specified as follows:

$$Y = \text{logit}[\theta(x)] = \log \left[ \frac{\theta(x)}{1 - \theta(x)} \right]$$

$$= \alpha + X_1\beta_1 + \beta_2X_2 + \dots + X_i\beta_i + \dots + \beta_kX_k \dots \dots \dots 1$$

$$\text{Where } \theta = \frac{e^{(\alpha + X_1\beta_1 + \beta_2X_2 + \dots + \beta_kX_k)}}{1 + e^{(\alpha + X_1\beta_1 + \beta_2X_2 + \dots + \beta_kX_k)}}$$

$\beta_i$  = the coefficient of the  $i^{\text{th}}$  independent variable; for  $i = 1, 2, \dots, k$

$\alpha$  = the constant of the equation

Food security status was taken as a dichotomous dependent variable, with the household being either food secure or food insecure. The predictor variables were mixed, i.e. continuous and dummy variables. A logistic regression model was constructed using the predictor variables with food security status ( $Y_f$ ) as a logit function as presented below:

$$Y_f = \alpha + \sum_{j=1}^{k=n} \beta_j X_j + \varepsilon \dots\dots\dots 2$$

Where:  $Y_f$  = A Logit function, i.e. food security status;  $\alpha$  is the constant, i.e. the household food security status when the effects of the independent variables are zero.

$\beta_i, i=1, \dots, k$  Coefficients

$X_i, i=1, \dots, k$  Independent variables

$\varepsilon$  = the error term

The variables that were supposed to influence household food security status were selected based on literature review, past research findings and preliminary survey in the study area (Table 4). As SLF is the guiding analytical framework in this study, the selection of explanatory variables used in the binary logit regression analysis was made in a way reflective of the households' endowments of different forms of capital. Variables like the household head level of education, age, marital status, gender, household size, and dependency ratio represent the human capital of the household. Credit access, annual income, ownership of savings account and participation in non/off-farm activities used to represent financial capital. From the physical capital, livestock ownership and market distance were included. Household heads membership in different institutions was weighed and included to represent social capital. From the natural capital, farmland was included. Other variables including technology adoption, the interest variable growing the two crops and location of the study area were also included. Hence, the household food security status was hypothesized to be a function of the following explanatory variables.

Table 4 Explanatory variables and priori hypothesis

Variable code	Descriptions	Measurement	Hypothesis
sex	Gender of the household head	Male = 1, Female = 0	+
age	Age of household head	Years	+
eduionlevl	Literacy of household heads	Literate =1, illiterate = 0	+
famlysiz	Household family size	Number	+/-
depratio	Dependency ratio	Ratio	-
annincom	Total household annual income	ETB	+
farmlsiz	Farmland size	Hectare	+
TLU	Ownership of livestock	TLU (1 TLU = 250kg)	+
offfarmpart	Engagement in off-farm income generating activities	Yes = 1, No = 0	+/-
grwplcedu	Growing P.edulis	Yes = 1, No = 0	+
grwancho	Growing anchote	Yes = 1, No = 0	+
socilcapl	Social capital	Weight	+/-
savacnt	Ownership of savings account	Yes = 1, No = 0	+
marktdis	Access to market (Proximity)	Hour	-
ownfmprod	Quantity of own production	Quintal	+
tecnoadop	Technology adoption	Adopter =1, non-adopter = 0	+

### Description of Explanatory Variables and Working Hypothesis

Age of the household head: age of the household head is a continuous explanatory variable measured in years. Rural households mostly devote their lifetimes or base their livelihoods on agriculture. As the age of the household head increases, he/she become more experienced, acquire more knowledge, and physical assets, have relatively richer experiences of the social and physical environments and greater experience of farming activities thereby affecting food security positively (Abera et al., 2011; Haile et al., 2005). Older household heads are expected to have better access to land than younger heads because younger men either have to wait for land distribution or have to share the land with their families (Haile et al., 2005). They are more risk averter and mostly they intensify and diversify their production activities, and hence as their age increases their chance of being food secure increases. Younger household heads were expected to have relatively poorer experiences of socio-physical environments and farming than older household heads (Shumiye, 2007). In light of this, it was hypothesized that age of the household head influences the household food security positively.

Gender of the household head: gender of the household can be male or female. Gender of the household head looks at the role played by individuals in providing households' needs including the acquisition of food (Kuwornu et al., 2010). Female-headed households have higher dependency

ratios, which hinder the household capacity to allocate labor to on-farm or other income-generating activities. Male-headed households have more access to agricultural technologies and more security on farmland as compared to female-headed households. Male-headed households are also in a better position to pull the labor force than the female-headed ones (Fekadu, 2010; Kuwornu et al., 2010). In general, male-headed households are expected to have higher food security status than female-headed households due to the fact that female-headed households in rural Ethiopia are formed as a result of the death of husband or divorce, a situation which leaves the women with insufficient resources such as land, livestock and other productive assets (Abera et al., 2011). Thus, it was hypothesized that male-headed households are more likely to be food secure than female-headed households.

Educational status of the household head: education equips individuals with the necessary knowledge of how to make a living. Literate individuals are keen to get information and use it (Ayalneh & Abebaw, 2009). The impact of education on household food production might be through promoting awareness on the possible advantages of modernizing agriculture through technological inputs and by diversifying the household income, which in turn enhances the household's food supply. Households led by non-literate heads are less likely to understand modern farming technologies provided to them through any media (extension workers, radio, etc.) than literate household heads (Shumiye, 2007). Educated household heads have the capacity to innovate and to adopt timely technology like soil conservation measures and have a better understanding of the cash crops that can help them to have a better income than the non-educated households (Fekadu, 2010; Kuwornu et al., 2010; Mekuanent et al., 2014). This highlights that those households with relatively better-educated household heads are more likely to be food secure than those headed by uneducated household heads (Haile et al., 2005). Hence, it was hypothesized that literate household heads are more likely to be food secure than illiterate household heads.

Family size: family size refers to the total number of household members who lived and ate with the household at least for six months. The larger the household size (economically inactive) the more implication on food consumption than on labor supply to boost production. Households with larger family sizes or dependents are expected to be less likely to feed their families sufficiently (Shumiye, 2007). Due to the fact that land and finance to purchase agricultural inputs are very

limited, increasing family size tends to exert more pressure on consumption from the limited resources than the labor it contributes to production (Fekadu, 2010; Haile et al., 2005; Mekuanent et al., 2014). Alternatively, the household where productive age groups are higher than the non-productive age groups, the probability of the household to be food insecure would be less, provided that the area provides good working atmosphere and production potential (Ayalneh & Abebaw, 2009). The study conducted in Nigeria revealed that the larger the family size, the greater the productivity and the more the social status of the farmers (Oladele, 2011). Thus, the family size was hypothesized to have a negative or positive association with household food security.

**Farmland size:** farmland size is a continuous explanatory variable and an important determinant of the household food security. Farmland size is the total area of land cultivated to food and cash crop by the household, measured in hectares. A positive relationship has been established between farmland size and improvement in household food security (Fekadu, 2010; Mekuanent et al., 2014; Shumiye, 2007). The larger the farmland owned by the household, the higher the expected level of food production and the more likely to be food secure (Kuwornu et al., 2010). Therefore, it was hypothesized that the household with large cultivated land is more likely to be food secure and vice versa, all things being equal.

**Dependency ratio:** dependency ratio is obtained by dividing the inactive labor force (age less than 15 and above 65) by active labor force (age between 15 and 65) within a household. When a large household size corresponds with the availability of adequate adult labor, it can have a positive effect. But households with more inactive productive labor force compared to active age show a high dependency ratio and are more likely to be food insecure (Fekadu, 2010; Kuwornu et al., 2010; Mekuanent et al., 2014). Hence, the dependency ratio was hypothesized to be negatively associated with household food security.

**Livestock ownership:** is a continuous variable and is measured in Tropical Livestock Unit (TLU<sup>2</sup>). Livestock contributes to the households' economy in different ways, for instance as a source of

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<sup>2</sup> Tropical Livestock Unit (TLU) is an animal unit equivalent to a live-weight of 250 kg. An inventory of livestock was taken and each livestock of the household was changed to its equivalent TLU using conversion factors suggested by FAO (2003), in Sub-Saharan Africa 1 head of cattle = 0.5 TLU, 1 sheep or goats = 0.1 TLU, 1 donkey = 0.6 TLU, 1 horse = 0.8 TLU, 1 mule = 0.8 TLU, and 1 poultry = 0.01 TLU.

pulling power, source of cash income, source of supplementary food (meat, milk, eggs), means of transport, fuel, manure that is used as fertilizer, fiber, hides, and horns (Haile et al., 2005). In addition, unlike urban dwellers, the rural households accumulate their wealth in terms of livestock; hence, livestock is the most important indicator of wealth and may provide a reserve that can be converted to cash in times of need. Ownership of large number of livestock decreases the likelihood that households are being food insecure while permitting households to enhance their economic wellbeing in general and their food entitlement in particular (Abera et al., 2011; Ayalneh & Abebaw, 2009). The smaller the wealth status of the household head or TLU that the household has, the higher the food insecurity (Shumiye, 2007). Therefore, the expected effect of TLU on household food security was positive.

Quantity of own farm production: this is the total annual cereal yield (in quintal) produced by the household during the 2015/16 harvesting period. The higher the amount of grain food obtained from own production, the more likely the household is to be food secure. The quantity of the households' own production increases the probability of food security (Kuwornu et al., 2010; Shumiye, 2007). Therefore, the expected effect of this variable on food security was positive.

Engagement in off-farm income-generating activities: it is measured by whether the household head is involved in diversified income sources such as daily labor, running petty trade, weaving and selling firewood or not. Off-farm income-generating activity is an additional work engaged in by the household aside farming to supplement household income (Kuwornu et al., 2010). Those households who did not engage in off-farm income-generating activities are more likely to face food deficit if farm income is not enough (Shumiye, 2007). However, the level of off-farm activity can influence the households' food security either positively or negatively depending on the level and gains from the activity. This is because engagement in off-farm activity can bring in money thereby corroborating the food security situation of the household. Alternatively, if farmers spend more of their time on off-farm activities at the expense of working on their farm and particularly if the wage they earn does not commensurate with the forgone farm income, their food security situation can be worsened (Abera et al., 2011; Kuwornu et al., 2010). Therefore, the expected effect of the variable on food security can be positive or negative.

Total annual income of the household: it refers to the sum of earnings of the household from both on-farm and off-farm sources. The more the household head engages in gainful employment, the higher he/she earns income and the greater the chances of being food secure. The income is expected to increase the household's food production and access to more quantity and quality food (Kuwornu et al., 2010). Households that manage to secure larger income from any source have better access to the food they need than those households that do not (Ayalneh & Abebaw, 2009). The higher the level of the total amount of income from different sources, the lesser would be the likelihood of the household being food insecure (Hana & Dereje, 2016). Therefore, the total annual income was hypothesized to influence the household food security status positively.

Technology adoption: technology adoption refers to the use of farm inputs like chemical fertilizers, pesticides, improved livestock breeds, and improved crop varieties. Those households who reported as non-adopters of all or at least any one of these technology packages were considered non-adopters. Non-adoption was expected to increase the likelihood of being food insecure through its effect on decreasing food availability and income (Shumiye, 2007). Any farm input that augments agricultural productivity is expected to boost overall production, which in turn contributes towards attaining household food security (Haile et al., 2005; Mesay, 2008). Hence, those households who have adopted the technology are expected to have better food production capacity than the non-adopters. Therefore, the household that adopted the technology or used farm input was hypothesized to be food secure.

Distance to the nearest market: proximity to the market center creates access to additional income via off-farm employment opportunities and easy access to information on inputs and transportation. It is thus, those households closer to the market center have a better chance of improving household food security than those who do not live proximate to the market center (Amsalu, Bekabil, & Beyene, 2013; Fekadu, 2010). Therefore, it was hypothesized that access to the nearest market center measured in hours has a positive impact on household food security.

Growing *P.edulis*/anchote: growing the two tuber crop is an important factor of interest as one of the central objectives of this study was to look into the contribution of these crops to household food security. In this case, whether the farmers have grown *P.edulis*/anchote or not in their

respective study area was used as one independent variable (dummy variable) to look into their relationship with household food security. These crops are cultivated for their food, medicinal and cultural values in the study area. The growers used these crops to cover food shortages during the food deficit period, particularly when cereals are not mature and ready for harvest. Therefore, it was hypothesized that those households who engaged in growing of *P.edulis*/anchote are more likely to be food secure than the non-growers being all other things equal.

Social capital: refers to the social resources including networks, social claims, social relations, affiliations, associations, culture, membership of formalized groups and relationships of trust that facilitate co-operation when pursuing different livelihood strategies (Scoones, 1998). Social capital was a weighted continuous variable. The weight was calculated by giving equal value for each variable and multiplying by one the responses of the households; then summing up for each respondent. The reason for developing weight was to convert the dummy variables to a single continuous variable so that it can be easily fitted to the logit model. Therefore, the social capital of the household head was expected to influence household food security positively.

Ownership of savings account: it is a dummy variable taking the value of 1 if the household has a bank account and 0 otherwise. Access to savings increases the ability of households to deal with shocks, which bring about abrupt changes in food production, prices, and income, and so affect food security (Lilian et al., 2013 quoted in Hana & Dereje, 2016). Membership of formal savings institutions indicates financial capital endowments and influences household food security positively; moreover, more savings encourage more investment in farm and household affairs (Abera et al., 2011). Therefore, ownership of the savings account was hypothesized to affect the household food security status positively.

### Goodness of fit assessment of the model

The continuous explanatory variables were checked for the existence of multicollinearity using the Variance Inflation Factor (VIF). VIF was used to measure the degree of linear relationships among the continuous explanatory variables. VIF shows how the variance of an estimator is inflated by the presence of multicollinearity (Gujarati, 2004). A commonly given rule of thumb is that if any of the VIFs exceed 10, it is an indication that the associated regression coefficients are poorly

estimated because of multicollinearity. It is also evident that there might be interaction among dummy variables, which could lead to the problem of multicollinearity. To detect this problem, contingency coefficients were computed for each pair of dummy variables. The values of contingency coefficient range between 0 and 1, zero indicating no association between the variable and values close to 1 indicating a high degree of association, which means a high degree of multicollinearity. As a rule of thumb, those dummy variables with the computed value of less than 0.75 (cut-off point) shows weak association and considered as free from the problem of multicollinearity; and a value above 0.75 indicates a strong association of variables and the existence of multicollinearity.

Likelihood Ratio test, Hosmer-Lemeshow goodness-of-fit test, McFadden's Pseudo  $R^2$ , and overall correct classification statistical methods were used to determine the significance or goodness-of-fit of a logistic regression model. The computed value of likelihood ratio (LR) test obtained as the ratio of the maximized value of the full model likelihood function  $L_1$  to the maximized value of the simple model likelihood function  $L_0$ .

$$\begin{aligned} \text{The likelihood ratio-test statistic} &= -2 \log \left( \frac{L_0}{L_1} \right) \\ &= -2 [\log(L_0) - \log(L_1)] = -2 [L_0 - L_1] \end{aligned}$$

Where  $L_0$  and  $L_1$  are the maximized log-likelihoods under the null and alternative hypothesis, respectively was used to test the null hypothesis. The null hypothesis is defined as the p-coefficients for the covariates in the model are not important in explaining the response variable against the alternative that at least one of the covariates is important. If the p-value of LR was less or equal to 0.05 the null hypothesis was rejected and concluded that at least one of the covariates included in the model are important in explaining the variation in the outcome variable. Similarly, the null hypothesis of Hosmer-Lemeshow test statistics was that there was no difference between the predicted values using the model and the actual values of the dependent variable. If the p-value of the Hosmer and Lemeshow goodness-of-fit statistics was less or equal to 0.05, the null hypothesis was rejected. If it was greater than 0.05, it failed to reject the null hypothesis and concluded that the model estimates did fit the data well and explained much of the variance in the dependent variable. The fit is considered to be good if the overall correct classification rate exceeds 50%.

In addition, the reliability of the produced result was assessed using Cronbach's alpha. Reliability refers to the capacity of a measure to produce consistent results. A measure is unreliable if all or at least some of its items are unreliable. The Cronbach Alpha coefficient ranges between 0 and 1, with a high value indicating a high level of consistency among the items (Blaikie, 2003). Alpha equals zero when the true score is not measured at all, and hence there is only an error component. Alpha equals one when all items measure only the true score and there is no error component. As a general rule of thumb, a reliability coefficient of alpha is excellent if Alpha is larger than 0.75, good if Alpha is between 0.40 and 0.74, and poor if Alpha is less than 0.40.

# Chapter 4 Growers Indigenous Production Practices and Socio-economic Importance of the Two Tuber Crops

## 4.1. Introduction

Indigenous knowledge is defined as the traditional knowledge of farmers in production, protection, and preservation of crops generated by their ancestors and internalized by the local people. It is associated with oral information, unlike modern knowledge is not written down and thus remains outside recorded history (Ponge, 2013). Understanding how and why farmers carry out different indigenous production practices and information on the production constraints are essential to promote certain crop. Knowing these practices would enable one to grow the crop, understand yield gaps and associated constraints and make the necessary investigations (Kazmi et al., 2014; Mulugeta et al., 2007). Nowadays, much knowledge about the utilization and intrinsic value associated with NUCS remains hidden in the indigenous knowledge of the rural communities. This knowledge is transferred from generation to generation through observations and narrations (Chivenge et al., 2015). Ethiopian traditional knowledge of useful plant characteristics, for instance, enables them to select varieties that require less fertilizer, out-grow weeds best, and are less susceptible to pests (IPGRI, 1999). With this view in mind, this chapter aimed to contribute to the knowledge gap related to the two tuber crops production, storage, processing, utilization, and marketing whereby to pave the way for further crops improvement and enhanced production in the study area.

The remaining part of this chapter discusses farmers' participation in the two crops production, growers' reasons for production, traditional foods prepared from the two crops, growers' reasons for less production, non-growers farmers' reasons for not growing the two crops, acquisition of planting materials, local varieties and growers selection criteria, cropping pattern, production trends, gender division of labor, and growers' marketing participation.

## 4.2. Growers Indigenous Production Practices and Socio-economic Importance of *Plectranthus Edulis*

### 4.2.1. Farmers Participation in *Plectranthus Edulis* Production

As shown in Table 5, 45.8% of interviewed farmers in Chenchu and 39% in Jima Arjo district have participated in the production of *P.edulis*. Despite clear variation in the culture and livelihood of the farmers, there was no statistically significant variation between the two districts in their level of participation. The FGD participants in Chenchu district showed that the poor farmers are mainly involved in the production of this crop. Their justification was that the poor lack the capacity to cultivate other crops due to shortage of land and other inputs; hence, as an alternative, they would try to fill the food shortage through planting *P.edulis*. Here, the growers consider the crop as the “poor individual’s” crop.

Table 5 Farmers participation in *Plectranthus edulis* production by district

Participation	Plectranthus edulis growing area			$\chi^2$ -value
	Chenchu (N=155)	Jima Arjo (N=95)	Overall total (N=250)	
Yes	71(45.8)	37 (39.0)	108 (43.2)	1.129
No	84 (54.2)	58 (61.1)	142 (56.8)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses

In contrast to Chenchu district, the FGD participants in Jima Arjo district stated that all categories of farmers are involved in the production of *P.edulis*. They further emphasized that they mostly grow the crop around the homestead and in the margin of their farmland, due to this fact they consider it as a fence for other food crops. Therefore, its farm operation is suitable for elders and females who cannot engage in the main field and hard work. Females well know the family matters related to food demand at home and its benefits. Hence, they deliver better management skills than other family members. In addition, the crop requires less input and one can grow simply in the small area of land while producing a better yield. However, in Chenchu district due to lack of interest from the new generation, elders are mostly taking part in its production. This is most likely associated with the crop’s low market demand and price.

#### 4.2.2. Growers Reasons for *Plectranthus Edulis* Production

All interviewed respondents' main reason for growing *P.edulis* was to use it for food (Table 6). The FGD participants in both study areas showed that the growers' main reason for this crop production is for food; it is particularly important for those households who have no other means to cover food shortage between September and November. The crop becomes ready for harvest when other cereal crops do not mature and get ready for harvest. Yeshitila indicated that resource-poor farmers often consider the crop as poor people food (Yeshitila, 2007). The FGD participants in Jima Arjo district showed that due to its early maturity when other crops do not get ready for harvest and may fail due to adverse weather condition they use the crop to fill the food shortage gap. In addition to food, 29.6% of growers in Chenchu and 75.7% in Jima Arjo district produced the crop to get additional cash income ( $P<0.01$ ). In Jima Arjo district, 78.4% of growers also use this crop for its medicinal value, while none reported in Chenchu district. About, 63.4% and 86.5% of growers in Chenchu and Jima Arjo districts, respectively, grow the crop because of its ability to improve soil fertility, i.e. the crops that follow *P.edulis* give a better yield. The highest proportion of growers in Jima Arjo district produced the crop for its drought and disease resistance ability, to get a high yield with less input and to get a high yield from the small area than in Chenchu district ( $P<0.01$ ).

Table 6 Household reasons for growing of *Plectranthus edulis* (Multiple responses is possible)

Growing reasons	Plectranthus edulis growers (N=108)			
	Chenchu	Jima Arjo	Overall total	$\chi^2$ -value
Food	71 (100)	37 (100)	108 (100)	-
Additional income	21 (29.6)	28 (75.7)	49 (45.4)	20.855***
Medicinal value	0 (0.0)	29 (78.4)	29 (26.9)	76.077***
To improve soil fertility	45 (63.4)	32 (86.5)	77 (71.3)	6.346***
Drought resistance ability	29 (40.9)	25 (67.6)	54 (50.0)	6.948***
Disease resistance ability	21 (29.6)	29 (78.4)	50 (46.3)	23.299***
To get a high yield with less input	20 (28.2)	25 (67.6)	45 (41.7)	15.534***
To get a high yield from a small area	29 (40.9)	30 (81.1)	59 (54.6)	15.888***
To cover food shortage	40 (56.3)	32 (86.5)	72 (66.7)	9.949***
For its taste	41 (57.8)	6 (16.2)	47 (43.5)	17.068***
To reduce risk	25 (35.2)	30 (81.1)	55 (50.9)	20.479***
To conserve the plant	16 (22.5)	18 (48.7)	34 (31.5)	7.690***
Demands less labor	0 (0.0)	12 (32.4)	12 (11.1)	25.905***

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\*  $p<0.01$

Some 56.3% of growers in Chencha and 86.5% in Jima Arjo district produced the crop under the study to cover food shortage. A higher proportion of growers in Chencha district ( $P<0.01$ ) produced the crop for its taste than in Jima Arjo district, this is probably due to the availability of several varieties in Chencha district, growers consider the taste to choose one variety over the other. The case study respondent in Chencha district showed that he has been growing the crop to support his large family. About 35.2% of respondents in Chencha district and 81.1% in Jima Arjo district use the crop to reduce risk in case other crops fail due to adverse weather conditions. This shows that more growers in Jima Arjo district were involved in the production of the crop to reduce risk than in Chencha district ( $P<0.01$ ). Some 22.5% and 48.7% of growers in Chencha and Jima Arjo district, respectively, reported that they have been growing it to pass on to the next generation. In Jima Arjo district, 32.4% of growers stated that they grow the crop for its less labor demand, while none responded in Chencha district ( $P<0.01$ ). In most cases, in Chencha district, growers are planting the crop on the virgin land, which requires supply of high energy.

A higher proportion of growers, 78.4% in Jima Arjo district used the crop for medicinal value (Table 6). Though the information obtained from formal survey in Chencha district didn't show any medicinal value of *P.edulis* the information obtained from FGD participants showed that they use the crop's tuber for treatment of gastritis. This may need further investigation. Similarly, in Jima Arjo district they used for asthmatic and coughing treatment. They used to treat a person suffering from asthmatic and/or coughing with the steam of boiled tuber. In Jima Arjo district, the FGD participants also reported that they used the leaf part to treat cattle infested with leeches. Here, they smash the leaves, mix it with hot peppers, and feed the infested cattle to remove or kill leeches.

#### 4.2.3. Traditional Foods and some Expressions on the Importance of *P.edulis*

Traditional foods prepared from the tuber as explained by the FGD participants in Chencha district are *Dono doysis/shusho* (Gamo language); its preparation involves boiling of the tuber in the pot and serving with *kita* (flat bread) or *kocho* (a traditional flat bread made from *enset*). The other one is *fisose*, which is prepared through boiling of the tuber along with maize and cabbage, and consumed with *kocho*. *Toka* is making traditional food by boiling the tuber along with *amicho* (underground fleshy inner portion of the *enset* corm) and serving. *Fatala* is a traditional food made

by mixing the tuber with *kocho*, *amicho*, fava bean, and beans; they consume it along with other food like *kita*. However, in Jima Arjo district only one type of food is prepared from the tuber. Here, the tuber is peeled after boiling and served with *qocqocaa* (a paste of green or red pepper with a pungent taste). The tuber is important in local diets between September and November since other food crops are not ready for consumption (Yeshitila & Weibull, 2012). The authors further noted that the farmers suggest the tuber as special food for individuals recovering from illness, possibly because of its high digestibility.

In Chenchu district, people describe the crop as '*Shenfo asha Dorze kora*', meaning a life-saving *Dorze* potato. In the same way, they state '*Gamo dono ofinsa kawo*', meaning Gamo potato is the king of the hunger. The study conducted in Wolaita reported the sayings that link the growing of *P.edulis* with Meskel religious festival, which is expressed as '*Maskala shukkadii?*' '*Donuwa tokkadii?*' meaning have you been slaughtered for the Meskel festival? Have you grown *P.edulis*? (Yeshitila, 2007). As a tradition, farmers start to eat the tuber after the Meskel festival. In Jima Arjo district, they describe its importance as '*Dinicha maaliif qotuu birraa ittiin ba'uufi malee, ilma maaliif dhalchu maqaa abbaa dha'uuf malee*' (Afan Oromo), meaning the reason for growing Oromo potato is to pass through food shortage period, the reason for having a baby boy is to substitute the next generation. '*Lafti lafa caalaaree lafa dinichaa malee, namni nama caalaaree dhaba birriiti malee*', meaning one farmland is not greater than the other farmland, except the farmland that follows *P.edulis* harvest; there is no difference between humankind, the difference is due to lack of money. This highlights that the yield of the crop that follows *P.edulis* is high.

#### 4.2.4. Why Growers Produce Less *Plectranthus edulis*?

This study tried to answer the question regarding why growers produce this crop less as compared to other crops despite its importance and long-time farmers' production experience. As presented in Table 7, the growers produce the crop less as compared to other crops (particularly Irish potatoes) due to low demand and price, shortage of land, long maturity, and high labor demand. In Chenchu and Jima Arjo district, 47.9% and 58.3% of growers, respectively, reported that low market demand and price are their main reasons for less production of this crop. This highlights that low market demand and price are equally important in both locations. According to the FGD participants in both study areas, growers mostly produce the crop for home consumption; added to

that, youngsters are not interested in its production. Hence, this finding justifies crop displacement with other crops like Irish potato.

Table 7 Growers reasons for less production of *P.edulis* (Multiple responses is possible)

Reasons for less production	Plectranthus edulis growers (N=108)			$\chi^2$ -value
	Chencha	Jima Arjo	Overall total	
Low demand and price	34 (47.9)	21 (58.3)	55 (51.4)	1.044
Shortage of land	16 (22.5)	16 (44.4)	32 (29.9)	5.470**
Long maturity	18 (25.4)	0 (0.0)	18 (16.8)	10.973***
Not consumed frequently	12 (16.9)	2 (5.6)	14 (13.1)	2.704
Demands high labor	5 (7.0)	3 (8.3)	8 (7.5)	0.058

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$

In Jima Arjo district, more proportion of growers reported that shortage of land is their major reason for less production than in Chencha district ( $P < 0.05$ ). Alternatively, 25.4% of growers in Chencha district indicated that long maturity was their major reason for less production of the crop; while none reported in Jima Arjo district ( $P < 0.01$ ). The FGD participants in Chencha district showed that they produce Irish potato and other crops twice a year. Moreover, once an Irish potato gets ready for harvest, they can harvest as a whole and use the land for other crops production. In contrast, due to the fact that *P.edulis* is produced only once per year, the land cannot be used for other crops production. They further point out that people do not eat *P.edulis* tuber frequently as a major food. Nevertheless, in Jima Arjo district, other crops are also produced once per year, hence, long-maturity was not a constraint. Here, growers as rational decision-makers would rather look at the crop's comparative advantage while allocating the land to different crops. Therefore, it appears that other crops are advantageous with regard to benefits.

Non-grower farmers were asked to explain their reasons for not involved in the production of *P.edulis*. As presented in Table 8, the Chi-square information testified that there is a tremendous difference between the two districts in responding to the lengthy maturity, lack of labor, ant, and wild animals as the major constraint for not growing the crop. In Chencha district, the respondents stressed that the crop occupies the land for a long period due to long maturity. That is given that the crop gets ready for harvest after 5 to 6 months. Moreover, bulk harvesting is not possible as soon as the tuber gets ready for harvest. Due to this fact, they use the land as a storage place.

Table 8 Farmers reasons for not growing *P.edulis* (Multiple responses is possible)

Reasons for not growing	Non-growers of <i>P.edulis</i> (N=142)			$\chi^2$ -value
	Chencha	Jima Arjo	Overall total	
Climate change	3 (7.1)	5 (10.2)	8 (8.8)	0.264
Low market demand/price	11 (26.2)	11 (23.4)	22 (24.7)	0.093
Shortage of land	16 (38.1)	23 (48.9)	39 (43.8)	1.059
Lack of fertile land	5 (11.9)	4 (8.5)	9 (10.1)	0.281
Long maturity	13 (31.0)	2 (4.3)	15 (16.9)	11.281***
Lack of labor	8 (19.1)	3 (6.4)	11 (12.4)	3.284
Lack of seed tuber	4 (9.5)	5 (10.6)	9 (10.1)	0.030
Problem of ant (red)	0 (0.0)	7 (14.9)	7 (7.9)	6.789***
Problem of wild animal	1 (2.4)	6 (12.8)	7 (7.9)	3.301
Demands high labor	8 (19.1)	7 (14.9)	15 (16.9)	0.273

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$

Another motive stated by the FGD participants in Chencha district was that Irish potato is replacing it, given that its demand/price is low. Ant is entirely the reasons for not growing the crop in Jima Arjo district. In addition, some 12.8% of growers in Jima Arjo district indicated that wild animal attack was their reason for not growing the crop, while only 2.4% reported in Chencha district. Climate change, low market demand, low price, shortage of land, lack of fertile land, lack of seed tuber and excessive labor demand are equally important reasons for not growing the crop across the two districts. However, in Jima Arjo district they repeatedly cited lack of seed tuber as a primary constraint for not growing the crop. Therefore, improving the crop and availing the seed tuber for the farmers is the task left for concerned stakeholders.

#### 4.2.5. Local Varieties of *Plectranthus Edulis* and Growers Selection Criteria

As presented in Table 9, this study identified six local varieties of *P.edulis* in Chencha district. These local varieties include *Lofo dono*, *Chanko dono*, *Giso dono*, *Dalako dono*, *Gircho dono*, and *Hole dono* (Gamo language). Similarly, two local varieties, white and red were recorded in Jima Arjo district. Growers considered the crop's drought resistance ability, maturity period, taste, tuber yield, and tuber size, ability to improve soil fertility, shelf life, cooking time, market demand, and price to identify and select the best performing local varieties (Table 10). In addition to the mentioned traits, the FGD participants in Chencha district stated that growers look into the extent of hair-like structures to choose the best performing local varieties.

Table 9 Local varieties of *P.edulis* and growers preference (Multiple responses is possible)

Local varieties	N	Percent
Chencha district (N=71)		
Lofo Dono	68	95.8
Chanko Dono	62	87.3
Giso Dono	34	47.9
Dalako Dono	7	9.9
Gircho Dono	15	21.1
Hole Dono	10	14.1
Jima Arjo district (N=37)		
White	34	91.9
Red	35	94.6

Source: Survey data (2017); N=total number of respondents.

In Chencha district, *Lofo dono* is the primary favored local variety (95.8%), followed by *Chanko dono* (87.3%) and *Giso dono* (47.9%). The FGD participants in Chencha district also realized this order of importance. Growers prefer *Lofo dono* over the other due to its high yield, large size tuber, high multiplication capability, good taste, excellent odder, less water retaining capacity after boiling, dense flesh, low fibre content, better market demand and price, early maturity, much less time demand for cooking and ability to improve soil fertility.

Table 10 Growers local variety selection criteria (Multiple responses is possible)

Plant characteristics	Plectranthus edulis growers (N=108)			$\chi^2$ -value
	Chencha	Jima Arjo	Overall total	
Drought resistance ability	58 (82.9)	37 (100)	95 (88.8)	7.144***
Disease/pest resistance	55 (78.6)	37 (100)	92 (86.0)	9.221***
Maturity period	46 (65.7)	36 (97.3)	82 (76.6)	13.485***
Taste	46 (65.7)	6 (16.2)	52 (48.6)	23.741***
Tuber yield	67 (95.7)	37 (100)	104 (97.2)	1.632
Tuber size	64 (91.4)	37 (100)	101 (94.4)	3.360
Color	21 (30.0)	8 (21.6)	29 (27.1)	0.860
Hairy structure	46 (65.7)	26 (70.3)	72 (67.2)	0.228
Smell	28 (40.0)	10 (27.0)	38 (35.5)	1.779
Ability to improve soil fertility	51 (72.9)	37 (100)	88 (82.2)	12.211***
Plant height	42 (60.0)	35 (94.6)	77 (72.0)	14.358***
Shelf life/storability	45 (64.3)	31 (83.8)	76 (71.0)	4.472**
Cooking time	49 (70.0)	35 (94.6)	84 (78.5)	8.677***
Market demand/price	49 (70.0)	35 (94.6)	84 (78.5)	8.677***

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\* p<0.01, \*\*p<0.05

The FGD participants in Chencha district indicated that the tuber treat ulcer when consumed in its cooled state after boiling. However, *Lofo dono* has low drought and disease resistance ability as compared to *Gircho dono* and short shelf life as compared to *Chanko dono*. In agreement with the

current findings, Yeshitila (2007) reported that early maturing varieties often have large tuber sizes but have a short shelf life.

In Jima Arjo district, growers preferred to grow the white local variety to red ones. The FGD participants indicated that white local variety produces high yield and big size tuber, takes less time while cooking, has a soft texture, good taste, contains low fiber content, and has better market demand and price. Growers used a red local variety to treat asthmatic disease. Yeshitila & Weibull (2012) highlights that the variabilities observed between various local varieties can be used in the future breeding program aimed at developing the best performing varieties that best suit the growers' requirement.

#### 4.2.6. Cropping Pattern of *Plectranthus Edulis*

##### a) Site Selection, Land Preparation and Planting Practices

As shown in Table 11, a high proportion of growers, 55.9% in Chench district favor growing both in the dwelling backyard and in the main field. A similar result was found in the Wolaita zone, indicating that farmers cultivate crops in the home garden to reduce time and labor to transport manure (Yeshitila, 2007). Alternatively, 51.4% of growers in Jima Arjo district prefer to produce in the main field, which was statistically significant at 1% probability level.

Table 11 Growers planting site selection practice

Planting sites	Plectranthus edulis growers (N=108)			$\chi^2$ -value
	Chench	Jima Arjo	Overall total	
In the home garden	17 (25.0)	18 (48.7)	35 (33.3)	32.866***
In the main field	13 (19.1)	19 (51.4)	32 (30.5)	
On both sites	38 (55.9)	0 (0.0)	38 (36.2)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\* p<0.01

As stated in Table 12, the growers prepare the land between March and May, in both study areas. In all cases, planting is between April and May depending on the commencement of rain and land preparation. Preparation of land starts around the month of January in Wolaita and involves a range of cultivation practices (Yeshitila & Weibull, 2012), and planting takes place between March and April to take advantage of moisture following the start of rain (Yeshitila, 2007). This shows that land preparation and planting takes place slightly earlier in Wolaita than in Chench district.

Table 12 Land preparation period (Multiple responses is possible)

Land preparation period	Plectranthus edulis growers (N=108)			$\chi^2$ -value
	Chencha	Jima Arjo	Overall total	
January	7 (10.0)	0 (0.0)	7 (6.6)	3.855**
February	11 (15.7)	0 (0.0)	11 (10.4)	6.312**
March	16 (22.9)	8 (22.2)	24 (22.6)	0.006
April	45 (64.3)	20 (57.1)	65 (61.9)	0.505
May	37 (53.6)	17 (48.5)	54 (51.9)	0.237

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*p<0.05

The majority of growers, 74.7% in Chencha district, showed that they use virgin land (the land that has never put under crop production before) for planting (Table 13). In contrast to this, 83.3% of growers in Jima Arjo district revealed that they plant it after preparing the land three times (P<0.01). In concurrence with the current finding, Yeshitila (2007) noted that growers plowed the land over three times. This allows the growers to mix the manure with the soil and make the soil suitable and fertile for growing the crop. Growers use hand or traditional digging tools like *gaso* in Jima Arjo district and *tsoile* in Chencha district. Additionally, a few growers use oxen for cultivation of the land.

Table 13 Land preparation frequency

Land preparation frequency	Plectranthus edulis growers (N=108)			$\chi^2$ -value
	Chencha	Jima Arjo	Overall total	
Planted in virgin land	53 (74.7)	0 (0.0)	53 (49.5)	70.947***
Once	3 (4.2)	0 (0.0)	3 (2.8)	
Twice	4 (5.6)	0 (0.0)	4 (3.7)	
Three times	11 (15.5)	30 (83.3)	41 (38.3)	
Four times	0 (0.0)	6 (16.7)	6 (5.6)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\* p<0.01

In Chencha district, the FGD participants disclosed that land is prepared in two ways in the area: the primary one is a plain preparation of the land between February and March like for Irish potato and other crops using either oxen or *tsoile*. Growers prepare the land in such a way when they have more time and labor for land preparation and want to produce for home consumption and market. The second one is planting on the virgin land between March and May, known as *gembo/itimo*. The land is ready through digging the virgin land, encompassing somewhere between 10 to 20m long, and around 1m width depending on the size of the land allocated. Finally, the growers plant the tuber in the center of virgin land and blanket with the soil drawn from both sides.

The FGD participants in Chenchā district demonstrated that planting in the virgin land or *gembo/itimo* is a major practice in the area. Their major explanations behind planting in the virgin land were to get more yield, save time when deliberate to produce high-quality tubers on small farmland. They added that the tuber produced along this way has a special taste and smell. The growers sometimes practice intercropping with barley, wheat, flaxseed, and fava beans when the emerging plant is scattered. The acknowledged reasons were to get high yield (two products from the same land) and to use the land economically. However, the main practice is a monoculture. In Chenchā district they plant the crop alone as a mono-crop due to its inability to do well both in terms of growth and yield when they plant as an intercrop (Mulugeta, 2008). In both study areas, growers practiced vegetative propagation. In Chenchā district, the growers were planting the tuber after removing the sprout and the two lengthy tips and dividing the tuber into two or more pieces depending on its size. Various scholars noted that farmers prefer to plant the tuber after dividing it into pieces rather than the whole to get more yield (Mulugeta, 2008; Yeshitila, 2007; Yeshitila & Weibull, 2012). However, in Jima Arjo district planting the whole tuber is a common practice.

In Jima Arjo district, the FGD participants agreed that the growers' first task is selecting suitable land, followed by clearing and burning debris. During March, while plowing the land, they distribute the manure and mix with the soil. After plowing the land two or more times using oxen, planting takes place during May. They prefer to grow where crop threshing has taken place in previous seasons. Such land is fertile because of the crop residues and manure. In Jima Arjo district, the planting period varies depending on the planting materials used. Planting the seed tuber is between April and May, and transplanting the young plant is during June. If they plant the young plant during the same period, the plant might not continue to exist because of the shortage of water. The FGD participants showed that they are practicing rotational farming; they further revealed that if they used to plant it on the same land, year after year, it would turn out to be stagnant and its tuber would end up small.

#### b) Acquisition of Planting Materials

As displayed in Table 14, the majority of growers in Jima Arjo district used their own seed tuber saving, from relatives, friends, and neighbors than in Chenchā district ( $P < 0.01$ ). While a high

percentage of growers in Chencha district use planting material purchased from the market ( $P < 0.05$ ). The FGD participants in Chencha district recognized the existence of the crops true seed; however, no one has tried to make utilization of it for planting purpose. Because of this reality, they thought about the true seed as useless. Fekadu (under publishing) conducted an experiment and found that *P.edulis* could be multiplied through true seed; he further indicated that the plant is self-pollinating and could produce a tuber. This is a tremendous opportunity for the crop further improvement.

Table 14 Sources of *Plectranthus edulis* planting material (Multiple responses is possible)

Sources	Plectranthus edulis growers (N=108)			$\chi^2$ -value
	Chencha	Jima Arjo	Overall total	
Own seed tuber	55 (77.5)	36 (97.3)	91 (84.3)	7.214***
From relatives	24 (33.8)	23 (62.2)	47 (43.5)	7.959***
From friends	21 (29.6)	28 (75.7)	49 (45.4)	20.855***
From neighbor	25 (35.2)	28 (75.7)	53 (49.1)	15.937***
From the market	62 (87.3)	25 (67.6)	87 (80.6)	6.061**

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$

Unlike Chencha district, growers in Jima Arjo district used seedlings (young plants or regrowth from previous mother plant) for planting. In agreement with the recent findings, the study conducted in East Wollega, Ilu Ababora, and the Wolaita zone reported the use of young vegetation to establish a new plant (Yeshitila & Temesgen, 2016; Yeshitila & Weibull, 2012). When the growers use young plants, it would help them to save the seed tuber. However, growers often prefer to plant seed tubers. The given reason was that when they use the seed tuber, they could get additional yield than when they use seedling.

### c) Fertilizer Application Practice

The main inputs required for growing *P.edulis* are seed tuber, natural fertilizer, and household labor. As provided in Table 15, 91.6% of growers in Chencha and 94.4% in Jima Arjo district practiced the application of natural fertilizer. The majority of growers, 69.2% in Chencha and 55.9% in Jima Arjo district used manure ( $P < 0.1$ ). The use of chemical fertilizer was not observed in both study areas, and in this regard, Yeshitila and Weibull (2012) reported a similar result in the Wolaita zone. In Chencha district, 96.9% of growers practiced application of manure during planting, while 58.1% of growers in Jima Arjo district practiced the distribution of manure before

cultivation ( $P<0.01$ ). The FGD participants in Jima Arjo district showed that the manure application was before plowing the land between September and October.

Table 15 Growers fertilizer application practice

Fertilizer application practice	Plectranthus edulis growers (N=108)			$\chi^2$ -value
	Chencha	Jima Arjo	Overall total	
Participant farmers	65 (91.6)	34 (94.4)	99 (92.5)	0.289
Fertilizer type				
Manure	45 (69.2)	19 (55.9)	64 (65.3)	4.754*
Manure and compost	16 (24.6)	14 (41.2)	30 (30.6)	
Chemical fertilizer	4 (6.2)	0 (0.0)	4 (4.1)	
Fertilizer application period				
During planting	63 (96.9)	5 (16.1)	68 (70.8)	66.580***
Before cultivation	2 (3.1)	18 (58.1)	20 (20.8)	
Any time	0 (0.0)	8 (25.8)	8 (8.3)	
Fertilizer application frequency				
Once	64 (98.5)	6 (18.2)	70 (71.4)	69.185***
Twice	1 (1.5)	19 (57.6)	20 (20.4)	
Three times	0 (0.0)	8 (24.2)	8 (8.2)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\*  $p<0.01$ ; \*  $p<0.10$

#### d) Cultivation and Earthing up Practices

As presented in Table 16, all interviewed growers in both study areas practiced cultivation (shallow digging around the root system). The FGD participants in Chencha district showed that growers started cultivation following the emergence of the first shoot between June and July. They practice cultivation to encourage the growth of more steam, to get more tuber or high yield, to get bigger tuber, and to protect from weed. Similarly, all interviewed growers practiced earthing up (piling up of the soil around the stems) for similar reasons. They practice earthing up between July and August; sometimes, if they plant the tuber late, they extend earthing up to September. Females and youngsters did cultivation while men undertake earthing up. They are often carried out earthing up to cover the runner-like structures that emerge at the base of the stem, which leads to producing tubers (Yeshitila, 2007).

Table 16 Cultivation and earthing up practices

Cultivation and earthing up practice	Plectranthus edulis growers (N=108)			$\chi^2$ -value
	Chencha	Jima Arjo	Overall total	
Cultivation practice	71 (100)	36 (100)	107 (100)	-
Cultivation frequency				
Once	2 (2.8)	0 (0.0)	2 (1.9)	2.604

Twice	13 (18.3)	10 (27.8)	23 (21.5)	
Three times	55 (77.5)	26 (72.2)	81 (75.7)	
Four times	1 (1.4)	0 (0.0)	1 (0.9)	
Growers cultivation reasons (Multiple response is possible)				
To produce more stems	65 (91.6)	16 (44.4)	81 (75.7)	28.815***
Production of more tuber	71 (100)	36 (100)	107 (100)	-
To get bigger tuber	65 (91.6)	36 (100)	101 (94.4)	3.223
To protect from weeds	62 (87.3)	28 (77.8)	90 (84.1)	1.629
Earthing up practice	71 (100)	36 (100)	107 (100)	-

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\* p<0.01

### e) Harvesting and Storage Mechanisms

Harvesting time extends between September and November (Table 17). Most growers, 43.7% in Chenchha and 70.6% in Jima Arjo district, pointed out that the crop gets ready for harvest during October. Followed by November and September in both locations. Maximum storage life after harvesting is not more than two days in both study areas. The seed tuber used for planting purpose is harvested between April and May in both locations. During this time the tuber possibly used for own planting purpose or selling as seed tuber.

Table 17 *Plectranthus edulis* harvesting practice

Harvesting season	Plectranthus edulis growers (N=108)			$\chi^2$ -value
	Chenchha	Jima Arjo	Overall total	
Harvesting for consumption				
September	15 (21.1)	3 (8.8)	18 (17.1)	8.439
October	31 (43.7)	24 (70.6)	55 (52.4)	
November	19 (26.8)	7 (20.6)	26 (24.8)	
December	5 (7.0)	0 (0.0)	5 (4.8)	
January	1 (1.4)	0 (0.0)	1 (1.0)	
Harvesting for use as a seed tuber				
January	0 (0.0)	1 (4.0)	1 (1.1)	8.159
March	4 (6.0)	4 (16.0)	8 (8.7)	
April	35 (52.2)	11 (44.0)	46 (50.0)	
May	28 (41.8)	8 (32.0)	36 (39.1)	
June	0 (0.0)	1 (4.0)	1 (1.01)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses

Harvesting is mainly the duty of women. The case study respondent in Jima Arjo district mentioned that he on no account practiced harvesting for the period of his lifetime. Storage mechanisms of the crop harvested for consumption in Chenchha district included putting on a dry and cool place in the ground and keeping it in the sack or basket. If they intend to use it for planting, they get rid of the tip of both lengthy ends, divide into two or more pieces, treat with ash and save in straw or

shadow place where there is no direct sunlight for about 15 to 30 days until planting period. They are also stored by digging the ground around the home in the shadow area until planting period. During this time, it is necessary to make sure that livestock is not in contact with the farm. If they intend to sell, some growers do not even take the tuber home, as an alternative they deliver to the market. The FGD participants in Chencha district indicated that they would harvest whenever they need for home consumption, selling or use as seed tuber. Here, in situ or ground, is the only available storage facility for growers.

In Jima Arjo district, the tuber remains in the ground and harvested when the need arises for home consumption or selling. Some growers wrapped the tuber with *teff* straw and store in the ground that is prepared in the shadow place, stated by the FGD participants. This study revealed that the crop is perishable and has a short shelf life, and there is no improved storage facility in the study area. According to the Global food security index report in lower-income countries up to 40% of a crop can be lost during post-harvest storage, and another 10% during transport because of spillage or contamination (GFSI, 2018). In this report, it was indicated that the use of improved food storage technologies such as metal silos was shown to reduce food insecurity and child malnutrition in Ethiopia. This highlights the importance of improving the storage facility for this particular crop.

#### f) Gender Division of Labor

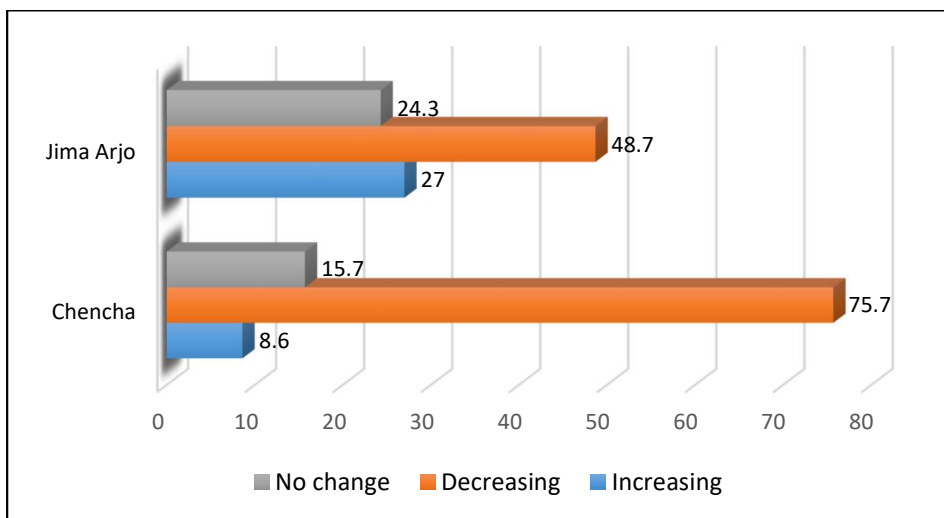
The group of FGD participants were asked to differentiate who is doing what among the given list of activities related to *P.edulis* production. The result revealed that across the two districts all family members have participated in activities related to its production. However, land allocation for different crops and land preparation for *P.edulis* are dominantly the duty of male. Harvesting, storage, marketing, variety, and seed tuber selection are dominantly the duty of women. Planting, manure application, cultivation, and earthing up are the accountability of all family members. Allocation of the tuber for selling, home consumption, and seed tuber made through discussion between husband and wife. Women transport the product to the market by caring on the back. Cooking is entirely the burden of female household members, and children have the privilege to eat at a time of shortage. In contrast to the current findings, a study conducted in the Wolaita zone

indicated that a major share of activities like tuber selection, planting, management, and storage is done by males (Yeshitila, 2007).

#### 4.2.7. *Plectranthus Edulis* Production Trend

As presented in Figure 3, the majority of growers 75.7% in Chencha and 48.7% in Jima Arjo district perceived that the crop's production trend is decreasing over the last 10 years. In line with the survey result, the FGD participants in both study areas agreed that its production trend is decreasing. The acknowledged reasons for the declining trend include shortage of land/fertile land, declining soil fertility, lack of improved variety, replacement with Irish potato (in Chencha district), lack of attention from government (like research and extension), scarcity of seed tuber, lengthy maturity period, low market demand, and price. Hellemans et al. (2017) revealed that farmers have lost the crop production interest after the introduction of Irish potato and sweet potato; the same authors further indicated that the crop is still forming an important nutritious part of the local community's diet.

Figure 3 Growers perception on production trend of *Plectranthus edulis*



The FGD participants in Chencha district indicated that they have never received any advice about its production; they further blamed the DA's due to the fact that they want them to displace the crop. This might arise from undermining its importance for the growers from the DA's side as the focus of the extension system is on major cereal crop species. In agreement with this, Yeshitila

(2007) noted that the current extension system of the country is not giving adequate attention to *P.edulis* production.

Long maturity is a constraint in Chenchha district. Unlike other crops, they produce *P.edulis* only once a year. Hence, the crop occupies the land for an extended period. This finding is supported by research conducted in Chenchha and Wolaita districts, which state the crop needs fertile land unlike other root crop species (Yeshitila, 2007; Yeshitila & Weibull, 2012). Various literature including IBC (2012); Mulugeta (2008); Yeshitila & Temesgen (2016) pronounced a decreasing trend of underutilized root and tuber crop production. Despite these constraints, however, the growers' desire is to remain producing *P.edulis*. They emphasized that if the plant is improved, they want to produce more like that of Irish potato. This might be an opportunity to further improve and enhance its production and productivity. In reality, the findings of this study did not show *P.edulis* is better than Irish potato in terms of generating income, shelf life and maturity period, in fact, if they are able to produce other crops twice a year, there is no point to stick on it.

#### 4.2.8. Growers Marketing Participation

As shown in Table 18, 33.3% of growers in Chenchha and 48.7% in Jima Arjo district have participated in the selling of this crop. The low level of marketing participation of growers highlights that they are mainly producing the crop for home consumption due to lack of market demand and low price. The major markets in both study areas include farm gates, village markets, and district markets. In Chenchha district, 55.6% of growers sell the tuber in the farm gate while none reported in Jima Arjo district ( $P < 0.01$ ). However, both the village and district market are equally important in both locations. Relatively, the crop fetches better price during the planting period (April-May) and lower price during the harvesting period, i.e. during the pick production period. Across all the study areas, all interviewed growers agreed that the crop had a lower price as compared to Irish potato.

Table 18 *Plectranthus edulis* growers marketing participation

Marketing participation	Plectranthus edulis growers (N=108)			$\chi^2$ -value
	Chenchha	Jima Arjo	Overall total	
Yes	23 (33.3)	18 (48.7)	41 (38.7)	2.382
No	46 (66.7)	19 (51.4)	65 (61.3)	
Major market outlet (Multiple response is possible)				

At the farm gate	10 (55.6)	0 (0.0)	10 (28.6)	13.222***
Village market	17 (94.4)	9 (52.9)	26 (74.3)	7.884***
District market	13 (72.2)	9 (52.9)	22 (62.9)	1.392
Perception of growers market price				
Better price	0 (0.0)	0 (0.0)	0 (0.0)	-
Less price	23 (100)	18 (100)	41 (100.0)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\* p<0.01, \*\*p<0.05

The market outlet of the crop is informal, short, and simple. These included growers sell to consumers, growers sell to farmers for seed tubers, growers sell to small traders, and in turn, small traders sell to consumers and farmers to make a small profit. Farmers mainly purchase for consumption and planting purposes particularly during planting season. Lack of market demand and price were the major reasons for not selling the crop. Because of this, they grow on the small plot of land for home consumption.

### 4.3. Growers Indigenous Production Practices and Socio-economic Importance of Anchote

#### 4.3.1. Farmers Participation in Anchote Production

Table 19 shows that in the sample 82.9% of farmers in Ayira and over one-third (39.5%) in Gimbi district were found to have participated in the production of anchote (P<0.01). The probable reason for less participation of farmers in Gimbi district was mainly due to declining soil fertility. The growers showed that soil erosion is a problem in the area, adding that the crop needs highly fertile land and sufficient manure application. It was observed that land degradation is a serious problem in Gimbi district.

The FGD participants across all the study areas indicated that wealthier and intermediate farmers mainly grow anchote. The reasons expressed by the FGD participants include the crop needs fertile land, sufficient manure, and money to buy the true seed. This reflects the direct relationship between anchote growing and the ownership of livestock and the availability of fertile land. Another interesting insight raised by the FGD participants for less participation of poor farmers was that poor households can simply make food from Irish potato (do not need expensive ingredients like butter), while preparation of food from anchote needs butter and other ingredients.

Here, the importance of livestock is manifold one through the provision of draught power, supplying manure and dairy products to complement anchote diet.

Table 19 Farmers participation in production of anchote

Farmers participation	Anchote growing area (N=184)			$\chi^2$ -value
	Gimbi	Ayira	Overall total	
Yes	45 (39.5)	58 (82.9)	103 (56.0)	33.124***
No	69 (60.5)	12 (17.1)	81 (44.0)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\* p<0.01

The FGD participants in Ayira district reveal that due to the fact that the crop is grown around the homestead, elders are mainly participating in the production of anchote. This saves elders energy from movement and gives them an opportunity to manage the crop easily. The other reason was elders from their experience have ample knowledge of its management and benefit. In contrast to Ayira district, the FGD participants in Gimbi district showed that youngsters have a tendency to take part in the production of this crop. Explaining that, its cultivation and weeding is tough (its operation requires sitting and working), hence its activity demands high energy. Moreover, its high value in terms of cash income and food motivates the participation of more young farmers.

#### 4.3.2. Growers Reasons for Anchote Production

In both study areas, all interviewed growers produced the crop primarily for food (Table 20). Besides food, 75.6% of growers in Gimbi and 56.9% in Ayira district produced the crop under the study to get additional cash income (P<0.05). In Gimbi district, statistically, significantly high proportions of growers produced the crop to cover food shortage when other crops are not ready for harvest, for its taste, to reduce risk in case other crops fail, for its better demand/price than in Ayira district. Due to the fact that Gimbi is the capital city of West Wollega zone, growers have the chance to get better market access. They use the money gained from its sale to buy household goods, to cover children's school fee, clothes, etc. Production of the crop for its medicinal value, for its ability to improve soil fertility, drought, and disease resistance ability, to get a high yield with less input and to conserve the plant and pass to the next generation were equally important for growers in both study areas.

Table 20 Growers' reasons for anchote production by district (Multiple responses is possible)

Purposes of anchote production	Anchote growers (N=103)			$\chi^2$ -value
	Gimbi	Ayira	Overall total	
Food	45 (100)	58 (100)	103 (100)	-
To get additional cash income	34 (75.6)	33 (56.9)	67 (65.1)	3.880**
For cultural value	41 (91.1)	42 (72.4)	83 (80.6)	5.662***
For medicinal value	32 (71.1)	39 (67.2)	71 (68.9)	0.177
To improve soil fertility	33 (73.3)	46 (79.3)	79 (76.7)	0.507
For its drought resistance ability	32 (71.1)	49 (84.5)	81 (78.6)	2.697
For its disease resistance ability	31 (68.9)	46 (79.3)	77 (74.8)	1.458
To get a high yield with less input	32 (71.1)	41 (70.7)	73 (70.9)	0.002
To get a high yield from a small area	33 (73.3)	43 (74.1)	76 (73.8)	0.009
To cover food shortage	33 (73.3)	30 (51.7)	63 (61.2)	4.981**
For its taste	33 (73.3)	6 (10.3)	39 (37.9)	42.732***
To reduce risk	32 (71.1)	30 (51.7)	62 (60.2)	3.975**
For its better demand and price	43 (95.6)	40 (69.0)	83 (80.6)	11.450***
To conserve the plant for next generation	33 (73.3)	36 (62.1)	69 (67.0)	1.454

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\* p<0.01, \*\*p<0.05

Among the interviewed households, 91.1% in Gimbi and 72.4% in Ayira district have grown the crop for its cultural value besides food and the source of cash income. During New Year and *Meskel* festivals (celebrated at the end of September), its dish is consumed first as one Oromo traditional food, whatever other delicious food is on the table. In this regard, Girma & Dereje (2015) highlights the existence of strong ties between the production of anchote and Oromo people; they usually serve its dish on special occasions like weddings, marriage ties, circumcision, and birthday (Habtamu, 2013). In agreement with the current findings, Masarat (2018) showed that the vital roles this crop plays in socio-economic, cultural and medicinal values besides food sources for growers. They present its food while visiting relatives, in-laws or any other valued person. During such occasions, it is important to note that those households who do not have anchote from their own farm are obliged to buy on the market. Before paying a visit, they would ask themselves such a critical question “how much money shall I need to buy anchote or how much anchote shall I need”. It is also a special food offered to valued guests. The study conducted in the diaspora community by Bula showed that several Oromo immigrants in North America and Europe have been importing anchote to use on special occasions (Bula, 2017). In line with this, the study conducted in Central Africa revealed that the farming community has extensive knowledge of plants that have a multi-purpose use at the local, national and international levels (Eyong, 2007).

Anchote has high medicinal value. In both study areas, overall 68.9% of growers used the crop for

medicinal value. The FGD participants in both study areas agreed that they use the tuber for treating *dhiitessaa* (Afan Oromo) – i.e. swelling in different parts of the body. They peel the tuber that is aged two or more years after boiling, then smash in the wooden mortar, and ground in a homemade grinding mill (made from the stone). While grinding they include a bar of salt, garlic, ginger, butter and *qocqocaa* (a paste of green or red pepper with the pungent taste). The tuber prepared in this way makes the swelling erupt and cures the person. Unlike the tuber used for treating *dhiitessaa*, they use an immature tuber around two-month-old locally called *tobbe* to treat a fractured bone. They also serve bridegrooms with anchote food five to seven days earlier his wedding day. They consider overstayed anchote as the best postnatal meal for women to help her recover from postnatal ailments and to regain strength and help sick people to recuperate (Girma & Hailu, 2007; Masarat, 2018; Bula, 2017; Yosef & Tileye, 2013). In this case, they associate anchote with fertility, and call the tuber as *fira deessuu*, which means ‘a relative of fertile women.’ The idea behind the use of soil-stored anchote tuber is that its nutrient concentration (calcium, iron, and protein) increases over time (Abera, 1995; Endashaw, 2007; Girma & Dereje, 2015; Yenenesh, 2015).

While I was asking the FGD participants in Gimbi district if there is any medicinal value that was not mentioned so far, one participant said “*you will laugh if I add one*”, no, I assured and encouraged him to tell us, then he said the tuber is also used to treat low libido in male. They give the soup that is prepared from the tuber younger than three months. The Oromo elders gained the knowledge of repairing effect of anchote from years of practical experiences. Various scholars Abera (1995); Endashaw (2007); Folla et al. (2013); Dandena (2010); Girma & Dereje (2015); Yeshitila & Temesgen (2016) found out that anchote is used to treat gonorrhoea, tuberculosis, tumor cancer, bone fracture, displaced joints, and skin eruptions. According to Eyong (2007) California based Shaman Pharmaceuticals was founded in 1989 with the goal of commercializing indigenous pharmaceutical uses of plants, which might be an opportunity to investigate the active ingredients of the crop and further exploit its potential.

#### 4.3.3. Traditional Foods and Expressions about the Importance of Anchote

The FGD participants showed that *afeli/bugi*, *qorii* and *stew/ittoo* are the common traditional foods prepared from anchote. They prepare *afeli/bugi* by peeling the tuber after boiling, and slicing

longitudinally, and serve with *qocqocaa*. They prepare *qori/murmuri* in such a way that, first they peel the tuber after boiling, slice into pieces, then they include butter, garlic, and *qocqocaa*, and serve alone with the spoon or hand. Sometimes they prepare *qori/murmuri* along with fava bean. They also prepare its stew and serve with *buddena* (a traditional flat sheet bread made from *Eragrostis teff* grain called *teff*) and *qocqocaa*. This gives growers an opportunity to utilize diversified food that is important from a nutritional point of view. In Gimbi, Ayira, Jima Arjo, and Nekemte cities, its dish is common in different hotels and restaurants. One can get its dish in normal and special anchote forms. They prepare special anchote along with various foods like meat, boiled egg, butter, and *qocqocaa*. Hotels and restaurants used grinding machines to grind the tuber for preparation of its dish.

The study conducted in Kellem Wollega by Masarat noted that the tip vegetative growing part of anchote is a delicious dish (Masarat, 2018). However, similar to the recent finding, the author noted that farmers in East and West Wollega have no idea about the consumption and ways of preparing the dish from the tip of the plant. Anchote tuber has a higher protein content and minerals (like Ca, Mg, P, Fe, and S) than cassava and sweet potato (Parmar et al., 2017). The authors further showed that its Ca content is three to five times higher than cassava and sweet potato, which makes it an important source of plant-based Ca for the local population.

Sayings that express the importance of anchote as expressed by FGD participants include “*anchote yaa fayyissaa hundumaa*” (Afan Oromo), which means anchote is the medicine of all diseases. They also sing a song during the *Meskel* festival, which is expressed as “*ancootee masqalaa ijjoleen marsite dararaa baqelaa shimbbirroon marsitee...*” Its translation is that children surrounded food prepared from anchote; birds surrounded blossomed fava bean. That is to show the children, who are not young enough for attending the ceremony outside stay at home and wait for the family by surrounding the food prepared from anchote. The study conducted by Bula showed that the society associates root crops with human parents and parents of all other crops because they form the foundation for seeds, leaves, and other edible parts of the plant. He further showed the expression in the Oromo proverb, “*muktti fiixeen nama hinbaatu, hundeetu nama baata malee,*” which means, it is not the tip of crops that bears a person but its root. This implies that even though children are important, parents make up the family’s foundation. Likewise, cultivating

the desirable tuber is associated with raising children. This symbolism becomes clear in the Oromo saying, “*muka hundeen miya’u ijjisaa miya’a*”, which translates as, “the tree with a sweet root produces a sweet fruit”. Parents raise children and cultivate in their children what they believe to be acceptable behavior (Bula, 2017).

#### 4.3.4. Why Growers Produce Anchote Less as Compared to Other Crops?

The growers produce the crop less as compared to other crops (like Irish potato) due to the shortage of land, high labor demand and lack of government attention (extension system and research) (Table 21). Although there was no statistically significant variation between the two locations, 48.8% in Gimbi and 43.3% in Ayira district showed that shortage of land/fertile land was their reason for less production of the crop. This shows that shortage of land is an equally important reason for less production of the crop in both study areas. In concurrence with the current findings, Masarat (2018) pointed out that the demand for land has been growing as the farm population is increasing over time. On top of this, the landholding share of farmers has declined due to the redistribution of land among the household members. The FGD participants in both study areas indicated that the crop requires highly fertile/manured land. If the growers' plant on the poor soil the resulting tuber ends up thin and small. They mostly prefer to grow around the homestead because such land has enough manure and is fertile.

In Gimbi district, more than three times more growers showed that its cultivation demands high labor than in Ayira district, which was statistically significant at 1% probability level. In consistent with the survey findings, the FGD participants showed that unlike other crops anchote demands high labor, i.e. its operation is lengthy, time taking, and difficult to carry out activities fast. It requires frequent supervision by husband and wife, not even left to children. Moreover, due to the fact that the crop is a single root system each individual plant needs attention. It is also difficult to transport and apply manure and produce in large farms.

Table 21 Farmers reasons for less production of anchote (Multiple responses is possible)

Reasons for less production	Anchote growers (N=103)			$\chi^2$ -value
	Gimbi	Ayira	Overall total	
Shortage of land	21 (48.8)	25 (43.9)	46 (46.0)	0.245

Demand high labor	31 (72.1)	13 (22.8)	44 (44.0)	24.163***
Lack of government attention	1 (2.3)	16 (28.1)	17 (17.0)	11.513***

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\* p<0.01

In Ayira district, 28.1% of growers showed that their reason for less production of the crop was lack of government attention, while only 2.3% of growers reported in Gimbi district (P<0.01). The FGD participants in both study areas showed that unlike other crops, anchote lacks attention from research and extension. The information obtained from the respective districts Agricultural and Rural Development Office testified that the crop is not part of the country’s extension package system. The FGD participants across the two study areas showed that wild animal attacks (like porcupine, ape, and monkey) were raised as the main reason for less production of the crop. In addition to the above mentioned wild animals, Habtamu (2013) identified wild pigs and warthogs in the study area. In general, wild animal attacks were found to be a major constraint that growers expressed their concern in both study areas. Planting the crop around the homestead helps family members and guarding dogs in protection.

Non-grower farmers were probed for their reasons for not growing anchote. Accordingly, as provided in Table 22 lack of fertile land, scarcity of land, lack of labor, excessive labor demand, lack of manure, and termite expansion were the major explanations of farmers in Gimbi district for not growing the crop. While lack of manure, scarcity of land and lack of fertile land were the major reasons of farmers in Ayira district for not growing the crop. In general, this study shows that lack of manure, scarcity of land and lack of fertile land were the major reasons of farmers in both study areas for not growing the crop. Lack of manure is directly related to ownership of livestock; hence, this indirectly highlights that ownership of livestock is the constraining factor that hinders the farmers’ participation in the production of anchote.

Table 22 Farmers reasons for not growing anchote (Multiple responses is possible)

Reasons	Non-growers (N=103)			$\chi^2$ -value
	Gimbi	Ayira	Overall total	

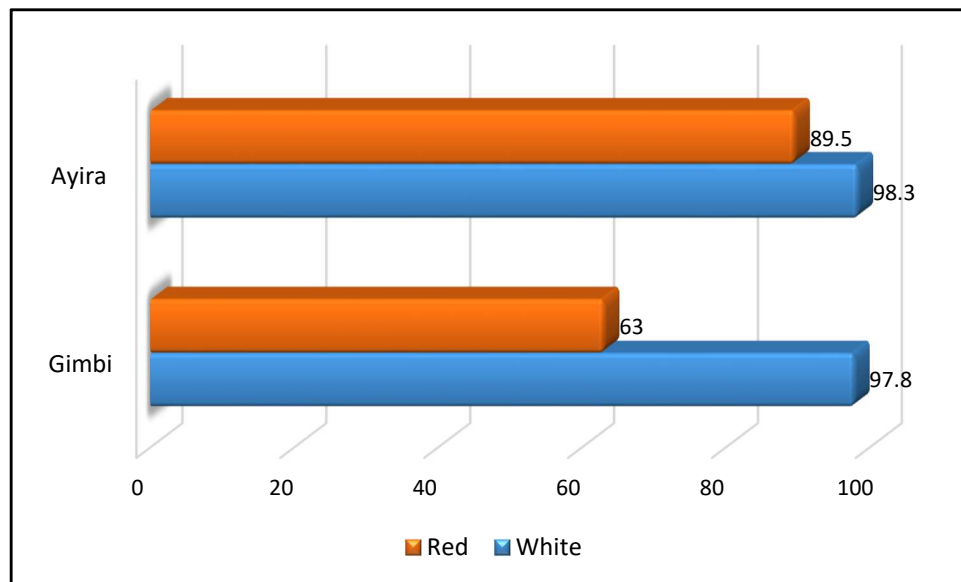
Lack of manure	3 (4.4)	4 (33.3)	7 (8.6)	10.878***
Shortage of land	43 (62.3)	4 (33.3)	47 (58.0)	3.526**
Lack of fertile land	44 (63.8)	5 (41.7)	49 (60.5)	2.089
Lack of labor	6 (8.7)	0 (0.0)	6 (7.4)	1.127
Demands high labor	6 (8.7)	0 (0.0)	6 (7.4)	1.127
Termite expansion	3 (4.4)	0 (0.0)	3 (3.7)	0.542

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\* p<0.01, \*\*p<0.05

#### 4.3.5. Local Varieties and Growers Selection Criteria

As shown in Figure 4, two local varieties of anchote (white and red) were identified in both study areas. During the FGD session in Gimbi district, some participants argued that the color of the tuber is associated with its age, which means as the tuber stays for a long period in the soil turns its color from white to red. Masarat (2018) reported a similar observation, however, the author further noted that the color and age of the tuber is unrelated, instead, the color variation is due to the genetic diversity between the landraces.

Figure 4 Local varieties of anchote and growers preference



As presented in Figure 4, 97.8% of growers in Gimbi and 98.3% in Ayira district prefer to grow white anchote to the red one. According to the FGD participants, white anchote is characterized by large tuber size, easy cooking, soft texture, less fiber content, white tuber color, good taste, has a better market demand and while grinding in the grinding mill does not need too much power.

This most often stems from the low fiber content of the tuber. White anchote is frequently preferred for preparation of cultural food during holidays and wedding ceremonies. They characterized red anchote as having high fiber content, high medicinal value, takes a long time while cooking, hard texture, low market demand, poor taste, and intermediate tuber size. The red-colored anchote is not palatable like that of the white one. They use white anchote as regular daily food, served in a lot of cooked types in homes and restaurants, while red anchote is right for its medicinal value (Parmar et al., 2017). The most important plant traits considered to choose the best performing local variety in both study areas are drought and disease/pest resistance ability, maturity period, taste, tuber size, tuber color, ability to improve soil fertility, shelf life, cooking time, market demand and price (Table 23).

Table 23 Local variety selection criteria (Multiple responses is possible)

Plant characteristics	Anchote growers (N=103)			$\chi^2$ -value
	Gimbi	Ayira	Overall total	
Drought resistance ability	43 (95.6)	56 (100)	99 (98.0)	2.539
Disease/pest resistance	43 (95.6)	56 (100)	99 (98.0)	2.539
Maturity period	42 (93.3)	56 (100)	98 (97.0)	3.848**
Taste	0 (0.0)	1 (1.8)	1 (1.0)	0.812
Tuber size	44 (97.8)	56 (100)	100 (99.0)	1.257
Color	3 (6.8)	0 (0.0)	3 (3.1)	3.660
Ability to improve soil fertility	44 (97.8)	51 (91.1)	95 (94.1)	2.008
Plant height	39 (86.7)	52 (92.9)	91 (90.1)	1.072
Shelf life/storability	40 (88.9)	50 (90.9)	90 (90.0)	0.112
Cooking time	45 (100)	55 (98.2)	100 (99.0)	0.812
Market demand/price	42 (93.3)	52 (94.6)	94 (94.0)	0.065

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*p<0.05

The growers also select the viable true seed by looking into its size (larger size) and the seed that is not fragmented while pressing between two fingers. In line with this findings, the farming community in Nigeria applied their indigenous knowledge in local variety selection, pest control, maintenance of soil fertility, the use of organic manure and storage technologies (Nnadi et al., 2013). Farmers in Ethiopia, like many other developing countries, have developed and maintained several diverse and locally adapted varieties of crops on their small plot of land because no single type can satisfy their basic needs (Yeshitila, 2007). The local varieties fit into the traditional farming system, and this may allow growers to maximize returns using low levels of technology and limited resources (IPGRI, 1999). In Ethiopia, farmers continue to produce different varieties

of crops because of their contribution to food security and cultural values (IBC, 2012). The recent study agrees with these scholars' assertion, which states though the farmers are aware of the potential of one variety over the other in providing better yield, they continue growing different varieties of crops for various purposes.

#### 4.3.6. Cropping Pattern of Anchote

##### a) Site Selection Practice

As presented in Table 24, a significantly high proportion of growers (62.8%) in Gimbi district produced in the main field followed by home garden (23%); while about 51.1% of growers in Ayira district produced in the home garden followed by main field (48.9%), which was statistically significant at 1% probability level. The intention of the growers for planting the crop in the home garden was an indication of the need to utilize manured land and protect the crop from wild animal attacks.

Table 24 Growers anchote planting site selection practice

Planting sites	Anchote growers (N=103)			$\chi^2$ -value
	Gimbi	Ayira	Overall total	
In the home garden	10 (23.3)	24 (51.1)	34 (37.8)	11.931***
In the main field	27 (62.8)	23 (48.9)	50 (55.6)	
In both sites	6 (14.0)	0 (0.0)	6 (6.7)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\* p<0.01

##### b) Land Preparation and Planting Practices

As presented in Table 25, the growers usually prepare the land between December and May in Gimbi district. In Ayira district, 75.9% of growers prepare the land during May; here, they appear to start land preparation relatively late. In each case, growers usually sow the seed between April and May. The majority of growers in Gimbi district, 55.6% and 35.6% prepare the land three and two times, respectively. Alternatively, 63.8% of growers in Ayira district prepare the land twice (P<0.05). This highlights that growers repeatedly cultivate the land in Gimbi district than in Ayira district. It was probably due to the existence of rather better market demand and growers' awareness about repeated cultivation benefits in Gimbi district than in Ayira district. In both study areas, growers used hand tools or traditional digging tools known as *gaso*, and oxen for preparation of land.

Table 25 Land preparation practice (Multiple responses is possible)

Land preparation period	Anchote growers (N=103)			$\chi^2$ -value
	Gimbi	Ayira	Overall total	
December	7 (14.9)	0 (0.0)	7 (6.7)	9.255***
January	8 (17.8)	0 (0.0)	8 (7.8)	11.179***
February	14 (29.8)	0 (0.0)	14 (13.3)	19.935***
March	5 (10.6)	2 (3.5)	7 (6.7)	2.157
April	9 (19.2)	1 (1.7)	10 (9.5)	9.148***
May	16 (34.0)	44 (75.9)	60 (57.1)	18.540***
<b>Land preparation frequency</b>				
Planted in virgin land	1 (2.2)	0 (0.0)	1 (1.0)	12.011**
Once	1 (2.2)	3 (5.2)	4 (3.9)	
Twice	16 (35.6)	37 (63.8)	53 (51.5)	
Three times	25 (55.6)	18 (31.0)	43 (41.8)	
Four times	2 (4.4)	0 (0.0)	2 (1.9)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\* p<0.01

The FGD participants in both study areas showed that if they plan to cultivate the crop in the large farm, i.e. in the main field, they prepare the land between March and April using oxen. They distribute manure one to two months earlier than the actual cultivation practice. They mix it with soil while cultivating the land, and they sow the seed during May. Land preparation begins between October and November, particularly in Gimbi district. During this time the land is dry, hence, it needs high energy.

Growers frequently broadcast the true seed following the short rain that starts between the months of April and May. After broadcasting they cover the seed either by plowing with oxen or using a digging hoe (Masarat, 2018; Mulugeta, 2008; Yeshitila & Temesgen, 2016). In the same way, they plant the seed tubers or *guboo*s during May. The FGD participants in both study areas showed that they produce crops in monoculture and in multiple-cultures. Growers practiced intercropping with maize, sugarcane, and cabbage when they intend to produce the true seed. Their motives for intercropping with other crops are to get additional yield from the same land and provide the post to the plant and produce the true seed. However, the main practice is a monoculture.

### c) Acquisition of Planting Materials

There was significant variation between the two locations in using the sources of planting materials from their own true seed saving, from friends and purchasing from the market (Table 26). A greater percentage of growers in Ayira district use their own true seed savings than in Gimbi district ( $P < 0.05$ ). Alternatively, in Gimbi district the growers get planting materials from friends and market than in Ayira district, which was statistically significant at 5% and 1% probability level, respectively. However, the use of their own seed tuber, from relatives and neighbors are equally important sources of planting materials in both study areas. Apparently, the experience of sharing seed tuber/true seed imbued the society with a sense of the value of the crop for food, cultural and medicinal values.

Table 26 Sources of anchote planting materials (Multiple responses is possible)

Sources	Anchote growers (N=103)			$\chi^2$ -value
	Gimbi	Ayira	Overall total	
Own true seed	32 (72.7)	52 (89.7)	84 (82.4)	4.933**
Own seed tuber	19 (43.2)	26 (44.8)	45 (44.1)	0.028
From relatives	24 (54.6)	25 (43.1)	49 (48.0)	1.312
From a friend	23 (52.3)	17 (29.3)	40 (39.2)	5.534**
From neighbor	23 (52.3)	22 (37.9)	45 (44.1)	2.087
From the market	36 (81.8)	32 (55.2)	68 (66.7)	7.994***

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\*  $p < 0.01$ , \*\* $p < 0.05$

The crop can be propagated both vegetatively and via true seed. However, the main practice is through the propagation of the true seed. Vegetative propagation is realized through planting of the seed tuber older than two years (known as *guboo*), to set up mother plants for further seed production. The FGD participants in both study areas showed that those growers who have well-fenced farms and enough manure could produce the true seed. Here, they dispose of the seed tuber/*guboo* from the soil and replant in a distinctive place or leave the mother plant where it was. The growers use both live plants and wooden posts to support the mother plants during production of the true seed (Yeshitila & Temesgen, 2016). When they use the true seed, they cannot get the true seed within the same cropping season. Alternatively, when they use older tubers/*guboo* they can harvest the true seed within the same cropping season. Those growers who have no true seed from their own farm could either buy from the market, family, friends or neighbors. In agreement with the current findings, Baena et al. (2012) showed that NUCS have mainly informal seed

systems.

#### d) Fertilizer Application Practice

As provided in Table 27, all interviewed growers in both study areas use natural fertilizer (manure and compost). This highlights that the crop is a manure loving, therefore, having a regular supply of manure is, without doubt, one of the necessary inputs for the cultivation of the crop.

Table 27 Fertilizer application practice

Fertilizer application practice	Anchote growers (N=103)			$\chi^2$ -value
	Gimbi	Ayira	Overall total	
Fertilizer application	45 (100)	58 (100)	103 (100)	-
Types of fertilizer				
Manure	11 (24.4)	21 (36.8)	32 (31.4)	1.799
Manure and compost	32 (71.1)	34 (59.7)	66 (64.7)	
Chemical fertilizer	2 (4.4)	2 (3.5)	4 (3.9)	
Fertilizer application period				
During planting	0 (0.0)	2 (3.6)	2 (2.0)	2.509
Before cultivation	43 (95.6)	49 (87.5)	92 (91.1)	
Any time	2 (4.4)	5 (8.9)	7 (6.9)	
Fertilizer application frequency				
Once	41 (91.1)	29 (50.9)	70 (68.6)	19.969***
Twice	4 (8.9)	17 (29.8)	11 (20.6)	
Three times	0 (0.0)	11 (19.3)	11 (10.8)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\* p<0.01

The research conducted on the response of anchote to organic and inorganic fertilizers rate in western Oromia showed that anchote responds to soil fertility, wood ash, and burnt crop residues (Girma & Hailu, 2007). Hence, growers prefer to plant it close to the home garden where cattle pen is located. When they grow it in the main field outside the homestead, they face transportation problems and wild animal attack. In contrast to the findings of the present study, research conducted in Sibru Sire and Wayu Tuqa districts reported that 13.9% of growers used chemical fertilizer to maintain its productivity. Most growers, 95.6% in Gimbi and 87.5% in Ayira district, applied manure before plowing the land. The FGD participants in both study areas showed that growers applied manure between September and October, before cultivating the land. In addition, they apply manure during weeding and cultivation depending on the stage of plant development and demand. They start weeding and cultivation 3 to 4 weeks after planting, and they practice earthing up each time its root gets out from the ground. They further showed that with chemical

fertilizer anchote is not productive. Various scholars Girma & Hailu (2007); Yeshitila (2007) reported a similar result indicating that anchote is not responsive to chemical fertilizer.

#### e) Cultivation and earthing up practices

As presented in Table 28, all interviewed growers practiced cultivation. The vast majority of growers in both locations cultivate the crop two to three times. The recounted justification for cultivation was to get bigger tubers, high yields and to protect from weeds. The FGD participants in both study areas showed that the first cultivation commenced after two to three weeks of planting. During this time husband and/or spouse sitting on a small chair, removing the weeds and cultivate the plant using a small ax while doing so they chant “*Guddadhu ammana naaf gayi*”, which means grow for me and attain this much, referring to their height sitting on the chair.

Table 28 Cultivation and earthing up practices

Cultivation and earthing up practice	Anchote growers (N=103)			$\chi^2$ -value
	Gimbi	Ayira	Overall total	
Cultivation practice	45 (100)	58 (100)	103 (100)	-
Cultivation frequency				
Once	0 (0.0)	0 (0.0)	0 (0.0)	12.108***
Twice	35 (83.3)	27 (49.1)	62 (64.0)	
Three times	7 (16.7)	28 (50.9)	35 (36.1)	
Four times	0 (0.0)	0 (0.0)	0 (0.0)	
Cultivation reasons				
To get bigger tubers	45 (100)	58 (100)	103(100)	-
To protect from weeds	31 (100)	21 (100)	52 (100)	-
Earthing up practice	44 (97.8)	58 (100)	102 (99.0)	1.302

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\* p<0.01

In addition, they frequently investigate their farm and remove newly rising weeds. All interviewed growers practice earthing up between July and August, and in some cases, if they sow late, earthing up is extended to September.

#### f) Harvesting and Storage Practices

Harvesting involves complete digging out of the tuber using traditional digging tools. The vast majority of growers, 90% in Gimbi and 79.3% in Ayira district, showed that the crop gets ready for harvest during September (Table 29). The tuber is ready for harvest in four to five months after planting depending on the management practices. This finding is supported by various scholars

Abera (1995); Yenenesh (2015), which reported similar results. The pronounced proportion of growers, 81.8% in Gimbi and 95% in Ayira district practiced harvesting of seed tuber/*guboo* during May. During this time, growers use the tuber for their own planting purpose or selling it as seed tuber. Harvesting is entirely the burden of female household members.

Table 29 Harvesting practice

Harvesting season	Anchote growers (N=103)			$\chi^2$ -value
	Gimbi	Ayira	Overall total	
<b>For consumption</b>				
September	36 (90.0)	46 (79.3)	82(83.7)	2.867
October	2 (5.0)	5 (8.6)	7 (7.1)	
November	1 (2.5)	6 (10.3)	7(7.1)	
December	1 (2.5)	1 (1.7)	2 (2.0)	
<b>For use as seed tuber</b>				
April	2 (18.2)	1 (5.0)	3 (9.7)	1.411
May	9 (81.8)	19 (95.0)	28 (90.3)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses

The FGD participants in Gimbi district showed that harvesting depends on the wealth status of growers and the availability of the farmland. The poor and those who have small farmland might harvest the entire tuber when mature and use the land for other crops production (like maize, wheat, and beans). During this time the tuber has a soft texture, takes less time while cooking, and contains less fiber content. Individuals who are curious about medicinal value, wealthier and own large farmland might leave tubers in the ground for two or more years. In times of staple food crops depletion from the store, growers are forced to harvest as early as possible. It is important to note that harvesting the tuber early may cause low yield and poor-quality produce.

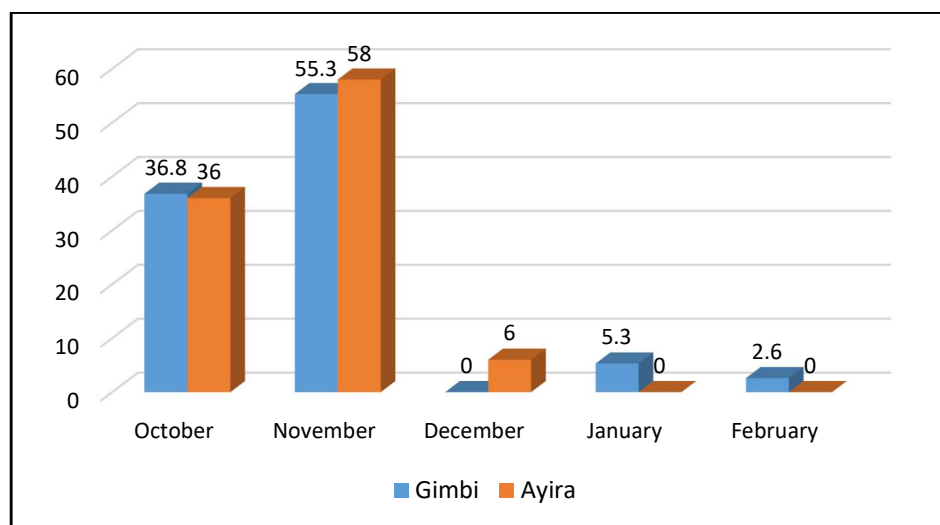
Alternatively, the crop is harvested for home consumption when the need arises, during holiday and when a guest pays a visit. This finding was in line with Yeshitila & Temesgen (2016), who noted that anchote produces a single tuber and its size gets bigger when maintained longer in the field. The authors further indicated that the tubers could stay in the soil with little quality loss until the next planting season. This shows that one can harvest the tuber any time of the year once it attains full maturity.

The commonly available storage facility in the study area is leaving in the ground and protecting

from animals reach. In most cases, growers directly wash the tuber and immediately prepare for consumption. If they want to store for some time, they maintain in a clean and shadow place outside their home or display on the floor at home without washing the soil. By doing so, they can store the tuber for about one month without deterioration. Another available storage mechanism is digging the ground and storing it there. By doing so, growers can keep the tuber for a maximum of two to three months without deterioration. If they intend for selling purpose, harvesting is on the market day or one day before market day. More often, growers tend to harvest the amount they need either for home consumption or for sale. The crop has special merit in that growers can store their produce on the production beds for a great number of months after maturity (Abera, 1995; Girma & Dereje, 2015). However, proper storage technology would help the growers to use the land for growing other crops and thereby improve their livelihood.

In Gimbi district, 55.3% of growers showed that harvesting of the true seed is during November, while 36.8% reported October. The corresponding figures in Ayira district were 58% and 36%, respectively (Figure 5). This shows that the peak production period of true seed is between October and November in both locations.

Figure 5 True seed harvesting season



Once they harvest the mature seed, they remove the pod carefully, wash it with water, treat it with wood ash, and make it dry in the sunlight. Finally, they store it in a tight, and air-spaced equipment and place in a cool, shadow, and out of reach of the rat. Alternatively, they store seeds in clay pots

or wrap it in a piece of cloth and suspend it on the wood post. By doing so, they can save the true seed for up to a year without losing its viability.

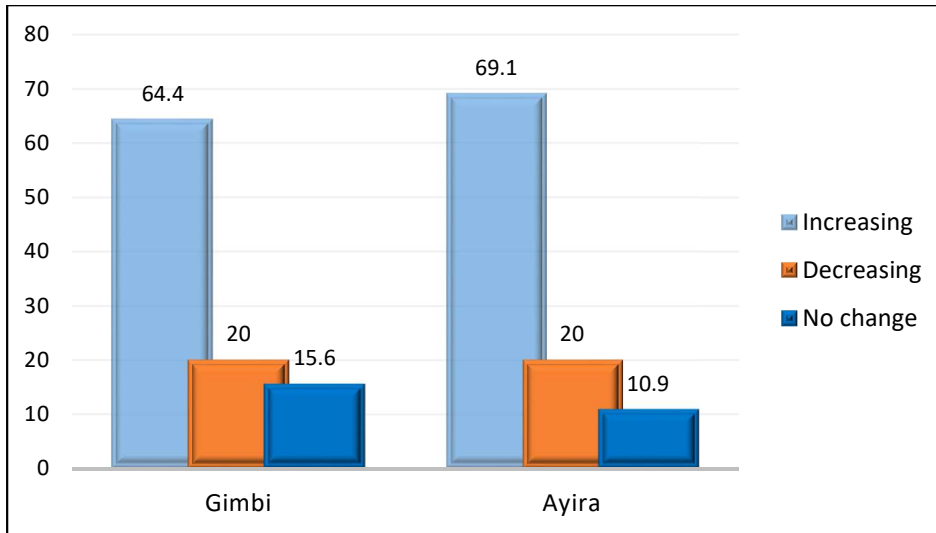
#### g) Gender Division of Labor in Relation to Anchote Production

The FGD participants in both study areas revealed that all family members have engaged in its production-related activities. However, land allocation for different crops and land preparation for anchote production are dominantly the duty of male. While harvesting, storing, marketing, variety and seed selection are dominantly the duties of females. Most of the times harvesting of true seed, drying and selecting is the job of females. All family members undertake planting and manure applications, while the husband and wife carry out cultivation and earthing up. Correspondingly, husband and wife make the decision on the allocation of the tuber for home consumption, selling and seed tuber. They also control the cash income gained from its sale. Cooking is completely the load of female household members, and children and the elderly have the privilege to eat the tuber at a time of shortage. Women farmers play a dominant role in the production and postharvest handling of the tuber, seed collection, extraction and preserving the seeds in a good state (Abera, 1995; Endashaw, 2007; Masarat, 2018; Yeshitila & Temesgen, 2016).

#### 4.3.7. Perception of Growers about Anchote Production Trends

As presented in Figure 6, the majority of growers, which account for nearly 64.4% of the total respondents in Gimbi and 69.1% in Ayira district perceived that the trend of anchote production has been increasing over the past 10 years. The most important noted reasons for an increasing trend were increasing awareness of growers about its benefits be it in terms of food or source of cash income, better management practices, growing market demand and price, and its high cultural and medicinal values.

Figure 6 Anchote production trend



The FGD participants across the two study areas also showed that in the earlier period, given that its price was low, growers tended to produce less. However, nowadays its demand and price are increasing from time to time, particularly, the demand from different hotels and restaurants are high. In addition, those growers who practice row planting and apply enough manure are getting better yield. The other cited reason was because of its utilization as a main dish alone and complements other food. The FGD participants in Gimbi district showed that they have been growing limited to their homestead, but now they began widely growing in the main field. However, they disclosed that the crop needs more management as compared to other crops. The reason was that every single plant needs high management like repeated cultivation, weeding and earthing up. The land preparation is also tiresome and tedious, given that land cultivation is during the dry time using hand tools. Consequently, they allocate a small plot of land due to the difficulty to manage in the large farmland.

#### 4.3.8. Growers’ Marketing Participation

The highest proportion of growers, 84.4% in Gimbi and some 41.4% in Ayira district have taken part in the selling of anchote (Table 30). This suggests that about two times more growers in Gimbi district participated in the selling of the crop than in Ayira district ( $P < 0.01$ ). The highest share of growers marketing participation in Gimbi district highlights the presence of better market demand and price. In both study areas, the crop fetches a better price as compared to Irish potato.

The FGD participants disclosed that between January and February its price would become higher. The recounted factors were this time is the fasting period of Orthodox Christians and most wedding occasions. In contrast, starting from the end of September onwards when harvesting reaches its peak, its price becomes low. This constraint suggests the need to develop the market value chain.

Table 30 Growers' marketing participation

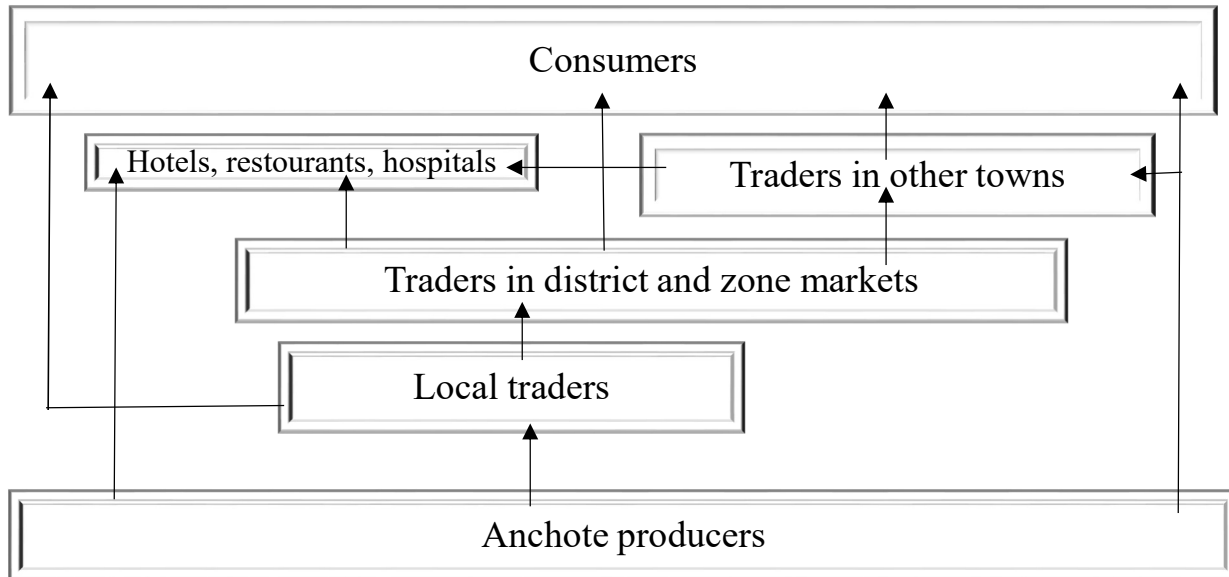
Marketing participation	Anchote growers (N=103)			$\chi^2$ -value
	Gimbi	Ayira	Overall total	
Yes	38 (84.4)	24 (41.4)	62 (60.2)	19.613***
No	7 (15.6)	34 (58.6)	41(39.8)	
<b>Major market outlet</b>				
In the farm gate	2 (5.3)	2 (8.3)	4 (6.5)	0.230
Village market	4 (10.5)	2 (8.3)	6 (9.7)	0.081
District market	38 (100)	24 (100)	62 (100)	-
<b>Means of transportation</b>				
Caring	1 (2.6)	8 (33.3)	9 (14.5)	11.173***
Horse/donkey back	38 (100)	20 (83.3)	58 (93.6)	6.770***
<b>Major market customers</b>				
Consumers	16 (42.1)	24 (100)	40 (64.5)	21.537***
Traders	36 (94.7)	0 (0.0)	36 (58.0)	54.219 ***
Farmers	5 (13.2)	0 (0.0)	5 (8.1)	3.435
<b>Growers' perception of the market price</b>				
Better price	33 (86.8)	24 (100)	57 (91.9)	3.435
Less price	5 (13.2)	0 (0.0)	5 (8.1)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parentheses; \*\*\* p<0.01

The growers usually sell the tuber during the start of Ethiopian new year (September) and various holidays. Masarat (2018) noted that its price varies with the tuber size, time of the year, amount of supply and market location. The information collected from the market visit in Ayira district showed that the average price of 1kg of anchote tuber was 6.2 Ethiopian Birr (ETB) and the average price of 100gm or one coffee cup of true seed was 6 ETB. The growers perceived that the price of true seed is expensive. Similarly, in Gimbi district, the average price of 1kg anchote was 6.55 ETB. This is probably due to the existence of Gimbi market, which is the west Wollega zone market. The retail price of anchote at Nekemte market was 4–5 times greater than other tropical root and tuber crops such as taro and sweet potato (Parmar et al., 2017). In line with this, Dandena (2010) also noted that anchote is highly demanded in the supermarket and cultural food preparation. In general, it was plain that in both study areas the price of anchote was higher than the price of Irish potato.

As depicted in Figure 7, the market outlet of anchote is informal, short, and simple. The recognized market outlets across all the study areas include growers directly sell to consumers, growers sell to farmers for seed tubers, growers directly sell to small traders, and in turn, small traders sell to consumers and farmers to make small profits.

Figure 7 Anchote marketing channel in western Ethiopia



Source: Own construction based on survey data

In addition, growers sell their produce to a passer-by to different places, mainly Addis Ababa. Those individuals who have relatives in Addis Ababa also buy and send the tuber to their relatives. The growers' main explanations for not taking part in the selling of anchote were their inability to produce sufficient amounts beyond their need for home consumption and interest to use only for food and medicine. The major anchote value chain actors include input (seed tuber, true seed, farm implement) suppliers, growers, traders, and consumers. In both study areas, input supply is not adequate and the planning of input supply through the extension system focuses on major food crops and excludes underutilized and neglected crop species. Moreover, farmers are not getting adequate advice to increase anchote production and productivity.

#### 4.4. Summary

This Chapter aimed to contribute to the knowledge gap related to the two tuber crops production, storage, processing, utilization, and marketing in southwestern Ethiopia. Indigenous knowledge is the traditional knowledge of the farmers about production, protection, and preservation of crops

generated by their ancestors and internalized by the local people. Understanding how and why farmers carry out different indigenous production practices is indispensable to promote a certain crop. In view of this, this section provides a summary of the chapter below.

This study elucidated that 45.8% and 39% of interviewed farmers in Chench and Jima Arjo district, respectively have participated in the production of *P.edulis*. Mostly, the growers are producing it for food, particularly to cover food shortages between September and November. Besides food, they grow to get small cash income, to improve soil fertility, for its ability to resist drought and disease, to get a high yield with less input, to get a high yield from a small area, to reduce risk in case other crops fail due to adverse weather conditions. It is also used to treat gastritis, asthmatic and coughing. In Jima Arjo district, they also use its leaf to treat the cattle infested with leeches.

Notwithstanding its importance and long period farmers' growing experience the crop is mostly produced in small plots of land around the homestead for home consumption due to low market demand and price, shortage of land, lengthy maturity, and high labor demand. The growers acquire planting materials from their own seed tuber savings, from relatives, friends, neighbors, and in some cases purchasing from the market. In Chench district, they also use seedling for planting. In any case, the growers prefer to plant often seed tubers, given that they can get additional yield than when they use seedlings. This study documented six local varieties of *P.edulis* namely *Lofo dono*, *Chanko dono*, *Giso dono*, *Dalako dono*, *Gircho dono*, and *Hole dono* in Chench district and two local varieties (white and red) in Jima Arjo district. Across all the study areas, they consider the crop's drought resistance ability, maturity period, taste, tuber yield, tuber size, shelf life, cooking time, market demand, and price to select the best performing local variety.

The land is prepared between March and May in both study areas. In all cases, they plant between April and May. They sometimes practice intercropping with other crops when an emerging plant is scattered. However, the primary practice is monoculture. In Chench district, before planting they remove its sprouts and the two lengthy tips and divide the tuber into two or more pieces depending on its size. In contrast to this, in Jima Arjo district the common practice is planting the whole tuber. When the plant emerges, they practice cultivation and earthing up to

encourage the growth of more stems, to protect from weeds and to get more and bigger tubers. The crop matures and gets ready for use during September, once the tuber attains its maturity they harvest whenever the need arises for home consumption or selling. Maximum storage life is not more than two days in both study areas; while in situ or ground is the only available storage facility in the study area. The seed tuber used for planting purpose is harvested between April and May in both locations. The crop production trend has been decreasing over the last 10 years due to the shortage of land, lack of improved variety, replacement with Irish potato (in Chenchu district), lack of government attention, scarcity of seed tuber, lengthy maturity, low market demand, and price. Due to this fact, only 33.3% of growers in Chenchu district and 48.7% in Jima Arjo district have participated in the selling of the crop. Relatively, the crop fetches better price during the planting period (April-May) and lower price during peak production. In general, the crop fetches a lower price as compared to Irish potato across all the study areas. Because of the stated factors, the growers produce the crop on the small plot of land for home consumption.

In a sample, 82.9% of farmers in Ayira and 39.5% in Gimbi district have participated in the production of anchote. The growers produce the crop primarily for food. Besides food, they use the crop to get additional cash income, to reduce risk in case other crops fail, for its medicinal value, for its drought and disease resistance ability, and to conserve the plant and pass to the next generation. Most importantly, its cultural value is significant for the community. During the New Year and *Meskel* festival, anchote dishes are prepared and consumed first, whatever other delicious foods are on the table. In Gimbi, Ayira, Jima Arjo and Nekemte cities, anchote dishes are common in different restaurants and hotels. To sum up, the crop plays a vital role in generating cash income, cultural and medicinal values besides food source for the community.

Anchote requires highly fertile/manured land; due to this reason, they mostly prefer to grow around homestead because such land has enough manure and is fertile. In addition, its cultivation demands high labor, i.e. its operation is lengthy, time taking, and difficult to carry out activities fast. Moreover, since the crop is a single root system each individual plant needs attention. It is also difficult to transport and apply manure and produce on a large farm. Despite its benefits, the crop lacks attention from research and extensions. On top of this, wild animal attacks are also another constraint for less production of the crop in the study area. Lack of manure, scarcity of land, and

lack of fertile land were the major reasons for farmers in both study areas for not growing the crop.

The major sources of planting materials included own true seed savings, from friends/neighbors and purchasing from the market. Anchote can be propagated both vegetatively and from true seed; however, the main practice is via propagation of the true seed. Two local varieties of anchote (white and red) were identified in both study areas. The most important plant traits considered to choose the best performing local variety are drought and disease/pest resistance ability, maturity period, taste, tuber size, tuber color, cooking time, market demand and price. Of the two local varieties, owing to large tuber size, easy cooking, soft texture, less fiber content, good taste, better market demand and price, the white one is preferred most across all the study areas. It is often preferred for the preparation of cultural food during holiday and wedding ceremony. The red one is not palatable like that of a white one. They also select the viable true seed by looking into its size (larger size) and the seed that is not fragmented while pressing between thumb and pointing fingers.

The growers usually prepare the land two to three times between December and May and sow the seed between April and May. All interviewed growers in both study areas apply natural fertilizer (manure and compost). Cognizant to this, growers prefer to grow the crop close to the home garden where the cattle barn is located. The crop matures and gets ready for consumption during September. However, true seed harvesting extends between October and November. The poor and those who have small farmland might harvest the entire tuber and use the land for other crops production. An individual who has a curiosity for medicinal value, rich and owns large farmland might leave the tuber in the ground for two or more years. Alternatively, they harvest for home consumption when the need arises, during holiday and when the guest pays them a visit. The available storage facility in the study area is leaving in the ground and protecting from animals reach. Alternatively, they dig the ground and store there for two to three months without deterioration. This study highlights the need for proper storage technology to help the growers to use their land for other crop production and thereby improve their livelihood.

Anchote production trend is increasing over the past 10 years due to increasing awareness of growers about its benefits, better management practices, growing market demand and price, and

its high cultural and medicinal values. They usually sell the tuber during the start of the new year (September) and at various holiday time. In both study areas, anchote fetches a better price as compared to Irish potato. However, it needs more management as compared to other crops. Due to this fact, the growers allocate a small plot of land due to the difficulty to manage in the large farmland. In general, growers have a wealth of knowledge including site selection, land preparation, variety selection, planting, management, harvesting, storage, and processing. However, this study found that growers were following traditional management practices using unimproved local varieties.

# Chapter 5 Constraints of the Two Tuber Crops Production

## 5.1. Introduction

Production of the two crops was not without constraints. Despite the enormous merits and potential of these crops in supporting the livelihood of growers, limited research has been conducted on the constraints affecting these crops in the study area. Understanding the constraints that impede production of these crops is indispensable for further research that aimed to improve their production and productivity. In view of this, this study employed a dimensionality reduction method, the Principal Component Analysis (PCA) to identify the major production constraints of the two crops.

As indicated in Chapter Three, 25 constraints of the two crops production were presented to the respondents for scoring exercise during the survey period. Consequently, all production constraints were subjected to PCA. PCA is useful when the data is obtained on a number of observed variables, and believe that there is some redundancy in those variables (Jolliffe, 2002). PCA is a multivariate technique used to reduce the dimensionality of large datasets consisting of a large number of interrelated variables to retain as much as possible the variation present in the data set while increasing interpretability (Abdi & Williams, 2010; Jolliffe & Cadima, 2016). It was accomplished by transforming a number of possibly correlated variables into a smaller number and the new set of variables, called Principal Components (PCs), which are uncorrelated and ordered so that the first few retain most of the variation present in the original variables (Jolliffe, 2002; Richardson, 2009).

There are many rules for deciding how many PCs are going to be retained in order to account for most of the variation in the original variables (Pituch & Stevens, 2016). The first rule is choosing the number of PCs based on the cumulative percentage of the total variation (commonly between 70% and 90%) and retaining PCs accounted for (Jolliffe, 2002). The second rule is the scree graph and the log-eigenvalue diagram. The cumulative percentage of the total variation and scree graph and the log-eigenvalue in most cases involve a degree of subjectivity in the choice of cut-off levels. The scree graph is even more subjective because it involves looking at a plot and deciding which

value of the slopes of lines joining. The third rule is the number of components with unequal eigenvalues and other hypothesis testing procedures, known as Bartlett's test (Jolliffe, 2002). The fourth criterion is Kaiser (1960), which states retain only those factors having eigenvalues greater than 1. The Kaiser criteria have been shown to be reasonably accurate when the number of variables is  $< 30$  (Pituch & Stevens, 2016). Now, which criteria to be used in deciding the number of components to be retained was the researcher's major question. In the past, various scholars (Almaz et al., 2014; Yeshitila, 2007) used Eigenvalue greater than 1 criterion technique in data reduction. Following the footsteps of these scholars and the accuracy of the criteria, this study used Eigenvalue greater than 1 criterion for retaining the optimum number of components.

Then the researcher's next question was how many subsets of the original variables are going to be retained. Here, again there are different criteria for the selection of optimal subsets of the original variables, which is called principal variables (Jolliffe & Cadima, 2016). The component loadings are the correlations between the variables and the components. Since these are correlations, possible values range from -1 to +1. As a rule of thumb, component loadings more than 0.5 are considered strong, between 0.3 and 0.5 are acceptable and less than 0.3 are usually considered weak. Thus, those variables having component loadings less than 0.3 were rejected and variables with the component loadings greater than 0.3 were retained for further descriptive analysis.

## 5.2. *Plectranthus Edulis* Production Constraints

Applying the eigenvalue greater than 1 criterion, the first seven components were maintained for further analysis. As already stated in the previous section, the researcher was interested in keeping only those PCs having eigenvalues greater than 1. Table 31 shows the components and how much variation they explained in the data (their proportions). These PCs are uncorrelated; therefore, the first seven PCs explain the sum of the variances of the individual components, i.e. 72.4% of the total variance of the original data, while the remaining 17 components explain only about 27.6% of the variation in the data. This shows that the first seven components explained more than 17 last components.

Table 31 Explained variance by components for *Plectranthus edulis* constraints

Variables	Principal Components						
	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6	Comp7
Eigenvalues	7.43	2.70	2.02	1.86	1.18	1.11	1.05
Total variance explained (%)	30.97	11.27	8.43	7.77	4.93	4.64	4.38
Cumulative total variance explained (%)	30.97	42.24	50.67	58.44	63.37	68.01	72.39
Rho	0.7239						
Kaiser-Meyer-Olkin measure of sampling adequacy:	0.7708						

The value of the Kaiser-Meyer-Olkin (KMO), a measure of sampling adequacy, was 0.7708 (77.08%), indicating the presence of strong patterns of correlation among the selected variables, justifying the use of PCA for analysis. A large KMO value (greater than 0.5) indicates that correlations between pairs of components can be explained by the other variables in the index (Kaiser, 1974 quoted in Wineman, 2014). Therefore, the KMO coefficient justifies the component scores can be estimated, i.e. the sample of this study is adequate and no more or small correlations among the components. In other words, it shows that the sampling is adequate and hence justifies the use of PCA to provide significant reductions in the dimensionality of the data. Accordingly, out of 24 original constraints, 13 were found to be the major constraints. The descriptive results of the household perception toward the severity of these constraints are discussed below.

As shown in Table 32, though, the growers face similar production constraints across the two districts, the respondents' perception toward the severity of some constraints varied between the two districts. The highest proportion of growers, 74.7% in Chenchu and 70.3% in Jima Arjo district showed that lack of improved variety is a high constraint. The FGD participants in Chenchu district revealed that lack of improved variety is their major constraint. The growers have been using the local varieties for a long period; however, yet no endeavor of research has attempted to improve the crop. Lack of tuber seed was rated a high constraint by 36.6% of growers in Chenchu and 59.5% in Jima Arjo district. The FGD participants in Jima Arjo district showed that lack of seed tuber is their major constraint.

In Chenchu district, 81.7% of growers showed that lack of improved management skill is a high constraint; while 38.9% in Jima Arjo district reported lack of improved management skill is a medium constraint ( $P < 0.01$ ). The FGD participants in both locations agreed that lack of improved management skill is their constraint. Growers have been following indigenous management

practices, which have been passing from one generation to the other over the decades. Female-headed households in Chencha district mainly relied on hired labor. The explanation was that male family members migrated to Addis Ababa and other areas for weaving work locally called *shimena* and in search of other jobs. This constraint is probably tackled by giving training for farmers and creating awareness on how to properly manage their farmland and enhance production. The highest proportion of growers, 90.1% in Chencha and 91.9% in Jima Arjo district stated that lack of government attention (research and extension) is a high constraint. This shows that the severity of the constraint is equally important across the two study areas. The FGD participants in Chencha and Jima Arjo district showed that they have never received any training or advice related to the production of this crop. The key informant from the Agricultural and Rural Development Office in Chencha district also pointed out that lack of extension service is the major constraint in the study area. He added that, when compared with other crops, *P.edulis* has not been given due attention from research and extension; due to this fact its production is declining.

The vast majority of growers (88.7%) in Chencha district appraised lack of improved storage facility is a high constraint; while 40.5% of growers in Jima Arjo district rated medium constraint ( $P < 0.01$ ). The growers store the tuber by leaving in the field where it is grown until harvesting either for home consumption, market or seed tuber. In line with this, Yeshitila & Weibull (2012) noted that the land used to grow this crop remains idle until the next planting season. The FGD participants in Chencha district indicated that due to its high-water containing nature the tuber does not withstand disease or any adverse effect when stored for a long period. Hence, the tuber gets rot/decay in the short period once removed from the ground. They stated, “When we put the tuber on the sunlight it will get dry, or shadow area easily gets to sprout, this is a big problem”. Similarly, the FGD participants in Jima Arjo district showed that its hair-like structure gets to emerge when stored for a long period in the ground; added to that rot/decay and the emergence of sprouts are also a big problem. In general, this study highlights that lack of improved storage facility is one of the major constraints in the study area, which calls the need to improve its storage facility.

Table 32 Perception of growers on *Plectranthus edulis* production constraints

List of constraints	Constraint severity								$\chi^2$ -value
	Chencha district (N=71)				Jima Arjo district (N=37)				
	No constraint	Low	Medium	High	No constraint	Low	Medium	High	
Lack of improved varieties	9 (12.7)	8 (11.3)	1 (1.4)	53 (74.7)	10 (27.0)	0 (0.0)	1 (2.7)	26 (70.3)	7.3003
Lack of tuber seed	27 (38.0)	10 (14.1)	8 (11.3)	26 (36.6)	7 (18.9)	5 (13.5)	3 (8.1)	22 (59.5)	5.9205
Lack of management skill	2 (2.8)	7 (9.9)	4 (5.6)	58 (81.7)	14 (38.9)	5 (13.9)	14 (38.9)	3 (8.3)	59.3844***
Lack of government attention	4 (5.6)	3 (4.2)	0 (0.0)	64 (90.1)	0 (0.0)	1 (2.7)	2 (5.4)	34 (91.9)	6.0828
Lack of storage facilities	2 (2.8)	5 (7.0)	1 (1.4)	63 (88.7)	7 (18.9)	8 (21.6)	15 (40.5)	7 (18.9)	55.2968***
Shortage of land	13 (18.3)	27 (38.0)	15 (21.1)	16 (22.5)	2 (5.4)	5 (13.5)	10 (27.0)	20 (54.1)	15.4651***
Short shelf life	3 (4.2)	18 (25.4)	8 (11.3)	42 (59.2)	8 (21.6)	9 (24.3)	18 (48.7)	2 (5.4)	38.6049***
Long maturity	10 (14.1)	18 (25.4)	16 (22.5)	27 (38.0)	15 (41.7)	3 (8.3)	13 (36.1)	5 (13.9)	17.5823***
Displacement with other crops	11 (15.5)	18 (25.4)	12 (16.9)	30 (42.3)	14 (37.8)	10 (27.0)	6 (16.2)	7 (18.9)	79.1457**
Low market demand	11 (15.5)	13 (18.3)	10 (14.1)	37 (52.1)	5 (13.5)	3 (8.1)	9 (24.3)	20 (54.1)	3.2402
Low market price	12 (16.9)	10 (14.1)	11 (15.5)	38 (53.5)	6 (16.2)	1 (2.7)	13 (35.1)	17 (46.0)	7.5978
Long cooking time	19 (26.8)	23 (32.4)	24 (33.8)	5(7.0)	20 (54.1)	7 (18.9)	9 (24.3)	1 (2.7)	8.1476**
Presence of hairy structure	25 (35.2)	27 (38.0)	15 (21.1)	4 (5.6)	14 (37.8)	11 (29.7)	11 (29.7)	1 (2.7)	1.7217

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in parenthesis; \*\*\* p<0.01, \*\* p<0.05

In Jima Arjo district, 54.1% of growers indicated that shortage of land is a high constraint; while, 22.5% of growers in Chencha district showed that shortage of land is high constraint ( $P < 0.01$ ). The FGD participants in Chencha and Jima Arjo districts also revealed that shortage of land is their major constraint. The crop occupies the land for a long period after attaining its maturity. Due to population pressure and land fragmentation, land shortage poses a big challenge to the type of crops they grow, and the total area allocated to each crop (Yeshitila, 2007). Consequently, farmers shift to growing new root and tuber crop species that can give them more yield in a relatively shorter period. In addition, the FGD participants in Chencha district showed that its production demands high labor, particularly when virgin land/*gembo/itimo* is used. In Chencha district, 59.2% of growers showed that short shelf life is a high constraint, while 48.7% in Jima Arjo district reported that short shelf life is a low constraint ( $P < 0.01$ ). The FGD participants in Chencha district also agreed that short shelf life is a major constraint in the study area.

The FGD participants in Chencha district also reported that wildlife including monkeys, deer, rats, East African mole rats and porcupines in some cases destroy the whole plant. In addition to the wild animals identified in Chencha district, the FGD participants in Jima Arjo district reported that African wild pigs destroy the tuber. Among domestic animals, cattle, sheep, goat, and chicken are the major enemies of the crop that destroy with leg and eat both leaf and tuber. Growers are protecting domestic animals by making fences, herding, and tethering; and wild animal attacks by chasing/hunting, catching with traps particularly porcupine, guarding during the night, digging the spots and burning/killing East African mole rats. Putting camouflage/cartoon that looks human as a guard on a farm and putting on it fabric to keep away wild animals is also a common practice in the area. They also protect the crop from mold and decay by keeping the place clean and dry, reducing manure, avoiding late harvest or storing for a long period in the ground. In Jima Arjo district, the growers protect their farm by putting a cartoon or plastic bag in the farm that generates sound while the wind is blowing; smoking cattle horn and smearing soap in the cartoon to keep away porcupine. Sleeping overnight on a farm by making a hat locally called *godoo*. Common weeds that affect other crops also suppress and limit the growth of plants and thereby tuber development. Growers are protecting their farm from weeds through hand weeding and frequent cultivation.

The highest proportion of growers in Chencha district, 38.0% rated long maturity is a high constraint. In contrast, in Jima Arjo district, 41.7% of growers rated low and 36.1% medium constraint, which was statistically significant at 1% probability level in perceiving the severity of the constraint ( $P < 0.01$ ). The crop is produced once per year in both study areas; however, the farmers are producing other crops twice a year in Chencha district. The FGD participants in Chencha district agreed that long maturity is their major constraint because the plant takes 5 to 6 months to get mature and ready for harvest. In light of the fact that the crop occupies the land for a long period, farmers tended to shift to other crops production.

Displacement with other crops, particularly Irish potato, is another constraint in both locations. In Chencha district, 42.3% of growers showed that displacement with Irish potato is a high constraint, while 27.0% of growers in Jima Arjo district rated as low constraint. The FGD participants in Chencha district explained that due to the fact that its price is low, most farmers are shifting to grow other crops, particularly Irish potato. In line with this, Yeshitila & Temesgen (2016) reported displacement with other crops, limited research attention, and short shelf life as the reasons for the declining trend of root and tuber crops production. Lack of market demand was an equally important constraint of growers placed in both locations; more than half of the sampled respondents in both study areas indicated that lack of market demand was a high constraint. Similarly, 53.5% and 46.0% of growers in Chencha and in Jima Arjo district respectively showed that low market price is a high constraint. The FGD participants in both study areas acknowledged that lack of market demand and low price are the major constraints of its production.

In Chencha district, 33.8% of growers rated long cooking time as a medium constraint, while 24.3% of growers in Jima Arjo district revealed that long cooking time is a medium constraint. The FGD participants in Chencha district stated that, particularly between January and March, the tuber takes a long time while cooking. The other mentioned constraint was that the tuber does not stay for a long period in the belly after consumption, i.e. a person who consumes the tuber feels hungry after a short period. Some 21.1% of growers in Chencha and 29.7% in Jima Arjo district showed that the existence of hairy structures is a medium constraint. The FGD participants in Chencha district highlight that the tuber has poor table attraction due to the existence of hairy-like structure as compared to Irish potato. In this case, particularly children are not attracted to consume

it, due to this fact they call it locally *tshegurm dinich* (i.e. hairy potato in Amharic language). This constraint is probably lessened through breeding and selection of the best performing local varieties.

### 5.3. Anchote Production Constraints

The result of PCA shows that the first six components explained about 70.0% of the total variation of the original data, while the remaining 16 components explain only about 30.0% of the variation in the data (Table 33). This means that the first six components explained more than 16 last components. Hence, applying the Eigenvalue greater than 1 criterion, the first six components were maintained for further PCA to capture the most accurate information on the data set.

Table 33 Explained variance by components

Variables	Principal components					
	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6
Eigenvalues	7.37	2.18	1.86	1.45	1.40	1.16
Total variance explained (%)	33.49	9.89	8.47	6.58	6.33	5.24
Cumulative total variance explained (%)	33.49	43.38	51.85	58.43	64.76	70.01
Rho	0.7001					
Kaiser-Meyer-Olkin measure of sampling adequacy: 0.7909						

The value of the Kaiser-Meyer-Olkin (KMO), a measure of sampling adequacy was 0.7909 (79.09%), indicating the presence of strong patterns of correlation among the selected variables, justifying the use of PCA for analysis. A large KMO (greater than 0.5) coefficient justifies the component scores can be estimated, i.e. the sample of this study is adequate and no more or small correlations among the components. In other words, it shows that the sampling is adequate and hence justifies the use of PCA to provide significant reductions in the dimensionality of the data. Accordingly, out of 22 original constraints, 10 were found to be the major constraints. These constraints include lack of improved variety, lack of government attention, lack of storage facility, shortage of land, high labor demand, short shelf life, diseases, wild animal, long maturity and long cooking time (Table 34). Hence, the subsequent paragraphs explain the perception of growers about the severity of identified constraints.

The highest proportion of growers, 71.1% and 43.1% in Gimbi and Ayira districts, respectively demonstrated that lack of improved variety is a high constraint ( $P < 0.01$ ). The FGD participants in Gimbi district indicated that lack of improved seed variety is the major constraint. In Gimbi and

Ayira district, 51.1% and 75.9% of growers, respectively, stated that lack of government attention (research and extension) is a high constraint. The severity of the constraint was statistically significantly high at 5% probability level in Ayira district. The FGD participants in Gimbi and Ayira district showed that lack of government attention is their major constraint, for instance, they mentioned that when they apply chemical fertilizer its leaf falls down and the tuber development becomes dormant. This was probably due to lack of optimum level of fertilizer application. By and large, there is no extension package or expert advice in relation to anchote production, if there is any, it is an individual workers' effort. In this regard, Dandena (2010); IBC (2012) noted that so far, there has been no improved variety and developed agronomic practices of the crop, due to this fact the crop does not figure very prominently in modern crop research and receives no attention.

In Gimbi district, 31.1% of growers rated that lack of improved storage facility a medium constraint. Similarly, in Ayira district, 12.1% of growers revealed that lack of improved storage facility is a high constraint. They showed that Irish potato can be stored up to 4 months at home. On top of that, once Irish potato has achieved its maturity, it is conceivable to harvest as a whole and utilize the land for other crop production. Nevertheless, anchote does not leave the land for other crop production, in light of the fact that the tuber is stored in the ground for a long period. In addition, its production is laborers/tiresome compared with Irish potato. What is more, Irish potato does not require much water like that of anchote. They revealed that in the event that they plant Irish potato during October, the tuber gets mature after four months, during this time there is not much water.

Table 34 Severity of anchote production constraints

List of constraints	Constraint severity (N=103)								$\chi^2$ -value
	Gimbi district				Ayira district				
	No constraint	Low	Medium	High	No constraint	Low	Medium	High	
Lack of improved varieties	5 (11.1)	2 (4.4)	6 (13.3)	32 (71.1)	28 (48.3)	2 (3.5)	3 (5.2)	25 (43.1)	16.512***
Lack of Government attention	6 (13.3)	7 (15.6)	9 (20.0)	23 (51.1)	7 (12.1)	4 (6.9)	3 (5.2)	44 (75.9)	8.980**
Lack of storage facilities	12 (26.7)	18 (40.0)	14 (31.1)	1 (2.2)	34 (58.6)	12 (20.7)	5 (8.6)	7 (12.1)	19.149***
Shortage of land	3 (6.7)	7 (15.6)	10 (22.2)	25 (55.6)	30 (51.7)	8 (13.8)	15 (25.9)	5 (8.6)	35.414***
Demands high labor	9 (20.0)	4 (8.9)	16 (35.6)	16 (35.6)	44 (75.9)	1 (1.7)	8 (13.8)	5 (8.6)	32.214***
Short shelf life	13 (28.9)	7 (15.6)	11 (24.4)	14 (31.1)	35 (60.3)	9 (15.5)	1 (1.7)	13 (22.4)	17.339***
Diseases problem	9 (20.0)	19 (42.2)	17 (37.8)	0 (0.0)	43 (74.1)	10 (17.2)	4 (6.9)	1 (1.7)	32.956***
Wild animals	4 (4.4)	14 (31.1)	14 (31.1)	15 (33.3)	19 (33.3)	18 (31.6)	8 (14.0)	12 (21.1)	15.028***
Long maturity	9 (20.0)	18 (40.0)	16 (35.6)	2 (4.4)	20 (35.1)	13 (22.8)	10 (17.5)	14 (24.6)	14.148***
Long cooking time	18 (40.0)	15 (33.3)	11 (24.4)	2 (2.2)	33 (56.9)	15 (25.9)	4 (6.9)	6 (10.3)	9.765**

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in paranthesis; \*\*\* p<0.01, \*\* p<0.05

In Gimbi district, 55.6% showed that shortage of land was a significantly high constraint, while only 25.9% in Ayira district indicated that shortage of land is a medium constraint. This highlighted that the severity of the constraint was higher in Gimbi than in Ayira district. This was presumably because of the advantage of market access, better demand and price, growers in Gimbi district tended to produce more. Consequently, they need more land for anchote and other crops production, and thereby face a shortage of land. The FGD participants in Gimbi and Ayira districts indicated that shortage of land is the major constraint. The reason was because of increasing population size the available land was shared between family members, hence individual holding is reduced. Moreover, the crop requires highly fertile land and the land that is out of reach of human and animal contact. The FGD participants in both districts uncovered that termite expansion is a major constraint that destroys the growers' crop farms. They further highlight that soil erosion and sharing farmland among family members were the main reasons for the declining trend of their farmland.

In Gimbi district, 35.6% of growers rated high labor demand is a high constraint; while only 13.8% of growers in Ayira district showed that high labor demand is a high constraint, which was statistically significant at 1% probability level. The FGD participants in Gimbi and Ayira districts agreed that production of anchote demands high labor, unlike other crop production. The crop needs timely weeding and cultivation, otherwise, it cannot give better yield. Short shelf life is another constraint that affects the growers' tuber production. In Gimbi and Ayira districts, 31.1% and 22.4% of growers, respectively indicated that short shelf life is a high constraint.

In Gimbi district, 42.2% and 37.8% of growers appraised the disease as low and medium constraints, respectively. While, 17.2% and 6.9% of growers in Ayira district rated the disease as low and medium constraints, respectively. The growers repeatedly mentioned cholera as a major disease that affects the leaf part of the crop. A study conducted by Masarat (2018) revealed that anchote is not seriously attacked by disease or pests, but fruit decay results prematurely due to certain kinds of wasp and fruit fly. In agreement with the present findings, the author further uncovered that cholera (*Vibrio cholera*) has an effect on the mother plant that results prematurely falling down of fruit.

Growers located in both study areas showed that wild animals are their major constraint. In Gimbi and Ayira district, 95.6% and 66.7% of growers, respectively rated wild animals from low to high constraints. The FGD participants in both study areas asserted that since they use the farm to store the tuber, wild animal attack is particularly severe. These animals included monkeys, deer, porcupines, and gazelle feed and destroy both the leaves and the tuber. The growers protect their farm from porcupine by hunting, making the fence, catching using trap and killing, closing its hole with soil, chasing with the dog and applying cow dung. Farmers usually plant the crop near dwelling areas; thus they ensure the tuber by fencing and guarding at night (Abera, 1995). Domestic animals including cattle, sheep, goat, and donkey also feed and destroy the tuber and leaf. The growers protect these animals from getting access to the farm by making fences with thorny woods, herding, tethering, and covering the farm with maize and sorghum straw. They additionally ensure by placing cartoon on the farm that resembles humans and making something on it that is ready to deliver sound. Rats and worms destroy the seed and tubers, birds and weevils destroy the seed, while termite destroys both the leaf and the tuber. This highlights that the seed requires high care. They secure the true seed by treating with ash and save in equipment that has a tight cover and put it out of reach of rats. They also protect from rats using cat or suspend it on the pole. They protect the seed from weevils by applying anti-weevil chemicals, and from worms using pesticides and ash.

The common weeds also suppress and limit the plant growth and thereby the development of the tuber. They emphasized that weeds are a high constraint in light of the fact that there are no other means to protect the plant other than hand weeding. This was also one reason for citing high labor demand as a major constraint. Long maturity is another constraint that influences crop production in both locations. In Gimbi and Ayira district, 80% and 77.2% of growers, respectively rated long maturity from low to high constraint. The FGD participants in both study areas agreed that the tuber stored in the ground after attaining its maturity, hence, occupies the land for a long period. Here, it is not because of its lengthy maturity, but after attaining its maturity and gets ready for harvest, they use the land for storage. The highest proportion of growers, 60% in Gimbi and 43.1% in Ayira district rated long cooking time from low to high constraint. Apart from lengthy times, the tuber consumes high energy while cooking, this will also have a negative impact on the vegetation, as the farmers' main energy source is firewood in the area.

## 5.4. Summary

Production of the two tuber crops was not without constraints. Hence, this study uncovered the major production constraints of the two tuber crops employing PCA. Accordingly, out of 24 original *P. edulis* production constraints 13 were identified as major constraints. The major *P. edulis* production constraints included lack of improved variety, lack of tuber seed, lack of improved management skills, lack of government attention, lack of improved storage facility, shortage of land, short shelf life, long maturity, displacement with other crops, lack of market demand, low price, long cooking time, and too much hairy structure were their major constraints. Similarly, out of 22 original anchote production constraints, 10 were found to be the most important constraints. These constraints included lack of improved variety, lack of government attention, lack of storage facility, shortage of land, high labor demand, short shelf life, diseases, wild animal, long maturity and long cooking time. Growers have ample indigenous knowledge of wild animal protection mechanisms across all the study areas. Hence, the concerned stakeholders need to prioritize the identified constraints according to their importance and tackle them accordingly.

# Chapter 6 Contribution of the Two Tuber Crops to the Household Food Security

## 6.1. Introduction

The two crops are native to Ethiopia and are important tuber crops widely cultivated for their food values in southwestern parts of Ethiopia. Though Ethiopia has abundant agricultural resources, it is found under the list of the most food insecure countries in the world. Hence, diversification away from overreliance on staples should be one important option in achieving food security of the country. Among the other, utilization of untapped tuber crops will help to that end. In view of this, the current study employed MFI to determine the household food security status and binary logit regression model to identify the determinants of the household food security; and thereby the impact of the two tuber crops to the household food security. The remaining sections present the food security status of the household, sources of food, the relationship of the household food security status and their characteristics, determinants of the household food security, growers' perception about the contribution of these crops to the household food security, and coping strategies of the household during food shortage period.

## 6.2. Contribution of *Plectranthus Edulis* to the Household Food Security

### 6.2.1. Household Food Security Status

This section presents the food security status of the household that was obtained following the algorithmic classification guidelines developed by Maxwell and his colleagues. This guideline categorizes the household food security status into four namely food secure, mildly food insecure, moderately food insecure and severely food insecure. Later the first two categories were converted to food secure and the latter two to food insecure for ease of presentation. Accordingly, among the sampled households 66.4% in Chench district were food secure and 33.6% were food insecure; similarly, in Jima Arjo district 82.1% were food secure and 17.9% were food insecure (Table 35). The prevalence of food insecurity was higher in Chench district than in Jima Arjo district ( $p < 0.01$ ). The livelihood in Chench district is *enset* based (culturally the staple food is *enset*). This is probably the reason for the lower proportion of the household categorization under food secure in Chench district, as the MFI tries to capture all dimensions of food security. The information obtained from the case study respondent in Chench district also testified that the food

habits of the community mainly rely on *enset* (Box 1). The other was attributed to a shortage of land and lack of non-farm job opportunities, which may cause the decline of food availability and the inability of the household to access food.

Table 35 Multidimensional household food security status (N=250)

MD food security category	Chencha	Jima Arjo	Overall total	$\chi^2$ -value
Food secure	3 (1.9)	11 (11.6)	14 (5.6)	15.3295***
Mildly food insecure	100 (64.5)	67 (70.5)	167 (66.8)	
Moderately food insecure	46 (29.7)	15 (15.8)	61 (24.4)	
Severely food insecure	6 (3.9)	2 (2.1)	8 (3.2)	
Binary category of the household food security status				
Food secure	103 (66.4)	78 (82.1)	181(72.4)	7.2227***
Food insecure	52 (33.6)	17 (17.9)	69 (27.6)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in paranthesis; \*\*\* p<0.01

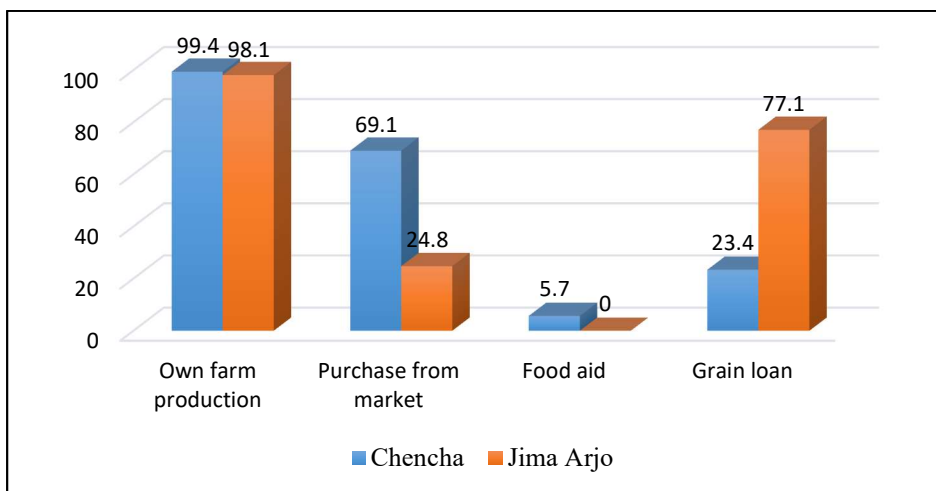
Those food secure households experienced none of the food insecure conditions, i.e. in terms of quantity, quality/diversity, acceptability/preferences, safety, and stability of food. Whereas food insecure households experienced one or more food insecurity conditions. According to Owino et al. (2014) in reality if one is food insecure mean one had difficulty accessing food, may not have had adequate food stored or may not have had a good harvest. A recent study conducted by Guyu (2015) in Benishangul-gumuz regional State showed the existence of green famine conditions in the area. He further indicated that despite favorable natural conditions such as climate, low population pressure, and less resource degradation, the green famine belt of Ethiopia including Benishangul-gumuz regional State, remotest areas of Oromia region such as Wollega and Illubabur, and Gambella region) had a substantial food insecurity condition. On the other account, Maxwell et al. (2014) indicated that the algorithmic methodology used to determine the HFIAS categories leads to a high estimate of food insecurity. The authors further indicated that even a single occurrence of certain experiences can put a household into a more severely food insecure category. This is likely part of the reason for the higher prevalence estimates. This is another explanation shared by the findings of this study for low estimates of food secure households. Another study conducted by Hana & Dereje (2016) in Girar Jarso district found out that 37.5% of the studied households were food insecure, which was closely related to the current findings in Chencha district.

The study conducted in Boset district by Getachew and his colleagues showed that 26.5%, 21.7%,

and 41.3% of households were highly food insecure using Months of Adequate Household Food Provisioning (MAHFP), HFIAS, and HDDS, respectively (Getachew et al., 2018), which was slightly similar to MAHFP and HDDS results. In consistent with the survey results, the key informants and FGD participants all indicated that food insecurity occurs on a seasonal basis. The FGD participants in both districts expressed that the severe food shortage period experienced by the households extends from May to November. This finding highlights that mechanisms need to be designed like non-farm income-generating opportunities and modern agricultural technology adoption to enhance farm output to help households get access to enough food.

Due to the fact that one source of food is not adequate to feed the whole family members throughout the year, in both study areas the households have various sources of food for their consumption. As indicated in Figure 8, across the two study areas, almost all sampled households major source of food was their own farm production. The highest share of the source of food from their own farm production was due to the fact that the households were entirely engaged in farming activities. In Chencha district, purchasing from the market is the second most important source of food, followed by borrowing food crops from relatives/neighbors to pay back from later day harvest, and food aid (i.e. safety net and NGO support) provide a minor contribution.

Figure 8 Household major sources of food in *Plectranthus edulis* growing area



Unlike Chencha district, in Jima Arjo district grain loan from relatives/neighbors is the second most important source of household food followed by purchasing from the market. Grain loan during the deficit period is one of the major social capitals known in the study community, particularly in Jima Arjo district. In agreement with the current findings, Furgasa & Degefa (2016)

recounted that own farm production is the number one source of food for the majority of households. The research conducted in Benishangul-gumuz regional State by Guyu also reported similar sources of household food (Guyu, 2015). The respondents were asked to disclose the number of months they were able to cover from their own farm production. As shown in Table 36, the households cannot feed their members on average for more than 4.5 and 9 months from their own farm production in Chench a and Jima Arjo districts, respectively. In Jima Arjo district, households are able to cover their food demand about 2 times more months than their counterpart in Chench a district ( $P<0.01$ ). This highlights that households in Jima Arjo district produce more food from their own farm, and are able to feed their household, in other words more food deficit is occurring in Chench a district.

Table 36 Number of months the household consumes from their own produce by district (N=250)

	Chench a	Jima Arjo	t-value
Average months	155 (4.5)	94 (9.0)	-10.7656***

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with mean in paranthesis; \*\*\*  $p<0.01$

The respondents were also asked to assess the households' annual food requirement meeting from their own farm production during the year. As shown in Table 37, 21.3% of the sampled households in Chench a district reported that they could meet their household annual food requirements from their own farm production, while more than three-fourths reported that they could not meet their household annual food requirements from their own farm production. In contrast to Chench a district, 72.6% of the sampled respondents in Jima Arjo district reported that they could meet their household annual food requirement from their own farm production, while the rest 27.4% reported that they could not meet their household annual food requirement from their own farm production. This highlights that more food deficits were faced by the households in Chench a than in Jima Arjo district ( $P<0.01$ ). They fill the food shortage gap through purchasing from the market, borrowing grain from relatives/neighbors, and food aid in Chench a district in particular.

Table 37 Household annual food requirements meeting from their own farm production

Household perception	Plectranthus edulis growing area (N=250)		$\chi^2$ -value
	Chench a	Jima Arjo	
Yes	33 (21.3)	69 (72.6)	64.2786***
No	122 (78.7)	26 (27.4)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in paranthesis; \*\*\*  $p<0.01$

The non-farm income that would help them cover the food shortage gap in Chench district mainly comes from weaving and remittance. Commonly farmers were displaying the traditional cloth for sale on the roadside on the market day. Women contributed a significant amount of income share in Chench district. This was mainly due to the high proportion of female household heads found in Chench district because of migration of males to different parts of the country in search of jobs. Similarly, FGD participants in Jima Arjo district identified six different sources of income. The major sources of income were livestock and livestock products, followed by coffee, crop, khat, trade, fruits, and vegetables. Here, relatively farmers in Jima Arjo district have limited non-farm opportunities than their counterparts in Chench district. In this regard, Mesay (2008) shows that non-agricultural economic activities are important income sources that enable rural households to cope with limited food and cash resources at their disposal.

### 6.2.2. Relationship between Food Security and Household Characteristics

Table 38 shows the distribution of the food security status of the sampled households by their characteristics. The results of the descriptive statistics showed that nine explanatory variables have statistically significant relationships with household food security status. The results revealed that food secure and food insecure household groups have a statistically significant difference with respect to the mean age of the household head at 1% probability level. The age of food secure households was on average 49.5 years while the food insecure average age was 43.9 years. This highlights that the age of food secure households was higher than food insecure ones. Among the food secure households, 53.2% were literate and 46.8% were illiterate, while 38.5% of food insecure households were literate and 61.5% were illiterate ( $P < 0.01$ ). Food secure households on average produced 12.9 quintals of crop, while food insecure households produced on average 6.9 quintals of crop. This shows that those households who produced more quintals of crop from their own farms were more food secure than those households who produced less, which was statistically significant at 1% probability level. Those households who owned more livestock (4.3 TLU) were more food secure (at  $p < 0.01$ ) than those households who owned relatively less livestock (3.0 TLU). Among the sampled households those who have high social capital (3.1 score) were food insecure, while those households who have low social capital (2.9 score) were food secure, which was significant at 5% probability level.

Table 38 Relationship between the household food security status and their characteristics

Variables	Measurement	Household food security status (N=250)		$\chi^2$ -value/t-test
		Food secure	Food insecure	
Age of household head	Years	49.5±1.1	43.9±1.6	-2.7725***
Gender of the household head	Female	60 (33.2)	30 (43.5)	2.3133
	Male	121 (66.9)	39 (56.5)	
Education of the household head	Illiterate	66 (46.8)	67 (61.5)	5.3061***
	Literate	75 (53.2)	42 (38.5)	
Total family size	Number	5.5±0.2	5.6±0.3	0.4772
Annual total crop harvested	Quintal	12.9±0.7	6.9±0.4	-4.9363***
Ownership of cash saving account	No	115 (63.5)	51 (73.9)	2.4112
	Yes	66 (36.5)	18 (26.1)	
Technology adoption	Non-adopter	11 (6.2)	7 (10.1)	1.1571
	Adopter	167 (93.8)	62 (89.9)	
Growing P.edulis	Non-growers	84 (59.6)	59 (54.1)	0.7448
	Growers	57 (40.4)	50 (45.9)	
Tropical Livestock Unit	TLU	4.3±0.3	3.0±0.3	-2.7184***
Social capital	Score	2.9±0.1	3.1±0.1	2.0657**
Engagement in off-farm activities	No	33 (23.4)	41 (37.6)	5.9574***
	Yes	108 (76.6)	68 (62.4)	
Dependency ratio	Ratio	1.1±0.1	1.2±0.1	1.0436
Market distance	Hour	0.73±0.03	0.83±0.1	1.0436
Farmland size	ha	0.8±0.1	0.5±0.05	-3.6788***
Annual income	ETB	6408.9±482.5	3393.6±441.1	-3.6406***
Location of the study area	Chencha	103 (56.9)	52 (75.4)	7.2227***
	Jima Arjo	78 (43.1)	17 (24.6)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in paranthesis & mean with SE; \*\*\* p<0.01; \*\* p<0.05

Engagement in off-farm income-generating activity is one means of income source for the farming community. Among the food secure households, 76.6% and 23.4% were those who engaged and were not engaged in off-farm activities, respectively (p<0.01). This shows that those households who engaged in off-farm income-generating activities were more food secure than those who did not participate. Farmland size owned by the household is the most important factor that determines the status of the farming household food security. Relatively, those households owned on average more farmland size (0.8ha) were food secure (p<0.01) than those households who owned small farmland size (0.5ha). The total annual income earned by the household (from on-farm and off-farm) was another important variable that had a significant relationship with household food security. Relatively, those households earned on average more income annually (6408.9 ETB) were more food secure (p<0.01) than those households with a low annual income (3393.6 ETB). The location of the study also had a significant impact on the sampled household food security status at 1% probability level. This shows that those households found in Jima Arjo district were more food secure than their counterparts in Chencha district. However, there was no noticeable

difference in the food security status of the household by total family size, ownership of cash saving account, technology adoption, growing *P.edulis*, dependency ratio, and market distance. The following section presents the outputs of the binary logit regression model.

### 6.2.3. Parameter Estimates of Determinants of Household Food Security

The binary logit regression model was employed to identify the determinants of the household food security, and thereby the impact of *P.edulis* on household food security. In this study, both coefficients and marginal effects were employed. Coefficients were used to understand how changes in predictor variables explain changes in response variable while marginal effects were used to estimate the effect of a unit change in each independent variable on the probability of being food secure, being all other variables held constant. The log-likelihood ratio chi-square of 86.26 with a  $p < 0.0000$  indicates that at least one of the parameters of the determinants of the household food security included in the model is significant. This is an overall model test that doesn't ensure every independent variable is significant (Table 39).

The existence of multicollinearity among predictor variables was checked using VCE and VIF before fitting the logit regression model. The results of VCE coefficients of discrete predictor variables fitted into the model were less than 0.75, applying the rule of thumb the value suggests that multicollinearity was not a serious concern. Similarly, the values of VIF for each continuous explanatory variable were less than ten, applying the rule of thumb the value suggests that there was no multicollinearity problem among continuous predictor variables. From the classification table, the sensitivity and specificity result indicated that 88.8% of food secure and 56.5% of food insecure households were correctly classified in their respective categories. In general, the model is classified overall 79.8% of the data correctly (Annex 7). The Hosmer-Lemshow test statistic was used to assess the goodness of fit of the model to the data. The Hosmer and Lemeshow chi-squared value was 5.87 with a p-value of 0.6621, the insignificant value suggests that the model estimates did fit the data well and explained much of the variance in the dependent variable. Cronbach's alpha coefficient was used to assess the internal consistency reliability of the data and the value of 0.5673 was obtained. Applying the rule of thumb, the Cronbach alpha coefficient suggests that about 56.7% of the data used in the study has good internal consistency reliability. In general, the goodness-of-fit assessment of the logit regression model implied that the model fits the data well.

The variables assumed to have an influence on household food security were subjected to the logit model. Accordingly, out of sixteen predictor variables hypothesized to influence the household food security, seven were found to be statistically significant. Table 39 presents the model outputs and the marginal effects of each predictor variable that are fitted into the model. The maximum likelihood estimates of the logit regression model showed that location of the study area, age of the household head, total crop production, livestock ownership (TLU), farmland size, total annual income, and engagement of household head in off-farm income-generating activities were theoretically consistent and statistically significant in determining the household food security. In agreement with the current findings, Amsalu et al. (2013) conducted the research in Shashemene district, Oromia Regional State, Ethiopia and analysed the determinants of the household food security using the logit regression model and revealed that family size, farmland size, annual income, off-farm income, and livestock ownership were significant in influencing household food security status. Similarly, a study conducted in Ghana using the binary logit model showed that an increase in household income and an increase in the quantity of their own farm production improved the food security status of farming households (Kuwornu et al., 2010). Furgasa & Degefa (2016) also pointed out that the nature of the main causes of Ethiopian food insecurity directly or indirectly laid their roots in environmental, demographic, economic, social, technological, infrastructural, and/or political aspects of the country.

However, holding all other variables constant, the coefficients of the gender of the household head, education level of the household head, total family size, ownership of cash savings account, technology adoption, growing *P.edulis*, social capital, dependency ratio, and market distance were statistically insignificant in determining the household food security. The interpretation and possible explanations of the significant variables in the model are discussed below.

#### Location (district) of the study area

The location was hypothesized to have a significant impact on household food security. In consistent with priori expectation, households' food security status was statistically significantly varied between the two districts at 1% probability level. The value of marginal effect showed that holding all other variables constant being in Jima Arjo district increases the probability of the household being food secure by 0.21. The probable explanation is that there is a variation in the size of farmland between Chenchu and Jima Arjo district. In Jima Arjo district, the mean farmland

holding was greater than in Chenchu district, which translates to more crop production by the household and hence increases the household food security. Most importantly, there is a clear variation between the two districts in terms of livelihood and culture of the people, in Chenchu district their livelihood is based on *enset*, migration is very high, and weaving is the major non-farm sources of income. Whereas in Jima Arjo district, the livelihood of the farmer is based on staple crops and coffee is the main source of cash income.

#### Age of the household head

Age of the household head was hypothesized to have a positive effect on the household food security, in agreement with a priori expectation the output of the logit regression showed that the variable had positive and significant ( $p < 0.01$ ) impact on the household food security. The value of the marginal effect implies that if the age of the household head increases by one year *ceteris paribus* the probability of the household being food secure increase by 0.004. The study conducted in Gamo Gofa zone showed that younger farm households cannot get enough land to support their livelihood compared to the older farm households (Fassil & Elias, 2016). An empirical analysis by Jemal & Kim (2014) also reported a significant positive influence of the age of the household head on the household food security.

#### Total crop production

In concurrence with earlier speculation, the estimated coefficient of the households' total crop production from own farm showed a positive and significant relationship with the household food security at 1% probability level. The positive sign of the variable revealed that the higher the output levels of the household crop production, the greater the likelihood of being food secure. Households whose own annual crop production was high were likely to be food secure relative to those who produced low. The marginal effect indicated that if the household crop production increase by one unit (1 quintal) annually the probability of the household being food secure increase by 0.015. This finding was in agreement with various scholars, who found a significant and positive relationship between their own food production and household food security (Kuwornu et al., 2010; Mekuanent et al., 2014).

Table 39 Parameter estimates of the binary logit model with their marginal effects

Explanatory variables	Plectranthus edulis growing area (N=250)		
	Coefficients	Std. Err.	Marginal effects
Woreda	1.9838***	0.6435	0.2126***
Age	0.0327***	0.0131	0.0040***
Gender of the household head	-0.3932	0.4471	-0.0458
Education level of the household head	0.0658	0.1785	0.0080
Total family size	-0.1180	0.0912	-0.0143
Total crop production	0.1243***	0.0369	0.0151***
Owing a cash saving account	0.3847	0.4050	0.0446
Technology adoption	0.3485	0.6714	0.0468
Growing P.edulis	0.1690	0.3647	0.0203
Total livestock owned (TLU)	0.1385*	0.0753	0.0168*
Social capital	-0.1605	0.3081	-0.0194
Engagement of HH in off-farm activity	0.8128*	0.4844	0.1109
Dependency ratio	-0.1708	0.1885	-0.0206
Market access	-0.6033	0.3706	-0.0729
Farmland size	1.2623***	0.4133	0.1526***
Total annual income	0.0002***	0.0001	0.00002***
Constant	-3.6872***	1.2060	
LR chi2(16)	86.26		
Prob > chi2	0.0000***		
Pseudo R <sup>2</sup>	0.2948		

Source: Survey data (2017); N=total number of respondents; \*\*\*, \*significant at 1% and 10%, respectively.

#### Livestock ownership (TLU)

The number of livestock owned by the household was expected to have a positive relationship with the household food security; consistent with priori expectation the number of TLU owned by the household was positive and significant (at  $p < 0.10$ ) in influencing the household food security. Livestock is an important source of income, food, draught power, and manure to improve soil fertility. The result of the marginal effect indicated that holding all other variables constant, a one-unit increase in TLU increases the probability of the household being food secure by 0.017. This indicates that households with more livestock produce more milk, milk products, and meat for direct consumption. In addition, households can have a better chance of earning more income from selling livestock and their by-products that enable them to purchase farm inputs. The findings of this study was in agreement with various scholars position Abera et al. (2011); Fekadu (2010); Jemal & Kim (2014); Mekuanent et al. (2014), which found significant and positive relationship between livestock asset endowments and the household food security implying that the more livestock a household has the better the food security. Taking this into account, farmers should be encouraged to engage in livestock production through the provision of improved management practice, breeds, veterinary service and feeds to improve production and productivity of the sector,

this will ultimately ensure the household food security status.

#### Engagement of household heads in off-farm income-generating activities

Engagement of the household head in off-farm income-generating activity was hypothesized to have a positive impact on household food security. In line with priori expectations, its coefficient was positive and significant at 10% probability level. The probable account was that those households who are engaged in an off-farm activity are endowed with additional income and are more likely to be food secure than those household heads who did not engage in an off-farm activity. This could be anticipated due to the fact that participation in off-farm increases the household income, whereby increase access to food. The value of the marginal effect showed that keeping all other variables constant, participation in off-farm activity increases the probability of the household being food secure by 0.11. The available off-farm opportunities in Chenchu district include weaving, petty trade, selling firewood, daily labor, remittance, and local beverages. Gautam & Andersen (2016) showed that diversification to off-farm livelihood strategies rather than relying only on subsistence farming enables households to have better incomes, enhance food security and increase agricultural production by smoothing capital constraints. In concurrence with this finding Abera et al. (2011); Mekuanent et al. (2014); Shumiye (2007); Jemal & Kim (2014) reported a positive and significant effect of off-farm activities on the household food security in rural areas. This finding is therefore consistent with the theory and past empirical findings.

In light of food security, the nature of the constraint the household encounters in the course of its food production is an important indicator of the likelihood of a household's vulnerability to food shortage sooner or later (Furgasa & Degefa, 2016). Keeping this in mind, the sampled households were asked to identify the major constraints of food crop production. Accordingly, they pinpointed a shortage of farmland, change of weather conditions, loss of soil fertility/erosion, low productivity, and wild animal (like a *porcupine*) as the major constraints of crop production. Similarly, they identified a shortage of grazing land, shortage of animal feed, lack of improved animal breeds and livestock disease as the major constraint of livestock production. In line with the current findings, the study conducted in Becho Woreda, Central Oromia, Ethiopia by Furgasa & Degefa (2016) identified high fertilizer price, shortage of farmland, poor soil fertility, lack of oxen, lack of grazing land, crop disease and insect pests, and lack of improved seed supply were the major constraints of food production among the study households. In Jima Arjo district, the

stated bottlenecks that affect the household heads to access off-farm were included lack of capital to engage in trade, lack of road, lack of skill and job opportunities other than agriculture, and undermining other jobs. Therefore, this finding highlights that any effort that aims to improve households' non/off-farm income earning opportunities should have to consider tackling the mentioned bottlenecks.

#### Farmland size

Farmland size was hypothesized to have a positive influence on household food security. In agreement with the hypothesis, the model result reveals that the farmland size, as a basic input in farming was significant at 1% probability level and had a positive influence on the household food security. The implication is that the probabilities of being food secure increases with increasing farm size. This shows that the household with large farmland produce more food for household consumption and market and have a better chance to be food secure than those households having small farmland. Various scholars Getachew et al. (2018); Haile et al. (2005); Jemal & Kim (2014) indicated that farmland size positively affects the food security status of the households. This is due to the fact that food production can be increased extensively through the expansion of areas under cultivation (Furgasa & Degefa, 2016). The result of the marginal effect indicated that holding all other variables constant, an increase in 1 ha of farmland increases the probability of the household being food secure by 0.15. This finding was consistent with the findings of Fekadu (2010); Mekuanent et al. (2014); Shumiye (2007), which indicated that the size of farmland is a proxy for a host of factors including wealth, access to credit, the capacity to bear risk and income. Large farmland size is associated with greater wealth, income and increased the availability of capital, which may help them purchase farm inputs to increase food production and thereby ensure food security. In both study areas, the farmers repeatedly cited a shortage of farmland as the major constraints that affect household food security due to population pressure and loss of soil fertility. Degefa (2005) indicated that not only the size of landholdings but also the quality of land affects the type and amount of crop produced by rural households. This, in turn, affects the household's level of food security. Hence, this study suggests that the government, research, and other stakeholders should give proper attention to the provision of yield-increasing inputs (fertilizer, improved seed, etc.) to enhance production and productivity of the available farmland.

### Total annual income

Total annual farm income was hypothesized to have a positive influence on household food security. In consistent with the hypothesis, its coefficient came out to be positive and significant at 1% probability level. The possible explanation is that those farmers who have better access to different types of on-farm and off-farm income are less likely to become food insecure than those households who have little access. Income enables households to modernize their production by giving them an opportunity to buy the necessary inputs and reduce the risk of food shortages during periods of unexpected crop failures through purchases (Wali & Janekarnkij, 2013). The value of the marginal effect implies if the household annual income increases by one ETB, holding all other variables constant the probability of the household being food secure increases by 0.000018, though is negligible. This result was consistent with Kuwornu et al. (2010); Getachew et al. (2018); Ayalneh & Abebaw (2009) who revealed a positive and significant relationship between household income and food security. The major sources of household income in Chencha district came from both on-farm and off-farm sources including crop, livestock and livestock products, weaving, and daily labor. In addition, remittance, petty trade, local alcohol, firewood, woodwork, and government support constitute minor contributions. In the same way, in Jima Arjo district, all interviewed farmers get their income from crops, followed by livestock and livestock products, petty trade, daily labor, and fruits and vegetables. In both study areas only limited options of off-farm opportunities are available for the farmers. Hence, efforts should be geared toward widening the farmers' off-farm income generating opportunities.

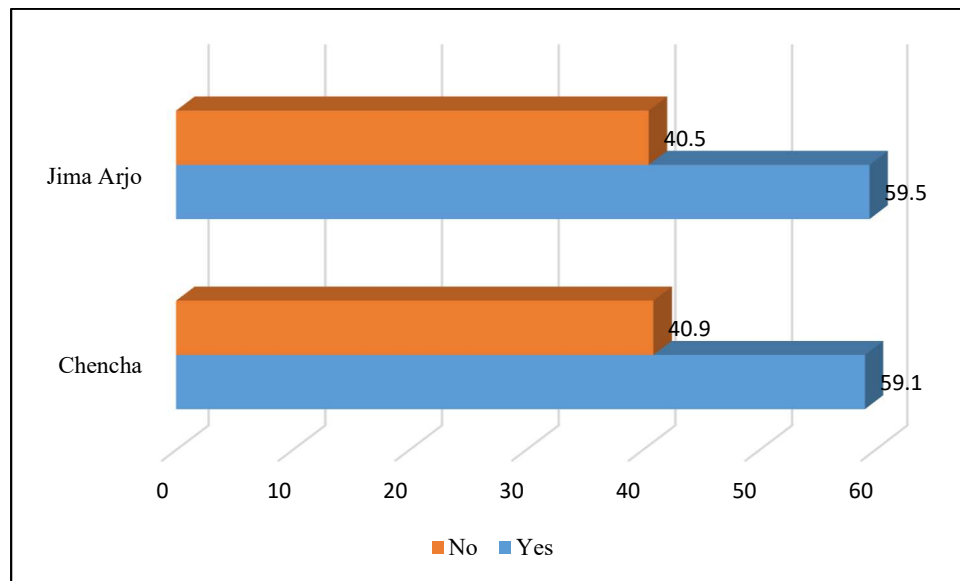
### 6.2.4. Growers Perception about *Plectranthus edulis* Contribution to the Household Food Security

Growing *P.edulis*, the interest variable in this study was hypothesized to have a positive impact on household food security. Nevertheless, the coefficient of binary logit regression showed a positive relationship between growing *P.edulis* and the household food security as priori expectation – the p-value could not suggest any significant implication on the household food security. However, this does not mean the crop has no contribution to household food security. It was due to the scale of its production and range of use, i.e. the growers do not consume frequently like other food crops rather they consume during food shortage period. The other is due to storage problem the growers did not produce the crop in large farmland like other crops; hence, its consumption is seasonal as

well. Despite the fact that growing *P.edulis* was statistically insignificant in influencing the household food security as it was supposed to be, the household perception toward its contribution to their household food security is presented below.

The majority of growers, 59% in Chench a and 59.5% in Jima Arjo district indicated that the crop is contributing to their household food security (Figure 9). The crop covers the food shortage gap during food shortage season, particularly when cereal crops do not become mature and ready for harvest. The FGD participants in Chench a district strongly emphasized that if they fail to grow *P.edulis*, they might end up with begging or famine during critical food shortage period (September to December). During this time, they use it without any worries. This highlights that its consumption gives the growers a relief period. The tubers get ready for consumption immediately following the sowing of other crops. They even use the crop while harvesting other crops, in this case, while consuming the tuber they can get an opportunity to save other food crops. In general, the crop is supportive, particularly for those who have a large family size and small farmland.

Figure 9 Growers perception about *P.edulis* contribution to the household food security



Similar to Chench a district, in Jima Arjo district the growers showed that while consuming the tuber they save other crops, which were later used for food or selling. In addition, it is used as a source of cash income, which may be used to buy other food crops, to cover children’s school fee and other family expenses whereby it helps them to save other crops. When there is a shortage of

food or other food crops about to be over, they use the tuber to cover the food shortage gap. Here, the interesting point is that since its price and demand in the market is low, they indirectly convert the tuber to cash through selling other crops. Even when other food crops are available at home or ready for harvest, they tend to consume the tuber and save other food crops.

Box 1 Reflection of the case study household from Chencha district about *P.edulis* contribution to the household food security

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*Tesfahun Gomba, aged 28, a male, is the head of 12 family members, completed 4<sup>th</sup> grade, and he is the father of two children. In addition, he is responsible for his father, brothers, and sisters because his father is old age. He owns 2ha of farmland. He has been growing *P.edulis* since he started farming. He explained that the crop is a good source of food along with *enset*. The land shortage is the major problem associated with *P.edulis* production due to the fact that it is produced once per year while other crops produced twice per year. He emphasized that the crop is highly contributing to his household food security. He added that the crop is important particularly when one has a large family size. Hence, the motive behind growing this crop was to support his large family size. He has been able to feed his household on average around 5 months from his own farm production, here the tuber has been helping him in filling the food deficit period.*

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### 6.2.5. Household Coping Strategies during Food Shortage Period

This section presents the major coping mechanisms used by households during the food deficit period. Due to the fact that achieving food security in its totality is impossible, it is unavoidable that certain households living in a certain community encounter food shortage with varying intensity and they act back their way to cope with the food shortage (Furgasa & Degefa, 2016). Rural households do not remain passive during the food shortage period, rather adopt various behavioral and material responses to cope with during food shortage crisis, notably transitory food insecurity situation (Meskerem & Degefa, 2015). This study shows that the majority of households were not able to consume only from their own farm products throughout the year. During the food deficit period, they use different mechanisms to fill the food shortage gap. In Chencha district, the farmers' main coping mechanisms in times of food shortage include making *kocho* from immature *enset* locally called *murga*, frequently consuming *amicho* alone, weaving, purchasing food crops, engaging in daily labor, remittance, saving, reducing the frequency of meal (skipping meal), reducing portion of food at mealtime, and borrowing money and/or food crops from relatives/neighbors (Table 40). Consumption of less preferred food (eating only *amicho* and *kocho* throughout the week without accompany, sweet potato, and sorghum) is also a common coping strategy in Chencha district as revealed by the FGD participants. They further elaborated that even

if *amicho* and *kocho* are very important and preferred food items in the area, it is unexciting if consumed frequently for extended periods. Mesay (2008) highlight that the type of meal that is consumed in any rural household largely depends on the economic status and cultural preferences of the people. The change and continuity in the type of meals that people consume at home, to some extent, tell the food security situation of the households. What people consume under normal conditions may differ from food shortage period.

Table 40 Household coping strategies during food shortages period (Multiple responses)

Coping strategies	P.edulis growing area (N=250)	
	Chencha	Jima Arjo
Selling firewood	8 (5.6)	2 (3.8)
Selling livestock & livestock products	5 (3.5)	4 (7.6)
Petty trade	18 (12.7)	7 (13.2)
Weaving	66 (46.5)	0 (0.0)
Purchasing food crops from the market	131 (92.3)	32 (60.4)
Daily labor	38 (26.8)	19 (35.9)
Safety-net	8 (5.7)	0 (0.0)
Reducing the number of meals	10 (7.1)	0 (0.0)
Frequently eating similar food ( <i>amicho/kocho</i> )	55 (39.0)	0 (0.0)
Remittance	26 (18.4)	2 (3.8)
Borrowing money/crop from relatives/neighbors	10 (7.1)	15 (28.3)
Planting early maturing crops	0 (0.0)	2 (3.8)
Using savings	13 (9.2)	14 (26.4)
Selling fruits and vegetables	2 (1.4)	5 (9.4)
Using P.edulis	10 (7.1)	3 (5.7)

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in paranthesis

In addition to agriculture, in Jima Arjo district, the major coping strategies of the farmers were purchasing from market, engaging in daily labor, borrowing money and/or crop from relatives/neighbors, mobilizing money from saving if any, and petty trade. Similarly, in Jima Arjo district the commonly less preferred foods that are consumed during the food shortage period include Irish potato, sweet potato, cabbage, *P.edulis*, millet, *godere*, and immature maize. In agreement with the current findings the study conducted in Ghana revealed that the prevailing food insecurity coping strategies adopted by farming households to mitigate the effects of food insecurity include eating less preferred foods, limiting the size of the food consumed, and skipping meal within a day, borrowing money and food (Kuwornu et al., 2010). Similarly, Furgasa & Degefa (2016) reported sales of livestock and firewood, alteration of consumption patterns, reduction of food portions, cash for work, borrowing cash and/or grain, and collection of wild foods.

### 6.3. Contribution of Anchote to the Household Food Security

#### 6.3.1. Household Food Security Status

Out of the sampled households, 75.4% in Gimbi district were food secure and 24.6% were food insecure; similarly, in Ayira district 78.6% were food secure and 21.4% were food insecure (Table 41). The result shows that there was no statistically significant variation between the two study areas in relation to the household food security status. As the two districts are coffee-growing areas, the proportion of food secure households was relatively higher.

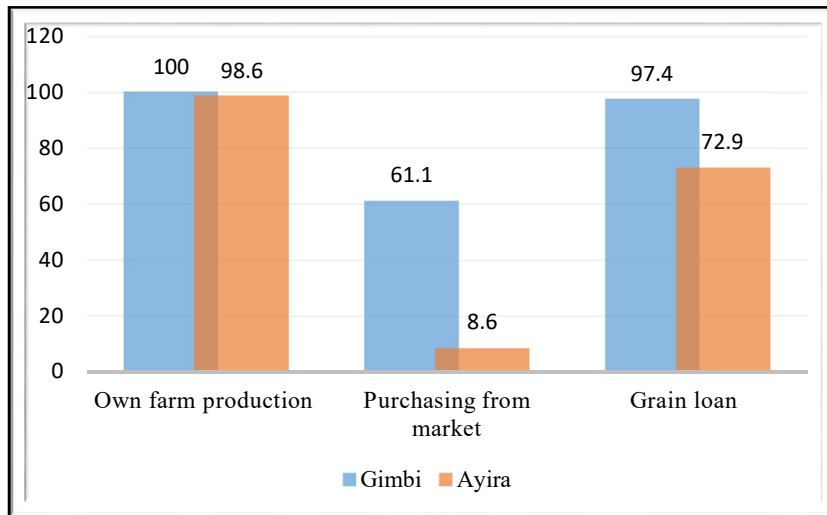
Table 41 Multidimensional household food security status

MD food security category		Anchote growing area (N=184)			
		Gimbi	Ayira	Overall total	$\chi^2$ -value
	Food secure	4 (3.5)	5 (7.1)	9 (4.9)	2.8689
	Mildly food insecure	82 (71.9)	50 (71.4)	132 (71.7)	
	Moderately food insecure	26 (22.8)	12 (17.1)	38 (20.7)	
	Severely food insecure	2 (1.8)	3 (4.3)	5 (2.7)	
Binary category of household food security status					
Food secure		86 (75.4)	55 (78.6)	141 (76.6)	0.2377
Food insecure		28 (24.6)	15 (21.4)	43 (23.4)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in paranthesis

In consistent with the survey results, the key informants and FGD participants all indicated that food insecurity occurs on a seasonal basis. The FGD participants in both districts stated that the severe food shortage period experienced by the households extends from May to November as compared to other months, which shows a cyclical pattern of inadequate availability and access to food. The coping mechanisms of the household during such period are presented in the subsequent section (see section 6.3.4). As shown in Figure 10, in Gimbi district, the major source of household food includes own farm production (100%), followed by grain loan from relatives and/or neighbors to pay back from later day harvest (97.4%), and purchasing from the market (61.1%). According to the FGD participants in Gimbi district, the first widely grown crops in the area are maize, followed by *teff* (*Eragrostis teff*), wheat, coffee, anchote, avocado, banana, peas and beans, Irish potato, sweet potato, barley, *P.edulis* and haricot beans.

Figure 10 Household major sources of food (Multiple responses is possible)



Similarly, in Ayira district, a major source of household food includes their own farm production (98.6%) followed by grain loan from relatives and/or neighbors (72.9%), while purchasing from the market comprised only 8.6%. Grain loan during deficit period is one of the major social capitals known in both study areas. However, purchasing food from the market constitutes a minor contribution in Ayira district. The possible explanation was that relatively the households produce sufficient food from their own farm than their counterparts in Gimbi district.

The respondents were asked to disclose the number of months they able to cover from their own farm production. Accordingly, the household consumed an average of 7.9 and 10.5 months from their own farm production in Gimbi and Ayira district, respectively (Table 42). This finding highlights that most of the time of the year the households' food security situation is in a better position. In Ayira district the households are able to cover their food demand about 1.7 times more months than their counterparts in Gimbi district ( $P < 0.01$ ). This is also another account for household relying less on the market to cover their household food demand in Ayira district.

Table 42 Number of months the household consume from their own produce (N=184)

	Gimbi	Ayira	t-value
Average months	114 (7.9)	69 (10.5)	-6.2457 ***

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with mean in paranthesis; \*\*\*  $p < 0.01$

The respondents were also asked to assess their households' annual food requirement meeting from their own farm production during the year. Accordingly, as presented in Table 43, in Gimbi

district 23.0% of the sampled households reported that they could meet their household annual food requirement from their own farm production.

Table 43 Household annual food requirement meeting from their own farm production

Household perception	Anchote growing area (N=184)			$\chi^2$ -value
	Gimbi	Ayira	Overall	
Yes	26 (23.0)	49 (73.1)	75 (41.7)	43.4803***
No	87 (77.0)	18 (26.9)	105 (58.3)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in paranthesis; \*\*\* p<0.01

In contrast to Gimbi district, 41.7% of the sampled respondents in Ayira district reported that they could meet their household annual food requirement from their own farm production. This highlights that the households located in Gimbi district experienced more food deficit than in Ayira district (P<0.01). This finding also endorses a previous statement that says the households in Ayira district consume an average more month from their own farm production and cover their household food demand than in Gimbi district.

### 6.3.2. Relationship between Food Security and Household Characteristics

Table 45 shows the distribution of the food security status of the sampled households by their characteristics. The results of the descriptive statistics showed that seven variables have statistically significant relationships with household food security. The food secure and food insecure households on average produced 18.7 and 7.7 quintals of food crops, respectively. This shows that those households that managed to produce a larger amount of crop were more food secure than those households that produced less, which was statistically significant at 1% probability level. Engagement in anchote growing was an important factor of interest in this study, the descriptive statistics show that 63.8% of food secure households were anchote growers while the rest 36.2% of food insecure households were non-growers. This finding highlights that those households who engaged in anchote growing were more food secure than non-growers (p<0.01). Those households who owned more livestock (5.6 TLU) were more food secure (p<0.01) than those households who owned relatively less livestock (2.2 TLU). Among the sampled households, those who have low dependency ratio (0.7) were food secure, while those households who have high dependency ratio (1.4) were food insecure, which was significant at 1% probability level.

Table 44 Relationship between the household food security status and their characteristics

Variables	Measurement	Household food security status (N=184)		$\chi^2$ -value/t-test
		Food secure	Food insecure	
Age of the household head	Years	42.2±1.0	44.4±2.1	1.0633
Gender of the household head	Female	18 (12.8)	4 (9.3)	0.3755
	Male	123 (87.2)	39 (90.7)	
Education of the household head	Illiterate	28 (19.9)	6 (14.0)	0.7627
	Literate	113 (80.1)	37 (86.0)	
Total family size	Number	5.5±0.1	5.3±0.3	-0.3505
Annual total crop harvested	Quintal	18.7±0.8	7.7±0.5	-7.3170***
Ownership of cash saving account	No	115 (81.6)	37 (86.1)	0.4616
	Yes	26 (18.4)	6 (14.0)	
Technology adoption/fertilizer	Non-adopter	13 (9.2)	3 (7.0)	0.2088
	Adopter	128 (90.8)	40 (93.0)	
Growing anchote	Non-growers	51 (36.2)	29 (67.4)	13.1124***
	Growers	90 (63.8)	14 (32.6)	
Tropical Livestock Unit	TLU	5.6±0.4	2.2±0.4	-4.2047***
Social capital	Score	0.8±0.1	0.9±0.1	1.3734
Engagement in off-farm activities	No	83 (58.9)	27 (62.8)	0.2112
	Yes	58 (41.1)	16 (37.2)	
Dependency ratio	Ratio	0.7±0.1	1.4±0.1	5.7069***
Market distance	Hour	0.7±0.04	1.0±0.1	3.0060***
Farmland size	ha	0.7±0.04	0.4±0.1	-2.8981***
Annual income	ETB	11625±757	4415±590.4	-5.1103***
Location of the study area	Gimbi	86 (61.0)	28 (65.1)	0.2377
	Ayira	55 (39.0)	15 (34.9)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents/mean with percentage in paranthesis/SE; \*\*\* p<0.01

Distance to the nearest market is another important factor that determines the status of farming households' food security. It is important for the household to supply their produce to the market or to buy input from the market. The result of descriptive statistics shows that those households traveling an average long hour (1 hour) to reach the nearest market were more food insecure than those traveling fewer hours (0.7 hours), which was statistically significant at 1% probability level. Relatively, those households owned on average more farmland size (0.7 ha) were food secure (p<0.01) than those households who owned small farmland size (0.4 ha). The total annual income earned by the household (from on-farm and off-farm) was another important variable that had a significant relationship with household food security. Relatively, those households earned on average more income annually (11624.9 ETB) were more food secure (p<0.01) than those households with a low annual income (4415 ETB). However, there was no noticeable difference in the food security status of households by location of the study, age, gender, education level of the household head, total family size, and ownership of cash savings account, technology adoption, social capital and engagement of the household head in off-farm income-generating activities. The

following section presents the outputs of the binary logistic regression model.

### 6.3.3. Parameter Estimates of the Determinants of the Household Food Security

As shown in Table 46 the log-likelihood ratio chi-square value of 92.25 with a  $p < 0.0000$  showed that at least one parameter of the determinants of the household food security included in the model is significant. It is an overall model test which doesn't guarantee every independent variable is significant. The results of VCE coefficients of discrete predictor variables fitted into the model were less than 0.75, applying the rule of thumb the value suggests that multicollinearity was not a serious concern. Similarly, the values of VIF for each continuous explanatory variable were less than ten; applying the rule of thumb the value suggests that there was no multicollinearity problem among continuous predictor variables. From the classification table, the sensitivity and specificity result showed that 93.0% and 73.7% of food secure and food insecure households, respectively, were correctly classified in their respective categories. In general, the model is classified overall 88.2% of the data correctly. The Hosmer and Lemeshow chi-squared value was 4.90 with a  $p$ -value of 0.7684, the insignificant value suggests that the model estimates did fit the data well and explained much of the variance in the dependent variable. Cronbach's alpha coefficient was used to assess the internal consistency reliability of the data, and the value of 0.6002 was obtained (Annex 7). Applying the rule of thumb, the Cronbach alpha coefficient suggests that about 60% of the data used in the study has good internal consistency reliability. In general, the goodness-of-fit assessment of the logit regression model implied that the model fits the data well.

Among the sixteen predictor variables assumed to have an influence on household food security, six were found to be statistically significant. Table 46 presents the model outputs and the marginal effects of each predictor variable that are fitted to the model. The maximum likelihood estimates of the logit regression model showed that age of the household head, total crop production from their own farm, growing anchote, dependency ratio, market distance, and total annual income were statistically significant in determining the household food security. However, holding all other variables constant, gender and educational level of the household head, total family size, ownership of cash savings account, technology adoption, social capital, location of the study area, total TLU owned, engagement of the household head in off-farm income-generating activities, and farmland size were statistically insignificant in determining the household food security. The

interpretation and possible explanations of the significant variables in the model are discussed below.

#### Age of the household head

Age of the household head was hypothesized to have a positive effect on the household food security, however, in contrast with the priori expectation the output of the logit regression showed that the variable had negative and significant ( $p < 0.01$ ) impact on the household food security. In fact, various literature Fekadu (2010); Kuwornu et al. (2010); Mekuanent et al. (2014) showed that age of the household head influences the household food security either positively or negatively. The probable explanations for the negative signs were that young and energetic household heads are expected to cultivate larger farms and have better ability to seek and obtain off-farm jobs and income compared to older household heads. The value of the marginal effect implies that if the age of the household head increases by one year holding all other variables constant the probability of the household being food secure decreases by 0.0015. The result of this study was in contrast with the findings of various scholars such as Ayalneh & Abebaw (2009); Fassil & Elias (2016); Jemal & Kim (2014), who reported a significant positive influence of age of the household head on the household food security. This is mainly because as the age of the rural household increases they acquire more and more experience in farming operations.

#### Total own farm production

In agreement with the priori hypothesis the households' total own farm production was significantly and positively related to the household food security at 1% probability level. The positive sign of the variable revealed that the higher the output levels of the household crop production, the greater the likelihood of being food secure. Those households who produced more amount of crop annually from their own farm were more likely to be food secure than their counterparts who produced less. The marginal effect indicated that if the household crop production increase by one unit (1 quintal) annually the probability of the household being food secure increases by 0.0072. This finding was in agreement with various scholars Kuwornu et al. (2010); Mekuanent et al. (2014), who found a significant and positive relationship between total food productions from own farm and household food security.

## Dependency ratio

The dependency ratio is defined as the ratio of the non-earning (young and the aged) persons of the family to the working members of the household. It was hypothesized to decrease the probability of household food security. In consistent with the hypothesis, the result of the logit regression model showed that the dependency ratio has a significant negative relationship with the household food security at 1% probability level. The negative sign shows that those households with low dependent family members are more likely to be food secure than those households with large inactive family members. The marginal effect indicated that if the dependency ratio increases by one-unit *ceteris paribus* the probability of the household being food secure decreases by 0.0480. The larger the dependency ratio, the higher the burden on active members to meet the cost of minimum household nutrition and hence the higher level of food insecurity (Sultana & Kiani, 2011). When a large household size corresponds with more inactive productive labor force compared to the active age shows a high dependency ratio and is more likely to be food insecure (Fekadu, 2010).

Table 45 Parameter estimates of the binary logit model with their marginal effects

Explanatory variables	Anchote growing area (N=184)		
	Coefficients	Std. Err.	Marginal effects
Location of the study area (District)	-0.9909	0.9067	-0.0330
Age of the household head	-0.0474***	0.0264	-0.0015
Gender of the household head	-1.2758	1.0368	-0.0264
Education level of the household head	-0.8059	0.8747	-0.0206
Total family size	0.1347	0.1967	0.0042
Total crop production	0.2330***	0.0713	0.0072**
Owing cash saving account	-1.1887	1.0018	-0.0560
Technology adoption	-1.9598	1.2624	-0.0329
Growing anchote	1.7878**	0.8269	0.0717
Total livestock owned (TLU)	0.1504	0.1174	0.0047
Social capital	-0.5703	0.6391	-0.0177
Engagement of HH in off-farm activity	-0.2717	0.6767	-0.0087
Dependency ratio	-1.5486***	0.5191	-0.0480*
Market distance	-2.1666**	0.8779	-0.0672
Farmland size	0.8177	0.8474	0.0254
Total annual income	0.0001**	0.00007	0.000004
Constant	5.069382**	2.8341	
LR chi2(16)	92.25		
Prob > chi2	0.0000		
Pseudo R <sup>2</sup>	0.5611		

Source: Survey data (2017); N=total number of respondents; \*\*\*p<0.01, \*\*p<0.05, \*p<0.1

### Market distance

A shorter market distance from the farmers' residence was assumed to encourage farmers to exchange goods like seeds, purchase of herbicides, pesticides, and fertilizers, and easily supply their produce to the market, which in turn affects grain yield positively and thus enhances food availability. In concurrence with the priori expectations distance to the nearest market was significantly and negatively associated with the household food security at 5% probability level. Negative signs show that those farmers residing close to a nearby market center were more likely to be food secure than those households located far away from the market center. The result of marginal effect analysis shows that if the time taken to reach the nearest market increases by one hour holding all other variables constant the probability of households to be food secure decreases by 0.0672.

### Total annual income

Total annual income was hypothesized to have a positive influence on household food security. In consistent with the hypothesis, its coefficient came out to be positive and significant at 5% probability level. The possible explanation is that those farmers who have better access to different types of farm and off-farm income are less likely to become food insecure than those households who have little access. Income enables households to modernize their production by giving them an opportunity to buy the necessary inputs and reduce the risk of food shortages during periods of unexpected crop failures through purchases (Wali & Janekarnkij, 2013). The value of the marginal effect implies that if the household annual income increases by one ETB, holding all other variables constant the probability of the household being food secure increases by 0.000004, although it is negligible. This result was in agreement with Kuwornu et al. (2010); Getachew et al. (2018); Ayalneh & Abebaw (2009), who reported a positive and significant relationship between the household income and food security. The major sources of household income in Gimbi and Ayira districts came from crops, coffee, livestock and livestock products. In addition, fruits and vegetables, anchote, honey, remittance, petty trade, daily labor, and selling firewood were contributed minor shares. This finding highlights that the existence of only limited options of off-farm opportunities available to the farmers located in both study areas. Hence, efforts should be geared toward widening the farmers' off-farm income generating opportunities.

### Growing anchote

In agreement with a priori expectations, the interest variable, growing anchote was significantly and positively associated with the household food security at 1% probability level. The positive sign highlights that those households who are engaged in anchote production were more likely to be food secure than those households who were not engaged in its production. The marginal effect shows that if the household shift from non-growing to growing anchote holding all other variables constant the probability of the household being food secure increases by 0.0717.

The households were asked to assess their perception toward the contribution of anchote to their household food security. Accordingly, as displayed in Table 47, 88.9% and 63.6% of growers in Gimbi and Ayira district, respectively showed that the crop has been contributing to their household food security ( $P < 0.01$ ). The FGD participants in Gimbi district showed that they use the crop to cover food shortages; in some cases when food shortages become severe, they cope with consuming only anchote. This is mainly due to the fact that anchote is relatively mature early when compared with other crops. While consuming it they can get an opportunity to save other crops that might be used in a later day for home consumption or convert to cash. In consistent with the findings of the household survey and FGD, the case study respondent showed that the crop was highly contributing to her household food security. Added to that she uses it for food, cultural and medicinal values and to get additional cash income (Box 2). In Ethiopia, farmers continue to produce different varieties of crops because of their contribution to food security and cultural values (IBC, 2012).

Table 46 Growers perception on anchote contribution to the household food security

Growers perception	Anchote growers (N=103)		$\chi^2$ -value
	Gimbi	Ayira	
Yes	40 (88.9)	35 (63.6)	8.4175***
No	5 (11.1)	20 (36.4)	

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in paranthesis; \*\*\* $p < 0.01$

In addition to food, it is a source of additional cash income, which helps them to cover children's clothing and school expenses, buy other food crops and pay *iqub*<sup>3</sup> more than any other crops do.

<sup>3</sup> It is a well-known traditional money saving and credit groups in different parts of Ethiopia

In general, the FGD participants in Gimbi district remarked that the crop is highly contributing to their household food security.

Box 2 Reflection of the case study household from Gimbi district on the contribution of anchote to food security

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*Jalane Gemechu, a female, who is 40 years old, the head of five family members, widow/her husband died 3 years ago, and she thought 8<sup>th</sup> grade. She has been engaged in farming for the last 26 years. She owns 0.25 ha of farmland. She noted that anchote is highly contributing to her household food security. She uses it for food, cultural and medicinal values and to get additional cash income, which is used to cover household necessities. During the meskel festival, she prepares anchote dish in various forms either as qori, murmuri or ito/stew. She added that anchote is also a prestigious food, one may offer to respected guests and the one that is brought to in-laws while visiting them. During the meskel festival, those families who do not have anchote from their own farm are obliged to buy from the market.*

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In Ayira district, the growers showed that the crop has significantly high contributions to their household food security. When there is a shortage of food, they use as the main dish alone or as a variety, or in some cases even they sleep consuming only anchote. As shown in Box 3 the case study respondent in Ayira district indicated that culturally the crop is considered as Oromo traditional food and it is consumed first whatever other delicious food is prepared. The other interesting point is that consuming a small amount is sufficient to satisfy someone; hence, they can get the chance to save other crops while consuming it. Anchote stew locally called *ittoo* is also prepared to accompany other food.

Box 3 Reflection of the case study household from Ayira district regarding the contribution of anchote to food security

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*Kebede Olana, a male, 38 years old, is married and the head of eight family members, he has completed 8<sup>th</sup> grade. He owns 2ha of farmland, and he has been engaged in farming and anchote growing since the last 20 years. His major livelihood is based on crop, livestock and coffee production. He stated that anchote has a high contribution to his household food security, especially during food shortage period. During the Ethiopian New Year and the Meskel festival, anchote is prepared as one traditional food variety. During this time, it is considered as Oromo traditional food and it is consumed first whatever other delicious food is prepared. During such occasions, ito/stew, qori and murmuri are the common traditional foods prepared from anchote. He further indicated that anchote is used for treating broken/fractured bone.*

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Apart from food, the tuber and its true seed are generating additional cash income for growers. When other crops are over or they are unable to buy from the market, or when other crops fail to provide sufficient yield due to flood or frost/snowfall or bad weather conditions, growers can survive by consuming anchote. This highlights the crop's ability to withstand bad weather

conditions. It also serves as food when other crops price become high in the market. Moreover, when electric power gets down and grinding mill is not working, they consume anchote and pass the whole day and night. To sum up, the crop is highly contributing to household food security in both study areas. In line with this, the study conducted in Nigeria showed that NUCS offers a significant opportunity for the poor people to earn a living due to the fact that they require little capital investment (Oladele, 2011).

#### 6.3.4. Household Coping Strategies during Food Shortage Period

This section presents the major coping mechanisms used by households during the food deficit period. In Gimbi district, the farmers' major coping strategies were selling livestock, purchasing from the market, engaging in daily labor, borrowing money/crop from relatives/neighbors, relying on family/relatives, planting early maturing crops (like anchote), using savings/*iqub* and growing different fruits and vegetables (Table 44). In this case, Mesay (2008) indicated that informal transfers are a kind of assistance between parents and son/daughters, between friends and neighbors in various forms at times of severe food shortage periods. The author further revealed that, recently, most of the informal transfers have taken forms of mutual support systems on the basis of trust and reciprocity in rural households. The FGD participants in Gimbi district supplemented that they plan ahead and plant early maturing crop species, for example, anchote get ready for harvest during August-September, while other crops are not. The household survey in Gimbi district also showed that the farmers survive through consumption of less preferred foods like boiling immature bananas and consuming it, consuming *gamade* alone, waqoo a plant that grows itself during autumn, sorghum, millet, and *godare* during food shortage period.

Table 47 Household coping strategies during food shortages period

Coping strategies	Anchote growing area (N=184)	
	Gimbi	Ayira
Selling livestock	9 (10.5)	5 (19.2)
Petty trade	4 (4.7)	0 (0.0)
Purchasing from the market	84 (97.7)	17 (65.4)
Engagement in daily labor	29 (33.7)	6 (23.1)
Reducing the number of meals	1 (1.2)	0 (0.0)
Remittance	3 (3.5)	1 (3.9)
Borrowing money/crop from relatives/neighbors	28 (32.6)	4 (15.4)
Planting early maturing crops	2 (2.3)	1 (3.9)
Using saving	11 (12.8)	0 (0.0)
Growing fruits and vegetables	8 (9.3)	4 (15.4)

Source: Survey data (2017); N=total number of respondents; Values are the number of respondents with percentage in paranthesis

Similarly, in Ayira district during food shortage period the farmers cope with selling livestock, purchasing from market, engaging in daily labor, borrowing money/crop from relatives/neighbors to pay back from future harvest, and growing fruits and vegetables. In addition, they grow early maturing crops including anchote. In Ayira district, the major less preferred food items consumed by the household during the food shortage period include yam locally called *kocho*, sweet potato, and cabbage. In agreement with the current findings, Mekuanent et al. (2014) reported farmers coping mechanisms including selling livestock, borrowing grains or cash from relatives, reducing the size of meals, escaping meals and eating less preferred foods. The study conducted in Ghana also revealed that during acute food shortage period people depended on all kinds of material for survival, including rhizome of bamboo, water leaves, and unripe bananas, which under normal circumstances were not part of Ghanaian foodstuff (Kuwornu et al., 2010).

#### 6.4. Summary

The current study assessed the households' food security status, its determinants and thereby the contribution of the two tuber crops to the household food security in the study area. The household perception about the contribution of the two tuber crops to the household food security and coping strategies during food shortage period were also uncovered.

MFI was employed to determine household food security status. Accordingly, among the sampled households 66.4% in Chenchu district were food secure and 33.6% were food insecure; similarly, the corresponding figures in Jima Arjo district were 82.1% and 17.9%, respectively. The prevalence of food insecurity was higher in Chenchu district than in Jima Arjo district. The major sources of food in both study areas were own farm production, purchasing from the market, borrowing food crops from relatives/neighbors to pay back from later day harvest. The households have able to feed their family members on average for 4.5 and 9 months from their own farm production in Chenchu and Jima Arjo district, respectively. In line with this, 21.3% of the sampled households in Chenchu and 72.6% in Jima Arjo district reported that they could meet their household annual food requirements from their own farm production.

An econometric model, the binary logit regression model was employed to identify the determinants of the household food security, and thereby the contribution of *P.edulis* to the household food security. The maximum likelihood estimates of the logit regression model showed

that location of the study area, age of the household head, total annual crop production, total livestock owned (TLU), farmland size, total annual income, and participation of the household head in non-farm income-generating activities were statistically significant in determining the household food security status.

Growing *P.edulis* was hypothesized to have a positive and significant impact on household food security. Nevertheless, the p-value of the logit regression result could not suggest any significant implication on household food security. This does not mean the crop has no contribution to household food security. In light of this, the households were asked to indicate their perception of the crop's contribution to their household food security. Consequently, nearly half of the sampled respondents in both districts revealed that the crop had been contributing to their household food security. They use the crop to cover food shortage gap during food shortage season, i.e. when other consumable and seed crops are over. While consuming the tuber they can get an opportunity to save other food crops, which can be later used for food or selling. They even use the tuber while harvesting other crops. So, the crop is supportive, particularly for those who have a large family size and small farmland. In addition, they use it to generate small cash income, which may be used to buy other food crops and cover other family expenses. Here, the interesting point is that since its demand and price in the market is low, they indirectly convert the tuber to cash through selling other crops.

In both districts, the food shortage occurs between May and November as compared to other months. During this time, in Chench district they cope with purchasing food crops from the market, making *kocho* from immature *enset*, frequently consuming *amicho* alone, engaging in daily labor, remittance, using saving, skipping a meal, reducing the portion of food at mealtime, borrowing money and/or food crops from relatives/neighbors, and consuming less preferred foods. Similarly, in Jima Arjo district the farmers coping strategies include purchasing from the market, engaging in daily labor, borrowing money and/or crops from relatives/neighbors, using savings, petty trade, and consuming less preferred foods.

In anchote growing area out of the sampled households, 75.4% and 24.6% in Gimbi district were food secure and food insecure, respectively; similarly, the corresponding figure in Ayira district were 78.6% and 21.4%, respectively. Own farm production, followed by grain loan from relatives

and/or neighbors to pay back from later day harvest, and purchasing from the market are the major sources of food for households in the study area. The households consume on average about 7.9 and 10.5 months from their own farm production in Gimbi and Ayira districts, respectively. This finding highlights that most of the time of the year the households' food security situation is in a better situation. In concurrent with this 23% of the sampled households in Gimbi and 41.7% in Ayira district reported that they could meet their household annual food requirements from their own farm production.

Out of the sixteen explanatory variables assumed to have an influence on household food security, six were found to be statistically significant. Accordingly, the maximum likelihood estimates of the logit regression model showed that age of the household head, total crop production from own farm, growing anchote, dependency ratio, distance to the nearest market, and total annual income were statistically significant in determining the household food security.

In agreement with priori expectations, the interest variable, i.e. growing anchote was significantly and positively associated with the household food security. The positive sign highlights that those households who were engaged in the production of this crop were more likely to be food secure than those households who were not. To support this claim, the households were asked to assess their perception toward the contribution of the crop to their household food security. Accordingly, 88.9% of growers in Gimbi and 63.6% in Ayira district showed that anchote has been significantly contributing to their household food security. They use the crop to cover food shortages. In some cases when food shortages become severe, they sleep by consuming only anchote. In addition to food, the tuber and its true seed are the sources of additional cash income.

Across the two study areas, the food shortage period experienced by the households was between May and November. During food deficit period the farmers cope with selling livestock, purchasing food crops from the market, engaging in daily labor, borrowing money and/or crop from relatives/neighbors, relying on family/relatives, planting early maturing crops, using savings/*iqub*, growing different fruits and vegetables, and consuming less preferred foods. It is a custom for farmers to borrow either money or crops from neighbors and/or relatives to pay back from future harvests in the study area and beyond in Ethiopia.

## Chapter 7. Conclusions and Recommendations

### 7.1. Conclusions

This study was aimed at investigating the growers' indigenous production practices, socio-economic importance, constraints associated with and the contribution of the two tuber crops to the household food security. Primarily the research assessed the household major reasons for the two tuber crops production, sources of planting materials, cropping pattern, available local varieties and selection criteria, production trends, types of foods prepared from the two crops, growers reasons for less production, non-growers farmers motives for not growing the two tuber crops, growers marketing participation, constraints associated with the two crops production, and the perception of the household regarding the contribution of the two tuber crops to the household food security.

#### *P.edulis*

The growers, for the most part, produced *P.edulis* for food, particularly to cover food shortage between September and November. Besides food, the crop helps them to get small cash income, and to reduce risk in case other crops fail due to adverse weather conditions. Notwithstanding its importance and long period farmers' growing experience, the crop is mostly produced on a small plot of land around the homestead for home consumption. This study identified six local varieties of *P.edulis* in Chench district and two local varieties in Jima Arjo district.

The growers prepare the land between March and May in both study areas. In all cases, they plant between April and May depending on the commencement of rain and land preparation. In Chench district, they plant the tuber after removing the sprout and the two lengthy tips and dividing the tuber into two or more pieces depending on its size. In contrast to this, in Jima Arjo district, the common practice is planting the whole tuber. The crop matures and gets ready for use during September, once the tuber attains its maturity they harvest whenever the need arises for home consumption or selling. Once the tuber is harvested, its maximum storage life is not more than two days; while in situ or leaving in the ground is the only available storage facility in the study area. Its production trend is decreasing over the last 10 years. Hence, it can be concluded that the interest of farmers toward growing this crop has been declining, because the crop has less advantage when compared to other crops.

The current study also identified 13 *P.edulis* production constraints. Among the identified constraints lack of improved variety, lack of tuber seed, lack of government attention (research and extension), lack of storage facility, long maturity, lack of market demand, low price and the existence of hairy structure are the most determinant constraints of its production. In general, growers have ample indigenous knowledge of this crop management including land preparation, management, use of organic manure, use of ash for tuber seed treatment, wild animal protection, local variety selection practices, and traditional storage facilities that can be used as a base for its further improvement.

The MFI algorithmic classification technique was employed to determine the household food security status. Accordingly, among the sampled households 66.4% in Chenchu district were food secure and 33.6% were food insecure; correspondingly, in Jima Arjo district 82.1% were food secure and 17.9% were food insecure. The households are able to feed their family members on average for 4.5 and 9 months from their own farm production in Chenchu and Jima Arjo district, respectively. In line with this, 21.3% of the sampled households in Chenchu and 72.6% in Jima Arjo district reported that they could meet their household annual food requirements from their own farm production. It appears that the prevalence of food insecurity is higher in Chenchu district, hence more attention is needed to improve the household food security situation.

The maximum likelihood estimates of the logit regression model showed that location of the study area, age of the household head, total annual crop production, total livestock owned (TLU), household head engagement in non-farm income-generating activities, farmland size, and total annual income were theoretically consistent and statistically significant in determining the household food security in *P.edulis* growing area.

Though the growers perceived that *P.edulis* has been helping them to cover the food shortage gap during the food shortage period, this study failed to provide evidence that supports the crop is significantly contributing to the household food security. Hence, this study concluded that the crop did not have a statistically significant impact on household food security.

## Anchote

In addition to food, growers produce anchote to get additional cash income, to reduce risk in case other crops fail, medicinal and cultural values. During the New Year and the *Meskel* festival, its dish is prepared and consumed first as one Oromo traditional food whatever other delicious food is on the table. It is common to find its dishes in different restaurants and hotels. Hence, the crop plays a vital role in socio-economic, cultural and medicinal values besides food source for the community.

The crop requires highly fertile/manured land, due to this reason, they mostly prefer to grow around the homestead. In addition, its cultivation demands high labor, i.e. its operation is lengthy, time taking, and difficult to carry out activities fast. It is also difficult to transport and apply manure and produce on a large farm. Despite its benefits, unlike other food crops, anchote lacks attention from research and extension. On top of this, wild animal attack is the main reason for less production of the crop in the study area.

Two local varieties of anchote (white and red) were identified in both study areas. Among the two local varieties, the white one is preferred most across all the study areas; owing to large tuber size, easy cooking, soft texture, less fiber content, good taste, better market demand and price, and during grinding in the grinding mill it does not need too much power. The red one is not palatable like that of white anchote. This study suggests that these traits are important, hence the plant breeders may use them to improve the local varieties in order to exploit the crop's potential and support the growers in realizing their demand.

The available storage facility in the study area is leaving in the ground and protecting from animals reach. Alternatively, they dig the ground and store there for two to three months without deterioration. If they intend for selling purpose, they harvest on the market day or on the eve of the market day. It appears that proper storage technology would help the growers to use the land to grow other crops and thereby improve their livelihood. The crop production trend is increasing over the past 10 years. Hence, working on the crop value chain development will help the growers to make more benefit from the crop and thereby improve their livelihood. In both study areas, the crop has relatively fetches better market price than Irish potatoes, due to this fact the majority of growers tended to produce anchote for the market. This is also a tremendous opportunity to further

improve the crop and utilize its untapped potential. In a nutshell, the growers have ample indigenous knowledge of site selection and preparation, the crops management practices, variety selection, wild animal protection, its food preparation, and storage of tuber and true seed preservation. However, anchote production demands high labor and highly fertile/manured land. Furthermore, contrary to the significant contribution of the crops to the farming community, the crop has not received due attention from the research and extension system of the country. Hence, there is a need to improve its agronomic management and integrate it with the growers' indigenous management practice.

In view of the fact that identification of the constraints that affect any crop production is the first step for its further improvement, this study identified ten anchote production constraints. Among the identified constraints, lack of improved variety, lack of government attention, lack of storage facilities, high labor demand, long maturity, and long cooking time are the most important constraints of anchote production. Therefore, the stakeholders need to prioritize these constraints and tackle them accordingly to enhance its production and productivity whereby help the growers to improve their livelihood.

The logit regression model showed that age of the household head, total crop production, growing anchote, dependency ratio, distance to the nearest market and total annual income were statistically significant in determining the household food security. Growing anchote, the interest variable in this study was significantly and positively associated with household food security. The positive sign highlights that those households who are engaged in the production of anchote were more likely to be food secure than those households who were not. The households have also perceived that the crop has been significantly contributing to their household food security. This shows both the logit regression model and the household perception testified that the crop has a significant impact on household food security. In general, despite various constraints that hinder its production, the crop is playing a vital role in bridging the food shortage gap, generating cash income, cultural and medicinal values.

This study argued that some MFI questions do not wholly reflect the context of rural communities, which may lead to misclassification of the household food security status. Particularly, the first six indicators manifest the severe condition of the households' food security condition, while the last

five indicators show consumption of high-value foods. For instance, from the first six indicators, that question about sending family members for begging and sending family members to neighbors or relatives in order to eat and survive when food is not available at home were seen by the community as losing pride. Correspondingly, from the last five indicators like the consumption of dairy, meat, and eggs are high-value foods. Most of the respondents particularly in Chenchu district responded never or rarely consumed those food items. Hence, this study suggests that further research needs to be conducted using MFI and appropriate indicators that reflect the rural community's context need to be replaced in order to better categorize the household food security status according to their responses.

Information on the association of the two tuber crops and the household food security was lacking and that in itself is an important constraint to develop the crop. To fill this gap, this study addressed both growers and non-growers to look into the contribution of the two crops to household food security. So far, the available research on the two tuber crops mainly focused only on growers and not established the relationship between the two crops and household food security. Cognizant to this knowledge gap this research established the relationship between the two tuber crops and the household food security and reached the conclusion that anchote has a significant impact on household food security. Nevertheless, *P.edulis* had no significant impact on household food security. This research described the general indigenous practices, parameters used to select the local varieties and associated constraints of the two crops to provide the scientific community with information needed to evaluate further and investigate the crop. In this regard, this research may also help the plant breeders to further improve these crops.

This study was in agreement with the findings of various scholars with regard to the growers' indigenous production practices, constraints, and household food security status. However, many studies attempted to offer generalizable findings by identifying the relationship between household food security with sets of predictor variables including land size, livestock holdings, family size, income, educational level of household head, etc., which revealed that better-off households experience less food insecurity. This research in addition to using these variables introduced a new variable, i.e. growing the two tuber crops, and established the relationship between these crops and the household food security.

The findings of this study have important research and policy implications for research institutions, higher education institutions, regional and federal governments, and the NGOs working in the locality. Therefore, based on the above conclusions, this study infers the following concerns for further research and policy implications:

## 7.2. Recommendations

- ❖ Regional and federal research institutes, and higher education institutions:
  - ✓ Should give more attention to further conducting the research on improving growers indigenous agronomic management practices, and integrating improved agronomic practices with the growers' indigenous knowledge and promoting it;
  - ✓ Particularly, the focus should be geared toward improving agronomic management practice of anchote, as the growers repeatedly cited that its management demands high labor.
  - ✓ Should give more attention to improving and promoting the best performing local varieties of anchote (early maturing and high yielding);
  - ✓ Need to develop and promote improved storage facilities to enhance *P.edulis* and anchote production;
- ❖ Ethiopian Health and Nutrition Research Institute needs to further investigate the medicinal values (active ingredients) of *P.edulis* and anchote;
- ❖ Regional and federal research institutes, higher education institutions and extension need to seek mechanisms and create awareness on ways to control wild animals and termite expansion in Gimbi and Ayira districts and beyond;
- ❖ The extension system of the country has emphasized on major cereal crops, now looking into the significant contribution of anchote to the household food security, policymakers need to gear up their efforts toward incorporating anchote in the existing extension packages.
- ❖ Considering its significant contribution of anchote to the household food security, any development program aimed at improving the household food security should focus on incorporating this crop in order to harness their potential for the enhancement of food security of the farmers that are dependent on it.
- ❖ Local government, extension, and NGOs should give due attention to the development of the value chain of anchote in the study area.

- ❖ Based on the evidences obtained from this study there are many areas that need interventions by different stakeholders to improve the food security situation of the household in the study area. Hence, the federal and regional government, NGOs, and other stakeholders need to design strategies that would focus on and address the identified significant determinants of the household food security in the study area.
  - ✓ Particularly, opening up and promoting of off-farm income-generating opportunities to enable household get diversified income sources that would help them to increase access to food in *P.edulis* growing areas.
  - ✓ Since increasing the size of farmland in the short period is not possible, in *P.edulis* growing area, to tackle shortage of farmland and increase the household crop production, the quality of available farmland should be maintained through soil management, use of modern agricultural technologies and provision of yield-increasing inputs (improved crop varieties, fertilizer, credit, etc.) with affordable price to enhance crop production and productivity, and thereby help the household achieve food security.
  - ✓ The rural roads that connect the farmers with the market need to be developed, this would save the farmers time spent to reach the market center. Moreover, the health extension center should have to create awareness of the farmers to reduce dependents through family planning in Gimbi and Ayira districts.
  - ✓ Any development program aimed at improving the household food security should also need to target the older household heads in anchote growing areas and younger household heads in *P.edulis* growing areas as the age of the household head is negatively and positively associated with the household food security, respectively.

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# Annexes

## Annex 1 Cross-sectional household interview questionnaire

1. Name of interviewer ..... Interview Date ..... Time .....
2. Zone ..... Woreda.....Kabele.....
3. Name of the household head .....
4. Age of the household head .....
5. Sex of the household head                      1. Male 2. Female
6. Marital status 1. Never married 2. Married 3. Divorced 4. Widowed
7. Religion 1. Orthodox 2. Protestant 3. Catholics 4. Adventists 5. Muslim 6. Wakefeta
8. Please describe your ethnicity 1. Oromo 2. Amhara 3. Gamo 4. Dorze 5. Other (specify)...
9. Education level of the household head 1. Do not attend school 2. Non-formal education  
3. Primary school 4. Secondary school 5. TVET 6. University degree

10. How many years have you been in farming? .....

11. How many People by Age, Sex currently living in your household?

No.	Name	1. Male 2. Female	Age	Dependent 2. Active labor 3. Hired employ

12. Are you active labor?                      1. Yes 2. No
13. If No what is/are the reason/s? 1. Aged 2. Sick 3. Others (specify) .....
14. What is your total farmland in *timad*/ha? .....
15. How did you get access to farmland? (Multiple responses are possible): 1. through land redistribution 2. Shared with relatives 3. Inherited from parents 4. Sharecropped in 5. Purchased 6. Cash rental 7. Others (specify) .....
16. How do you perceive change of your farmland holding size over the past 10 or so years?  
1. Increasing 2. Decreasing 3. No change
17. What is/are the reason/s for the trend on your farmland size holding? .....
18. Perceived status of your farmland in terms of suitability for farming and soil fertility .....
19. Main problems related to your farmland .....
20. Do you feel that you have shortage of land? 1. Yes 2. No
21. If YES what could be the possible reason? .....
22. If you have shortage of land, how do you ensure that your land produces enough food for your household?
23. What type of agriculture do you practice? 1. Crop production 2. Livestock production 3. Both
24. What are the main sources of food to the household? 1. Own produce 2. Purchase from market 3. Gathering from the wild 4. Food aid (from who) 5. Others (specify) .....
25. What are your major source of household income? Please Rank Top Three according to their importance
26. Types of crops grown, amount harvested and amount of money earned during 2009 E.C (2015/16)

No.	Crop types	Quantity produced per year in kuntal	Quantity sold per year in kuntal	Income per year in Birr
1.	Teff			
2.	Maize			
3.	Wheat			
4.	Barley			
5.	Sorghum			
6.	Irish potato			
7.	Pepper			
8.	Anchote			
9.	Dono/Oromo dinich			
10.	Enset			

11.	Sweet potato			
12.	Apple			
13.	Avocado			
14.	Mango			
15.	Cabbage			
16.	Carrot			
17.	Onion			
18.	Coffee			
19.	Peas and beans			
20.	Others (specify)			

27. Household livestock ownership by species and income earned during 2009 E.C (2015/16)

No.	Livestock species and their product	Number/amount	Income per year in Birr
1.	Cattle		
2.	Ox		
3.	Goats		
4.	Sheep		
5.	Chicken		
6.	Horse		
7.	Mule		
8.	Donkey		
9.	Honey		
10.	Milk, butter, yoghurt, etc.		
11.	Hide and skin		
12.	Others (specify) .....		

28. Household sources of income other than own farm and amount earned during 2009 E.C (2015/16)

No.	Sources of income	Amount per year in Birr
1.	Employment on some else's farm	
2.	Casual labor/daily laborer	
3.	Payment from Gov't /NGO's	
4.	Loan or credit obtained	
5.	Charcoal/fuel wood sales	
6.	Self-employment: petty trading, carpenter	
7.	Income from hand craft ( <i>shema</i> , etc.)	
8.	Salaries, wages of resident household members	
9.	Livestock trading/brokering	
10.	Remittances or gifts from households/relatives/friends	
11.	Renting house/land, equipment, etc.	
12.	Other income sources (specify).....	

29. Who is contributing to the household income? 1. Husband 2. Wife 3. Children 4. All members of the household

30. Do you have cash savings/bank account? 1. Yes 2. No

31. Which farm inputs you used during the year 2009 E.C (2015/16)?

No.	Input type	Tick one or more options
1.	Improved crop varieties	
2.	Improved dairy breeds	
3.	Improved chicken breeds	
4.	Pesticides/herbicides	
5.	Veterinary medicine	
6.	Chemical fertilizers	
7.	Manure	
8.	Improved forage crops	
9.	Credit for agricultural activities	

10.	Others (specify)	
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32. In which of the following agricultural related community group are you member?

No.	Type of groups	Tick one or more groups
1.	Land resource conservation and soil improvement group	
2.	Agricultural product marketing group	
3.	Savings or credit/ <i>iqub</i> group	
4.	Participation in labor support with neighbors/relatives	
5.	Women's group	
6.	Irrigation group	
7.	Participations in draft power assistance to/from neighbors/relatives	
8.	Grain loan during deficit period	
9.	Cash loan in times of need	
10.	Benefits from safety-net (Govt or NGO)	
11.	Cooperatives member (specify) .....	
12.	Neighbourhood coffee drinking	
13.	Membership in <i>Idir</i>	
14.	Others (specify)	

33. Did you grow anchote/Dono/Oromo dinich in the last season? 1. Yes 2. No

34. If NOT what is/are your reason/s? .....

Note: If the Respondents Answer is No Then Go To Page 10 – Food Security Part

35. If YES how long it is since you have started growing anchote/Dono/Oromo dinich? .....

36. Who is mostly involved in production of anchote/Dono/Oromo dinich? Why?

1. Poor 2. Intermediate 3. Wealthier 4. All wealth categories

37. Why only those wealth categories of farmers are involved in production of anchote/Dono/Oromo dinich? .....

38. Is the Elders or the Youngsters are mostly involved in the production of anchote/Dono/Oromo dinich? 1.

Elders 2. Youngsters 3. Both

39. Why only those farmers are involved in production of anchote/Dono/Oromo dinich? ....

40. What are your reasons for anchote/Dono/Oromo dinich production over time compared to other crops

No	Uses/purposes of producing anchote/ Dono/Oromo dinich	Tick	Rank (top three)
1.	Food		
2.	Additional income		
3.	Cultural/social/ritual value		
4.	Medicinal value		
5.	Feed for animals		
6.	For soil fertility improvement (as crop rotation)		
7.	For its drought resistance ability		
8.	For its disease and pest resistance ability		
9.	To get reasonable yield with less inputs		
10.	To get high yield from small area of land		
11.	To cover food shortage during food scarce period		
12.	For its taste		
13.	To reduce risk in case other crops fail		
14.	For its marketability		
15.	Has better price		
16.	For conservation of the plant to pass to next generation		
17.	Use as firewood		
18.	Demands less labor compared to other crops (Irish Potato)		
19.	Suitable to marginal growing conditions		

41. Which plant part is/are used for human consumption? 1. Leaf 2. Tuber 3. Seed  
 42. Which plant part is/are used for animal feed? 1. Leaf 2. Tuber 3. Seed  
 43. Does anchote/Dono/Oromo dinich have medicinal value? 1. Yes 2. No  
 44. If YES, list which plant part is/are used for treating which specific health problem/disease?  
 45. What are the sources of anchote/Dono/Oromo dinich for planting?

No.	Source of planting material	Tick one or more sources
1.	Own true seed	
2.	Own seed tubers saving	
3.	From relatives	
4.	From friend	
5.	From neighbor	
6.	Purchase from local market	
7.	Other source (specify)	

46. Which plant part do you use mostly for planting purpose? 1. Seed tuber 2. True seed 3. Both  
 47. Why? .....

48. How many types of traditional food do you prepare out of anchote/Dono/Oromo dinich?

No.	Types of food	Methods of preparation	Mode of utilization (major meal/accompany)
1.			
2.			
3.			

49. Where do you sell your anchote/Dono/Oromo dinich produce? 1. in the farm gate 2. Village market 3. District market 4. Zonal market 4. Other (specify) .....
50. How do you transport your produce to the market? 1. Carrying on the back 2. On horse/donkey back 3. Using cart 4. Using vehicle 5. Other (specify).....
51. To whom do you sell your produce? 1. Direct retail to consumers' 2. Trader/buyer 3. Cooperatives 4. Farmers 5. Other (specify).....
52. How far is the nearest market from your home in hours.....
53. How much is the price of one kg of anchote/Dono/Oromo dinich in nearest market? .....
54. How do you see the price of one kg/local unit of anchote/Dono/Oromo dinich in comparison with Irish potato?
55. When do Anchote/Dono/Oromo Dinich fetch better price .....
56. When do Anchote/Dono/Oromo Dinich fetch lower price .....
57. How do you perceive the production trend of anchote/Dono/Oromo dinich over the last 10 years or so?  
 Increasing 2. Decreasing 3. No change
58. If your answer is increasing what is/are the possible reasons? .....
59. If your answer is decreasing what is/are the possible reasons? .....
60. Does anchote/Dono/Oromo dinich is bringing any significant contribution to your household food security?  
 1. Yes 2. No
61. If YES how? .....
62. Does anchote/Dono/Oromo dinich has cultural significance in this area? 1. Yes 2. No
63. If YES, would you please tell us some of the cultural values/dishes prepared from it? .....
64. Is there any sayings or customs/rituals that express the importance of anchote/Dono/Oromo dinich in this are? 1. Yes 2. No
65. If YES, indicate along its implied meaning? .....
66. Indicate the local varieties of anchote/Dono/Oromo dinich grown in your farm?

No.	Anchote varieties	Rank	Dono/Oromo dinich varieties	Rank
1.	White		<i>Lofo Dono</i>	
2.	Red		<i>Chanko Dono</i>	
3.			<i>Giso Dono</i>	
4.			<i>Dalako Dono</i>	
5.			<i>Gircho Dono</i>	

6.			White	
7.			Red	

67. Have you ever encountered any anchote cultivar which gives more than one tuber per plant? 1. Yes 2. No

68. If your answer is YES, mention its name and explain the plant characteristics? -----

69. What are the plant characteristics you consider for selection of best performing varieties of P.edulis/anchote?

No.	Plant characteristics	Thick one		
		Poor	Good	Very good
1.	Drought resistance ability	Poor	Good	Very good
2.	Disease and pest resistance ability	Poor	Good	Very good
3.	Maturity period	Early	Intermediate	Late
4.	Taste/palatability	Poor	Good	Very good
5.	Tuber yield	Low	Intermediate	High
6.	Tuber size	Small	Intermediate	Big
7.	Hairy structure (P.edulis)	Low	Intermediate	High
8.	Its ability to improve soil fertility	Low	Intermediate	High
9.	Plant height	Short	Intermediate	Tall
10.	Shelf life	Short	Medium	Long
11.	Cooking time	Short	Medium	Long
12.	Fodder quality	Low	Intermediate	High
13.	Market demand	Low	Medium	High

70. How is the seed tuber selection techniques/knowledge pass from parents to children? ....

71. Do you recall any local varieties of anchote/Dono/Oromo dinich that you use to grow but not found any more?

1. Yes 2. No

72. If YES, what is the local name and the possible reasons of extinction? .....

73. How do you prepare the land for anchote/Dono/Oromo dinich planting? .....

74. When do you prepare the land for anchote/Dono/Oromo dinich planting (in month) .....

75. Where do you grow anchote/Dono/Oromo dinich? 1. In the home garden 2. In the main field 3. In both areas

76. What kind of tool is used for planting? .....

77. How many times do you prepare the land before planting? 1. Plant on the virgin land 2. Once 3. Twice

4. Three times 5. Four times

78. How many times do you harvest anchote/Dono/Oromo dinich per year? 1. Once 2. Twice

79. What types of planting material do you use? 1. Whole tuber 2. Tuber pieces 3. True seed

80. If you use seed tuber, how do you plant it? 1. With sprouts 2. After de-sprouting

81. Do you apply fertilizer on anchote/Dono/Oromo dinich farm? 1. Yes 2. No

82. If YES, what type of fertilizer do you apply? 1. Manure only 2. Compost 3. Manure and compost 4. Chemical fertilizer 5. Do not apply (why) .....

83. When do you apply fertilizer/manure? 1. During planting 2. Any time 3. Other (specify).....

84. How many times do you apply fertilizer until harvesting? 1. Once 2. Twice 3. Three times

85. Do you apply pesticides for the production of anchote/Dono/Oromo dinich? 1. Yes 2. No

86. Do you cultivate anchote/Dono/Oromo dinich? 1. Yes 2. No

87. If YES how many times do you cultivate until harvesting? 1. Once 2. Twice 3. Three times 4. Four times

88. When do you cultivate anchote/Dono/Oromo dinich? .....

89. What is/are your reason for cultivation? (Circle one or more) 1. Production of more stems 2. More tubers 3. Bigger tubers 4. Higher yields 5. To protect from weeds 6. Other (specify).....

90. Do you practice Earthing up 1. Yes 2. No

91. If YES, how many times do you practice earthing up? .....

92. What is your reasons for earthing up (Circle one or more) 1. To obtain more stems 2. More tubers

3. Bigger tubers 4. Higher yields 5. Other (specify).....

93. How do you grow anchote/Dono/Oromo dinich? 1. Monoculture 2. Multiple cropping

94. If multiple cropping, which crops do you grow in association with anchote/Dono/Oromo dinich and Why?

No.	Crops grown in association	Reasons or uses of intercropping
1.	Anchote/Dono/Oromo dinich +	
2.	Anchote/Dono/Oromo dinich +	
3.	Anchote/Dono/Oromo dinich +	
4.	Anchote/Dono/Oromo dinich +	

95. When do anchote/Dono/Oromo dinich get ready for harvest? .....
96. When do you harvest anchote/Dono/Oromo dinich for home consumption? .....
97. How do you store anchote/Dono/Oromo dinich harvested for consumption? .....
98. How long is the maximum storage duration of anchote/Dono/Oromo dinich for consumption? .....
99. When do you harvest anchote/Dono/Oromo dinich for sale (like when need arise).....
100. How do you store seed tubers harvested for sale? .....
101. How long is the maximum storage duration of anchote/Dono/Oromo dinich harvested for sale? ...
102. When do you harvest anchote/Dono/Oromo dinich for use as seed tuber? .....
103. When do you harvest true seed? .....
104. How do you store true seed? .....
105. How do you store seed tubers harvested for planting? .....
106. How long is the maximum storage duration of anchote/Dono/Oromo dinich for seed tubers?
107. What kind of tool you used for harvesting? .....
108. What special conservation treatments do you use before storage? .....
109. What storage problem do you encounter? .....
110. Who is doing what in relation to anchote/Dono/Oromo dinich production?

No.	Activities	Labor division			
		Men	Women	Boys	Girls
1.	Land allocation for different crops				
2.	Land preparation				
3.	Variety selection				
4.	Seed/seed tuber selection for planting				
5.	Planting/sowing				
6.	Weeding/disease/pest/insect control				
7.	Cultivation				
8.	Transporting manure/fertilizer to the field				
9.	Fertilize/manure application to the crop field				
10.	Irrigation of the field				
11.	Earthing up				
12.	Harvesting				
13.	Storing				
14.	Marketing				
15.	Allocation of tuber seed/seed for consumption, selling and planting				
16.	Income control from sale				
17.	Utilization of income obtained from sale				
18.	Value adding/cooking				
19.	Who are privileged to consume mostly				

111. Have you ever received any farmers training or advice in relation to anchote/Dono/Oromo dinich production?

1. Yes                      2. No

112. If YES what was the training all about? .....

113. Rate constraints that affect anchote/Dono/Oromo dinich production in your farm?

No.	List of Constraints	Severity of constraints (TICK)

		No constraint	Low constraint	Medium constraint	High constraint
1.	Lack of improved variety				
2.	Lack of tuber seed				
3.	Shortage of true seed				
4.	Lack of improved management skill				
5.	Lack of government attention				
6.	Lack of storage facility				
7.	Shortage of land				
8.	Low productivity				
9.	Drought				
10.	High labor demand				
11.	Short shelf life				
12.	Shortage of capital				
13.	Lack of ox				
14.	Disease				
15.	Insects/pest				
16.	Wild animal				
17.	Long maturity				
18.	Displacement with other crops				
19.	Lack of credit				
20.	Low market demand				
21.	Low price				
22.	Long cooking time				
23.	Existence of hairy structure				
24.	Fast digestion				
25.	Lack of children's interest				

114. Indicate animals/diseases/pests/insects that affect the plant/tuber along with their protection

Types of animals/ diseases/pests/insects	Name	Plant part (leaf/tuber)	Protection methods
Domestic animals			
Wild animals			
Field/storage disease			
Field/Storage/Insects/pest			
Weeds			

115. Why do you produce less compared to other crops? .....

116. What types of extension services do you get? .....

117. What is your plan/attitude towards future production of anchote/Dono/Oromo dinich? 1. Want to continue growing 2. Want to increase the land allocated for anchote/Dono/Oromo dinich production 3. Others (explain)

118. What needs to be done in your perception in order to tackle the mentioned constraints to enhance anchote/Dono/Oromo dinich production? .....

#### Food Security Indicator Questionnaire

1. In the past 30 days, how often did you or any HH member have to go a whole day without eating?

1. Never  
 2. Rarely (once or twice in the past four weeks)  
 3. Sometimes (three to ten times in the past four weeks) 4. Often (more than ten times in the past four weeks)

2. In the past 30 days, how often did you or any HH member go to sleep at night hungry?

1. Never  
 2. Rarely (once or twice in the past four weeks)  
 3. Sometimes (three to ten times in the past four weeks) 4. Often (more than ten times in the past four weeks)

3. In the past 30 days, how often was there ever no food in your HH?

1. Never  
 2. Rarely (once or twice in the past four weeks)  
 3. Sometimes (three to ten times in the past four weeks) 4. Often (more than ten times in the past four weeks)

4. In the past month, how often has the HH had to skip entire days without eating?
  5. Never
  6. Rarely (once or twice in the past four weeks)
  7. Sometimes (three to ten times in the past four weeks)
  8. Often (more than ten times in the past four weeks)
5. In the past month, how often has the HH had to send HH members to beg?
  1. Never
  2. Rarely (once or twice in the past four weeks)
  3. Sometimes (three to ten times in the past four weeks)
  4. Often (more than ten times in the past four weeks)
6. In the past month, how often has the HH had to send HH members to eat elsewhere?
  1. Never
  2. Rarely (once or twice in the past four weeks)
  3. Sometimes (three to ten times in the past four weeks)
  4. Often (more than ten times in the past four weeks)
7. In the past month, how often has the household eaten any pulses?
  1. Never
  2. Rarely (once or twice in the past four weeks)
  3. Sometimes (three to ten times in the past four weeks)
  4. Often (more than ten times in the past four weeks)
8. In the past month, how often has the household eaten any food made from grain?
  1. Never
  2. Rarely (once or twice in the past four weeks)
  3. Sometimes (three to ten times in the past four weeks)
  4. Often (more than ten times in the past four weeks)
9. In the past month, how often has the HH had to consume seed stock held for next season?
  1. Never
  2. Rarely (once or twice in the past four weeks)
  3. Sometimes (three to ten times in the past four weeks)
  4. Often (more than ten times in the past four weeks)
10. In the past month, how often has the HH had to gather wild food, hunt, or harvest immature crops?
  1. Never
  2. Rarely (once or twice in the past four weeks)
  3. Sometimes (three to ten times in the past four weeks)
  4. Often (more than ten times in the past four weeks)
11. In the past month, how often has the HH had to purchase food on credit?
  1. Never
  2. Rarely (once or twice in the past four weeks)
  3. Sometimes (three to ten times in the past four weeks)
  4. Often (more than ten times in the past four weeks)
12. In the past month, how often has the HH had to borrow food, or rely on help from a relative?
  1. Never
  2. Rarely (once or twice in the past four weeks)
  3. Sometimes (three to ten times in the past four weeks)
  4. Often (more than ten times in the past four weeks)
13. In the past 30 days, how often did you or any HH member have to eat foods you did not want to eat?
  1. Never
  2. Rarely (once or twice in the past four weeks)
  3. Sometimes (three to ten times in the past four weeks)
  4. Often (more than ten times in the past four weeks)
14. In the past 30 days, how often did you or any HH member have to eat a limited variety of foods?
  1. Never
  2. Rarely (once or twice in the past four weeks)
  3. Sometimes (three to ten times in the past four weeks)
  4. Often (more than ten times in the past four weeks)
15. In the past 30 days, how often were you or any HH member not able to eat the kinds of foods you preferred?
  1. Never
  2. Rarely (once or twice in the past four weeks)
  3. Sometimes (three to ten times in the past four weeks)
  4. Often (more than ten times in the past four weeks)
16. In the past month, how often has the HH had to reduce the number of meals eaten in a day?
  1. Never
  2. Rarely (once or twice in the past four weeks)
  3. Sometimes (three to ten times in the past four weeks)
  4. Often (more than ten times in the past four weeks)
17. In the past month, how often has the HH had to limit portion size at mealtimes?
  1. Never
  2. Rarely (once or twice in the past four weeks)
  3. Sometimes (three to ten times in the past four weeks)
  4. Often (more than ten times in the past four weeks)
18. In the past 30 days, how often did you worry that your HH would not have enough food?
  5. Never
  6. Rarely (once or twice in the past four weeks)
  7. Sometimes (three to ten times in the past four weeks)
  8. Often (more than ten times in the past four weeks)
19. In the past 30 days, how do you assess your household food security status?
  1. Food secure
  2. Mildly food insecure
  3. Moderately food insecure
  4. Severely food insecure (4 or worst)
20. In the past month, how often has the household eaten any dairy products?
  1. Never
  2. Rarely (once or twice in the past four weeks)
  3. Sometimes (three to ten times in the past four weeks)
  4. Often (more than ten times in the past four weeks)
21. In the past month, how often has the household eaten any eggs?
  1. Never
  2. Rarely (once or twice in the past four weeks)
  3. Sometimes (three to ten times in the past four weeks)
  4. Often (more than ten times in the past four weeks)
22. In the past month, how often has the household eaten any meat, fish?

- 1. Never
  - 2. Rarely (once or twice in the past four weeks)
  - 3. Sometimes (three to ten times in the past four weeks)
  - 4. Often (more than ten times in the past four weeks)
23. In the past month, how often has the household eaten any fruits?
- 1. Never
  - 2. Rarely (once or twice in the past four weeks)
  - 3. Sometimes (three to ten times in the past four weeks)
  - 4. Often (more than ten times in the past four weeks)
24. In the past month, how often has the household eaten any vegetables?
- 1. Never
  - 2. Rarely (once or twice in the past four weeks)
  - 3. Sometimes (three to ten times in the past four weeks)
  - 4. Often (more than ten times in the past four weeks)
119. On average how many months do you able to feed your households from own production?
120. Would you meet your households' annual food requirement from your own crop and animal production?
- 1. Yes
  - 2. No
121. If your answer is NO how do you fill the gap? .....
122. Does the income you earn from off/non-farm activities allow you to buy food during shortages?
- 1. Yes
  - 2. No
123. What are the main bottlenecks to produce crops and raise livestock that enable you to be self-sufficient in food? .....
124. What are the major bottlenecks to access off/Non-farm to support your family? .....
125. Which period in the year do you encounter permanent or seasonal food shortage/insecurity?
126. How do you cope with food shortages during this period? What are your coping strategies? .....
127. Are there less preferred famine foods that are consumed by your household during food shortages?
- 1. Yes
  - 2. No
128. If YES what are those food items? .....

## Annex 2 General checklist for FGD, Individual case studies and Key informants

### A. Key informants – Woreda agricultural bureau officers and DAs

- 1. Number of rural kebeles and urban kebeles
- 2. Population size
- 3. Area of the Woreda in ha or km<sup>2</sup>
- 4. Agro-climate (type, distribution and proportion)
- 5. Land-use land cover (type and distribution)
- 6. Vegetation cover: types, density, deforestation, etc.
- 7. Soils aspects: types, distribution, degradation (erosion, leaching, salinization, etc.)
- 8. Rainfall: (amount, distribution and variability)
- 9. Relief (plain, plateau, mountain, cliff and steep slopes)
- 10. Irrigation scheme in the Woreda
- 11. Main staple foods
- 12. Culture, value, traditions
- 13. Main source of livelihood
- 14. Major crop types grown in the area: dominant in terms of area cultivated and size of harvest during the year 2015/16
- 15. Major livestock production in the area: types, population, raising practices (common and unique features)
- 16. Non-farm/off-farm activities: availability, options and constraints
- 17. Situations of social and economic infrastructure: roads, transport, water, health, school, marketing, extension services, etc.
- 18. General production and marketing situation of Anchote/Dono/Oromo Dinich and constraints related to production, storage, marketing, processing, utilization, multiplication, etc.
- 19. What needs to be done in your opinion to tackle the mentioned constraints related to Anchote/Dono/Oromo Dinich production

Food security situation in the Woreda (Key informant Woreda agricultural bureau officers and DAs)

1. Drought, famine and food insecurity history of the area (root causes)
2. Food supply – adequate/inadequate/surplus or deficit at this Woreda? If there has been deficit, why?
3. Access – production (can people produce sufficient food?)
  - ✓ Purchase (who supplements food by purchasing)
  - ✓ What is the source of income in the area?
  - ✓ Transfer/gathering – who relies upon community resources to supplement their means of subsistence?
4. Who are the most vulnerable to food shortage/insecurity on a temporal/permanent base? Why? If insecure, why?
5. Is the food produced by the farmers adequate to cover their annual consumption requirement?
6. If they are unable to produce sufficient amount at home, can they purchase from local markets?
7. Are there households who supplement their source of livelihoods by receiving relief support freely or through safety net candidates?
8. What are the SHOCKS and RISKS in this area?
9. Which areas of the Woreda/kebeles are most vulnerable to food shortage/insecurity?
10. Are there any factors that explain this spatial variation?
11. What are the people's main coping mechanisms in times of food shortage? (such as sale of livestock, sale of fire woods, agricultural tools rental, alteration of consumption patterns, reduction of food portion, cash for work, gifts and/or borrowing cash and/or grain from well-off relatives and/or neighbors, sale off or mortgaging land, collection of wild foods, relief assistance and spontaneous migration, etc.)
12. Contribution of rural policy and institutions to alleviate the food shortage/insecurity problem.
13. Food security policy, new agricultural extension programs, etc.
14. Is there any NGO interventions in curbing food shortage/insecurity: development activities (protection), mitigating the problem, and relief (during severe problem).

Major problems of farmers in the community with regard to:

20. Crop production
21. Livestock raising
22. Off-farm income-generating ventures
23. Non-farm income generating activities
24. Land availability, fertility, etc.
25. Constraints in tackling food shortage
26. In your opinion what needs to be done in order to tackle the mentioned constraints to enhance the wellbeing of the farmers

B. In-depth individual household interview

1. Name, age, sex, family size
2. Level of education
3. Marriage history
4. Labor demand and supply (who can work and who cannot among family members)
5. How long it is since you have started farming
6. Farmland size
7. Ways of getting access to land in different times – own use or sharecropping in/out
8. Trends in your landholding size over the last 10 or so years
9. Perceived status of farmland in terms of suitability for farming and soil fertility
10. Main problems related to your farmland
11. Land management practices in this area (soil conservation, plantation, etc.)
12. Drought/rainfall distribution and famine history of the area
13. History of the area: landscape and biodiversity of the area
14. Land resource change over the past 10 or so years: vegetation, soils, water use and distribution
15. Common staple foods in this area - is there any change in type of staple foods and foodstuffs
16. Your major livelihood
17. Major sources of your income
18. Availability and access to irrigation scheme and related problem
19. Availability and access to credit service and related problem
20. Main health problems experienced by the household members
21. How long it is since you have started growing Anchote/Dono/Oromo Dinich?

22. Management practice of Anchote/Dono/Oromo Dinich (land preparation, planting season, cultivation, earthing up, harvesting, storage, marketing)
23. Is Anchote/Dono/Oromo Dinich contributing to your household food security? If yes explain how?
24. What are the cultural/social values of Anchote/Dono/Oromo Dinich to your household/community?
25. What are the medicinal values of Anchote/Dono/Oromo Dinich to your household/community?
26. Types of foods prepared out of Anchote/Dono/Oromo Dinich, their preparation methods and mode of utilization
27. Is there any sayings or customs that express the importance of Anchote/Dono/Oromo Dinich? What is its implied meaning?
28. Trends in Anchote/Dono/Oromo Dinich production in the last 10 or so years (increasing/decreasing/no change – why?)
29. Marketing situation of Anchote/Dono/Oromo Dinich
  - a. Availability of market and its access (distance from the community residence)
  - b. Where do you sell Anchote/Dono/Oromo Dinich?
  - c. How do you transport the produce to market?
  - d. To whom do you sell (private trader/buyer, direct retail to consumers, others (specify)?)
  - e. When does the price of Anchote/Dono/Oromo Dinich become high?
  - f. When does the price of Anchote/Dono/Oromo Dinich become low?
  - g. In which market Anchote/Dono/Oromo Dinich fetch better price?
30. What are the constraints related to Anchote/Dono/Oromo Dinich production, storage, marketing, processing, utilization, etc.?
31. What do you suggest to improve Anchote/Dono/Oromo Dinich production?
32. Which NGOs operate in root and tuber crops development/production?
33. Which farm inputs do you use?
34. Constraints related to input supply
35. Livestock owned (types and size)
36. Constraints to livestock raising
37. Types and amount of crops produced and constraints related to crop production
38. What opportunities of off/non-farm activities available to you and your families
39. Constraints related to access to off/non-farm activities
40. Participation in formal and informal institutions
41. Average number of months you are able to feed your household from own production
42. What are the main bottlenecks in producing enough crops and raising stock to enable you to be self-sufficient in food?
43. How do you survive food shortage seasons (coping strategies)?
44. Are there less preferred famine/wild foods that are consumed by your household during food shortages seasons?
45. What causes you/the household food insecure in this area?
46. Constraints in tackling food shortage in this area
47. What do you expect from government, NGOs and the people at large?
48. How do you think your household livelihood (standard of living) will improve?

C. Check List for Focused Group Discussion Producers

1. Zone .....

2. District.....

3. Major crops grown in this Woreda (Pairwise ranking)

N.o	Crop types	Pairwise ranking
1.		
2.		

4. Major source of income for farmers in this Woreda (Pairwise ranking)

No.	Sources of income	Pairwise ranking
1.		
2.		
3.		

5. Producers' reason for Anchote/Dono/Oromo Dinich production over the other crops

No	Uses/purposes of producing Anchote/ Dono/Oromo Dinich	Pairwise ranking
1.		
2.		
3.		

6. Types of foods prepared out of Anchote/Dono/Oromo Dinich, preparation methods, and utilization?

S.no.	Types of food	Preparation methods	Consumed as major meal, accompany other food...
1.			
2.			

7. Is there any cultural/traditional significance of Anchote/Dono/Oromo Dinich in this area? If yes, please tell us some of the cultural values/dishes prepared from it?

8. Is Anchote/Dono/Oromo Dinich has any medicinal value? If yes, please tell us which plant part is used for treating which specific health problem/disease?

9. Is there any sayings that express the importance of Anchote/Dono/Oromo Dinich in this area? What does that mean?

10. Is farmers grow Anchote/Dono/Oromo Dinich around homesteads or at the main field? Why?

11. Is farmers grow Anchote/Dono/Oromo Dinich as Monoculture or Multiple cropping

12. If multiple cropping, which crops do you grow in association with Dono/Oromo Dinich?

No.	Crops grown in association	Farm land (near home stead or main field)	Give reasons or uses of intercropping
1.			
2.			

13. Farmers' indigenous agronomic management practice of Anchote/Dono/Oromo Dinich

No.	Activities
1.	Months for preparing the land (seasonal mapping)
	Mode of preparing the soil (furrow, flat (as for cereals), patch and raised bed)
	Frequency of ploughing the land before planting and why?
	Tools used for land preparation (Ox, digging hoe, spade, <i>tsoile</i> , )
	Planting time (season) ( <i>note: take picture of land preparation</i> )
2.	Types of planting material (whole tuber, tuber pieces, true seed)
	Which plant part is used for planting purpose? Why? In case of tuber pieces time for breaking the whole tuber (day of planting: one day before planting, two days before planting, three or four days before planting)
	Is there any treatment of seed tuber pieces between breaking and planting (like spreading tubers in dry place in the house, mixing with ash, no treatment)
	Is planting the tuber pieces practiced with sprouts or after de-sprouting
3.	What type of fertilizer farmers apply
	Time of fertilizer application (during planting, any time, others)
	Frequency of application until harvesting
4.	Do farmers practice cultivation?
	Reasons/rationale for cultivation
5.	Do farmers practice wedding? Frequency of wedding
6.	Do farmers practice tipping?
	If yes, rationale for tipping
7.	Do farmers practice Earthing up
	If yes, rationale for earthing up
8.	Do farmers use pesticides for the production of Anchote/ Dono/Oromo Dinich?
9.	Tuber harvesting
	Time for harvesting tubers for home consumption
	Time for harvesting tuber for sale
	Time of harvesting tuber for use as seeds

	Tools used for harvesting
10.	Tuber storage Storage method of tubers for home consumption (stored in situ in the ground/soil, etc.) Maximum storage duration for home consumption Storage methods used before selling and maximum storage duration until selling Storage methods used for seed tubers (left in the place where they were grown until planting, etc.) Maximum storage duration for seed tubers until planting
11.	Seed tuber/true seed acquisition
12.	Trends of Anchote/Dono/Oromo Dinich production over the past 10 or so years (increasing, decreasing, or no change) Reasons for the said trend
13.	Utilization How do the crop utilized (is the tubers and/or root, eaten cooked) consumed as part of a major meal or accompany or how?
14.	Farmers attitudes towards future production of Anchote/Dono/Oromo Dinich – whether farmers want to continue growing Anchote or not?
15.	Why farmers produce less compared to Irish Potato?
16.	What needs to done in your perception in order to tackle the mentioned constraints and enhance the crop production

14. List local cultivar found in this Woreda (pairwise ranking)

No.	Dono/Oromo Dinich/anchote cultivar	Pairwise ranking
1		
2		
3		

15. Characteristics of each local cultivars and farmers variety selection criteria according to their importance

S.no	Farmers variety selection criteria	Pairwise ranking
1.		
2.		
3.		

16. Is there any local variety/s of Anchote/Dono/Oromo Dinich that farmers around this area use to grow but not found any more? If any, what is the local name and the possible reasons of extinction?

17. Production constraints associated to Anchote/Dono/Oromo Dinich production

No.	List of Constraints	Pairwise ranking
1.		
2.		
3.		

18. Animals/diseases/pests/insects which affect the plant/tuber along with their protection

Types of animals/ diseases/pests/insects	Name	Plant part (leaf/tuber)	Protection methods
Domestic animals			
Wild animals			
Field/storage disease			
Field/Storage Insects/pest			
Weeds			

19. Is the production of Anchote/Dono/Oromo Dinich is laborious and time consuming or easily practiced compared to other crops like Irish potato, if yes how?

20. Do the government and NGOs attempt to promote public participation in Anchote/Dono/Oromo Dinich related development activities, and in what ways?

21. Are there any NGOs working on Anchote/Dono/Oromo Dinich production activities?

22. What needs to be done in your opinion to tackle the mentioned constraints related to Anchote/Dono/Oromo Dinich production

23. Who is doing what in relation to Anchote/Dono/Oromo Dinich production?

No.	Activities	Men	Women	Boys	Girls
1.	Land allocation for different crops				
2.	Land preparation				
3.	Variety selection				
4.	Seed/seed tuber selection for planting				
5.	Planting/sowing				
6.	Weeding/disease/pest/insect control				
7.	Cultivation				
8.	Transporting manure/fertilizer to the field				
9.	Fertilize/manure application to the crop field				
10.	Irrigation of the field				
11.	Earthing up				
12.	Harvesting				
13.	Storing				
14.	Marketing				
15.	Allocation of tuber/seed for consumption, selling and planting/sowing?				
16.	Income control from sale				
17.	Utilization of income obtained from sale				
18.	Value adding/cooking				
19.	Who are privileged to consume mostly				

24. How is the knowledge of production practice passed from elders to younger people in the study area?

25. Have you ever advised farmers about improved management practice of Anchote/Dono/Oromo Dinich? If yes in what aspect? If no, why?

26. How do you perceive the contribution of this crop toward the household food security as compared to other root crops?

Marketing value chain analysis

- i. Where do farmers sell Anchote/Dono/Oromo Dinich?
- ii. How do you perceive price of Anchote/Dono/Oromo Dinich in different market?
- iii. In which market do Anchote/Dono/Oromo Dinich fetch better price
- iv. When do Anchote/Dono/Oromo Dinich fetch better price
- v. When do Anchote/Dono/Oromo Dinich fetch lower price
- vi. How do farmers transport the produce to market?
- vii. To whom do farmers sell their produce (private trader/buyer, direct retail to consumers, others (specify)?

Major problems of farmers in the community with regard to:

1. Crop production
2. Livestock raising
3. Off-farm income-generating ventures
4. Non-farm income-generating ventures
5. Farm land (land availability, fertility, etc.).
6. Drought, famine and food insecurity situation in this area
7. What causes the household food insecure in this area?
8. How do farmers cope with food shortage season/farmers coping mechanisms
9. Constraints in tackling food shortage by the household

### Annex 3 Logit regression analysis in P.edulis growing area

Log likelihood = -103.17638				Number of obs	247	
				LR chi2(16)	86.26	
				Prob > chi2	0.0000	
				Pseudo R2	0.2948	
hfstatus	Coef.	Std. Err.	z	P> z	[95% Conf.	Interval]
woreda	1.983824	.6434584	3.08	0.002	.7226685	3.244979
age	.0327123	.0131345	2.49	0.013	.0069691	.0584555
sex	-.3932462	.447115	-0.88	0.379	-1.269575	.483083
educionlev	.0658059	.1784591	0.37	0.712	-.2839676	.4155793
totfmlysiz	-.1180236	.0912438	-1.29	0.196	-.2968581	.0608109
totlcrphrv	.1242873	.0369132	3.37	0.001	.0519389	.1966358
cashsavact	.384732	.405013	0.95	0.342	-.4090788	1.178543
tecadopn	.348454	.6713588	0.52	0.604	-.9673851	1.664293
growanped	.1690283	.3646538	0.46	0.643	-.5456801	.8837367
TLU	.1384625	.0753172	1.84	0.066	-.0091566	.2860816
socalcapil	-.1604249	.3080825	-0.52	0.603	-.7642554	.4434056
nonfrmpart	.8128123	.4844121	1.68	0.093	-.1366179	1.762243
depratio	-.1707953	.1884994	-0.91	0.365	-.5402474	.1986569
marketdist	-.6032966	.3705846	-1.63	0.104	-1.329629	.1230359
famlnsize	1.262326	.4132705	3.05	0.002	.4523307	2.072321
anulincom	.0001502	.0000487	3.08	0.002	.0000547	.0002456
cons	-3.6872	1.206045	-3.06	0.002	-6.051005	-1.323394

### Annex 4 Marginal effects after logit in P.edulis growing area

variable	dy/dx	Std. Err.	z	P>z	[ 95%	C.I.]	X
woreda*	.212606	.06655	3.19	0.001	.08217	.343042	.380567
age	.0039545	.0016	2.48	0.013	.000826	.007083	47.749
sex*	-.0457702	.05001	-0.92	0.360	-.143778	.052238	.639676
educio~v	.007955	.02147	0.37	0.711	-.03413	.05004	1.92713
totfml~z	-.0142674	.01109	-1.29	0.198	-.036009	.007474	5.51822
totlcr~v	.0150246	.00402	3.74	0.000	.007152	.022897	11.2024
cashsa~t*	.0445606	.04521	0.99	0.324	-.044043	.133164	.340081
tecadopn*	.0467943	.1	0.47	0.640	-.149211	.2428	.927126
growan~d*	.0202744	.04388	0.46	0.644	-.065721	.10627	.433198
TLU	.0167382	.00878	1.91	0.057	-.000475	.033952	3.94857
socalc~l	-.0193931	.03735	-0.52	0.604	-.092605	.053819	1.17032
nonfirm~t*	.1108797	.07329	1.51	0.130	-.03277	.254529	.704453
depratio	-.0206467	.02259	-0.91	0.361	-.064924	.023631	1.14117
market~t	-.07293	.04544	-1.60	0.108	-.16199	.01613	.756113
famln~e	.1525973	.04826	3.16	0.002	.058003	.247191	.727891
anulin~m	.0000182	.00001	3.31	0.001	7.4e-06	.000029	5574.78

(\*) dy/dx is for discrete change of dummy variable from 0 to 1

## Annex 5 Logit regression analysis in anchote growing area

Log likelihood = -37.636506				Number of obs	153
				LR chi2(16)	92.25
				Prob > chi2	0.0000
				Pseudo R2	0.5611
fstatus	Coef.	Std. Err.	z	P>z	[95% Conf. Interval]
woreda	-.9909164	.906638	-1.09	0.274	-2.767894 .7860614
age	-.047447	.0264263	-1.80	0.073	-.0992416 .0043477
sex	-1.275755	1.036754	-1.23	0.218	-3.307756 .7562449
educonlev	-.8058523	.8747207	-0.92	0.357	-2.520273 .9085688
totfmlysiz	.1346668	.1966875	0.68	0.494	-.2508336 .5201673
totlcrphrv	.233044	.0712838	3.27	0.001	.0933303 .3727577
cashsavact	-1.188733	1.001766	-1.19	0.235	-3.152158 .7746912
fminptfrlz	-1.959707	1.262416	-1.55	0.121	-4.433998 .5145839
growancdin	1.787766	.8268918	2.16	0.031	.167088 3.408444
TLU	.150422	.1173824	1.28	0.200	-.0796432 .3804873
socalcapil	-.5703436	.6391351	-0.89	0.372	-1.823025 .6823382
nonfirmpart	-.2717054	.6767201	-0.40	0.688	-1.598052 1.054642
depratio	-1.548615	.5190813	-2.98	0.003	-2.565996 -.5312345
marketdist	-2.166588	.8779124	-2.47	0.014	-3.887265 -.4459118
farmlndsiz	.8176858	.8473953	0.96	0.335	-.8431784 2.47855
anualincom	.0001356	.0000677	2.00	0.045	2.96e-06 .0002683
_cons	5.069382	2.834066	1.79	0.074	-.485285 10.62405

## Annex 6 Marginal effects after logit in anchote growing area

variable	dy/dx	Std. Err.	z	P>z	[ 95% C.I. ]	X
woreda*	-.0330199	.03541	-0.93	0.351	-.102413 .036373	.457516
age	-.0014714	.00114	-1.29	0.197	-.003705 .000762	43.0131
sex*	-.0264097	.02086	-1.27	0.206	-.0673 .014481	.882353
educon~v*	-.0206014	.02087	-0.99	0.324	-.061503 .0203	.784314
totfml~z	.0041762	.00624	0.67	0.503	-.008054 .016407	5.41176
totlcr~v	.007227	.00356	2.03	0.042	.00025 .014204	16.2157
cashsa~t*	-.0559822	.06752	-0.83	0.407	-.188321 .076357	.156863
fminpt~z*	-.032943	.02093	-1.57	0.115	-.073958 .008072	.901961
growan~n*	.0716811	.05235	1.37	0.171	-.030931 .174293	.594771
TLU	.0046648	.00391	1.19	0.232	-.00299 .01232	4.91482
socalc~l	-.0176872	.02183	-0.81	0.418	-.060476 .025101	.810093
nonfirm~t*	-.0087248	.02321	-0.38	0.707	-.054211 .036761	.372549
depratio	-.0480248	.02864	-1.68	0.094	-.104149 .0081	.862971
market~t	-.067189	.04212	-1.60	0.111	-.149737 .015359	.790327
farmln~z	.0253576	.0288	0.88	0.379	-.03108 .081795	.622752
anuali~m	4.21e-06	.00000	1.49	0.136	-1.3e-06 9.7e-06	9860.68

(\*) dy/dx is for discrete change of dummy variable from 0 to 1

## Annex 7 Summary of goodness-of-fit model assessment

Goodness-of-fit assessment statistics	P.edulis growers	Anchote growers
Hosmer-Lemeshow chi2(8)	5.87	4.90
Prob > chi <sup>2</sup>	0.6621	0.7684
Sensitivity	88.76%	93.04%
Specificity	56.52%	73.68%
Correctly classified	79.76%	88.24%
Cronbach's Alpha/scale reliability coefficient	0.5673	0.6002