COLLEGE OF DEVELOPMENT STUDIES

CENTER FOR FOOD SECURITY STUDIES

ROLE OF UNDERUTILIZED CROPS IN IMPROVING FOOD SECURITY OF THE HOUSEHOLDS: A CASE STUDY IN GUTO GIDA DISTRICT, ETHIOPIA

DABA MENGESHA ADULA (GSR/2067/12)

OCTOBER, 2021

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A THESIS SUBMITTED TO CENTER FOR FOOD SECURITY STUDIES, COLLEGE OF DEVELOPMENT STUDIES ADDIS ABABA UNIVERSITY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN FOOD SECURITY AND DEVELOPMENT

OCTOBER, 2021

ADDIS ABABA, ETHIOPIA

APPROVAL SHEET

ADDIS ABABA UNIVERSITY

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As supervisor of the thesis, I certify that I have read and evaluated the thesis prepared by **Daba Mengesha** Entitled 'Role of Underutilized Crops in Increasing Food Security and Livelihoods of the Households: A Case Study in Guto Gida Woreda, Ethiopia' and recommend as fulfilling the requirement for the **degree of Master of Science Degree in Food Security and Development Studies**.

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Name, Major Advisor Signature & Date

As members of the Examining Board of the Thesis Open Defense, we certify that we have read and evaluated the thesis prepared by **Daba Mengesha** Entitled 'Role of Underutilized Crops in Increasing Food Security and Livelihoods of the Households: A Case Study in Guto Gida Woreda, Ethiopia' and recommend that it is acceptable as a proposal for the thesis required for the degree of Master of Science Degree in Food Security and Development Studies.

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Final approval and acceptance of this thesis is contingent upon the candidate's submission of the final copy of the proposal, incorporating all the comments by Examining Board, to the Council of Graduate Studies (CGS) through the Centre Academic Committee (CAC) of the Centre.

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Acknowledgements

I would like to give my heart full thanks to the Almighty God for his help and support me in all ups and down of my journey.

The accomplishment of this thesis would have been impossible without the encouragement and assistance of many individuals. First and foremost, my appreciation and gratitude go to my research advisor, Dr Messay Mulugeta for his valuable advice, comments and unreserved guidance. I greatly acknowledge him for allocating me adequate time for careful advisement from the inception to the conclusion of my research work. Without his encouragement, inspiration and professional support, the thesis work would have not been completed. His contribution to the completion of this study is priceless. Thank you, Dr. Messay for your impartiality, objectivity and uninterrupted supervision from the inception to the end of this research. Furthermore, I would also like to thank Dr Meskerem Abi, Head of Center for Food Security Studies, Addis Ababa University, and for the vital resources she shared me for this research. I witnessed Dr Meskerem kindness, selflessness and her impartiality at large. I am also grateful to the examination board of my thesis: _________________. I'm forever grateful to my beloved families, Malke Gerememu, my children and my friends for their continually supports and encouragement throughout my study and in all activities of my thesis work.

Finally, I would like to dedicate my work to my family and friends, especially my parents who afforded me this amazing opportunity through the many sacrifices and hardships they have endured

Daba Mengesha Adula

October, 2021

Declaration

I, **Daba Mengesha Adula,** do hereby declare to Addis Ababa University School of Graduate Studies that this thesis is a product of my original research work, and it has not been submitted to any other university for any academic degree. Materials and information other than my own are dually acknowledged.

Name: **Daba Mengesha Adula**

Signature: ______________________

Date of Submission: October, 2021

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Abbreviations and Acronyms

ADP	Area Development Program
ASWAP	Agricultural Sector Wide Approach
AVGRIS	Asian Vegetable Genetic Resources Information System
AVRDC	Asian Vegetable Research and Development Center
CDI	Crop Diversification Index
CGIAR	Consultative Group on International Agricultural Research
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Centre for Tropical Agriculture
CSA	Central Statistical Agency
DAs	Developmental Agents
EFSA	Emergency Food Security Assessment
EPA	Extension Planning Areas
FAO	Food and Agriculture Organization
FCS	Food Consumption Score
GDP	Gross Domestic Product
FGD	Focused Group Discussion
FNS	Food and Nutritional Security
GAPR	Global Agricultural Productivity Report
GDP	Growth Domestic Product
GGAO	Guto Gida Administration Office
HDDS	Household Dietary Diversity Score
HI	Herfindahl Index
HVCC	High Value Commercial Crops
IFAD	International Fund for Agricultural Development
IK	Indigenous Knowledge
IPCC	Intergovernmental Panel on Climate Change
IPGRI	International Plant Genetic Resources Institute
KIIs	Key Informants Interviews
MoAFS	Ministry of Agriculture and Food Security

NGOs	Non-Governmental Organizations
NUCS	Neglected and Underutilized Crop Species
NUS	Neglected and Underutilized Species
OLS	Ordinary Least Squares
ONRS	Oromia National Regional State
UNDP	United Nations Development Programs
UNSCN	United Nations System Standing Committee on Nutrition

Abstract

This paper focused on the contribution of crop diversification with underutilized crops in improving household food security and livelihoods in Guto Gida district of Ethiopia. Most of the farmers produce only stable food crops without considering their productivity, nutritional value and production sustainability. Besides, nutritional role, productivity, and stress tolerance of underutilized crops was not equally known and promoted in this region even though it improves nutritional quality and increases purchasing power of the households. Multistage sampling techniques was applied on a sample of 120 smallholder farmers was taken. Households are categorized as underutilized crop producers and non-producers. Food Consumption Score and Coping Strategy Index were employed to measure food security status of households. Ordinary least squares and simple leaner regression models, and descriptive statistic were used to analyze the data. The diversified producers of underutilized crops had showed significant level of crop production (22.48%), consumption (11.73%), total annual sale (19.32%) and total income generation (26.67%) than the non-producers of underutilized crops at alpha 5%. Based on this result it can be conclude that crop diversification with underutilized crops is one of the important options that can contribute significantly to household food security and livelihood status. Overall results of the survey imply that the current agricultural policy of Ethiopia government was not given attention to diversify and promotion the underutilized crops, so it should get series attention and firm, specific, clear policy and strategies due to the continued malnutrition and food insecurity threat in the country.

Keywords: *underutilized crop; food security; Food Consumption Score; Coping Strategy Index; Guto Gida district*

CHAPTER ONE: INTRODUCTION

1.1. Background of the Study

Currently world population is now increasing rapidly (UNDESA, 2012). In developing countries, not exceptional to Ethiopia, prevalence of food insecurity and malnourished people are large in number as the reports of (Asrat & Anteneh, 2020) that close to 840 million people are food insecure. This report also indicated that most of the developing counties are growing depended on few high yielding crops and intensify cultivated crops. To halt increasing in hunger and food insecurity knowing the potential of the area and improving in agricultural farming system of the area is key to increase production and productivity. Only a few crop species are cultivated and utilized in crop production in system in different countries (Stamp et al., 2012). Nowadays food and nutritional insecurity frequent in Sub-Saran Africa which stands at 23.8% with most countries being characterized as malnutrition (Gemechu et al., 2016). Agriculture is the main important and determinate sector that is vehicle for addressing food and nutrition security (Barrett, 2010).

The modern agricultural system promotes the cultivation and productivity of a few crops that necessitate high-tech and high-input crops, particularly cereal crops. This has resulted in a decrease in crop diversity and a monotonous nutrition system in crop production or farming in various developing nations, which has been linked to a decrease in nutrition diversity, as well as a decline in environmental health and future sustainable production (Jones et al., 2012). Rather than orienting the production and farming system into a high-input and only high yielding crops agriculture system, which is the only option for uplifting the farmers' livelihoods, different agricultural and development programs have prioritized local resources or opportunities for the communities' livelihoods (Khatiwada et al., 2012; Tafadzwanashe et al., 2017). Even though such crops bring improved nutritional and environmental health to the producing areas or communities, the cultivation and production of underutilized or neglected crops has continued to decline and lead to in all parts of the world (Adhikari et al., 2017). This crop diversity with indigenous crop species is critical to ensuring food and nutritional security in the face of current environmental concerns and a rapidly growing population in a world with limited natural resources (Iram & Butt, 2004).

Most native and underutilized crops are nutrient-dense, demonstrating their adaptability and production potential across continents, reinforcing the necessity of crop diversity in the face of food scarcity and climate change, which must be a priority in future study (Manners & van Etten, 2018).

The agriculture sector produces 90% of the world's food supply, according to FAO (2018), which recognized over 100 crops production statistics from 146 nations. There are an estimated 1,500 to 2,000 plant species utilized as supplementary foods in Southeast Asia alone, with 200 found in household gardens and 80 in market gardens as Engle and Faustino (2007). Only around 20 of those are vegetable crops, which are farmed intensively. There appears to be a large number of crop species viable for human use that have yet to be thoroughly studied. These crops have not been economically farmed because they are understudied and mostly unimproved. Underutilized plant species are those that have the potential to contribute to food security, nutritional and medicinal value, income, and environmental sustainability, but are underutilized (Jaenicke and Hoschle, 2006). These crops contribute to household livelihoods, poverty alleviation through new market options for value-added products, food security, and nutrition maintenance (Hoeschle and Bordoni, 2006; Taylor et al., 2014).

The present agricultural system and recent technology encourage the development and productivity of high-input, high-yielding crop species while intensifying a few numbers of crop species, particularly cereal crops. This has resulted in a decrease in crop diversity and a monotonous nutrition system in agricultural systems around the world, which has been linked to a decrease in nutrition diversity and a decrease in environmental regulatory services. Different agricultural and development programs have not focused on analyzing local opportunities for a community's livelihood based on local crop species and other local agricultural resources, instead focusing on orienting the production and farming system into a high-input and only high yielding crops agriculture system as the only option for improving farmers' livelihoods (Johns, 2004). The cultivation and production of underutilized or neglected crops, in particular, has declined and continues to diminish around the world, despite the fact that such crops have more potential to improve community food and nutritional security. This is especially crucial in a world with limited resources to maintain food and nutritional security for the current growing population (CGIAR, 2004).

New ideas, tactics, and policies are critical for developing countries to ensure food and nutrition security. To solve the food security challenge in drought-prone countries like Ethiopia, these should be long-term, durable, and effective solutions. Crop diversity, particularly neglected or underutilized crops, is critical in addressing food and nutrition security while also mitigating the effects of climate change in this setting (Chivenge, et. al. 2015). They are nutrient-dense crops that have shown the ability to adapt and produce on various areas, highlighting the necessity of crop diversity in the face of food scarcity and climate change, and emphasizing the importance of future study on crop diversity (Mannersa and Etten, 2018).

Cereal crops are the primary dietary source for the majority of Ethiopians. Teff, wheat, maize, sorghum, and barley are the most important cereal crops in Ethiopia's agriculture and food economy, accounting for roughly three-quarters of total cultivated area, 29 percent of agricultural gross domestic product (14 percent of total GDP), and 64 percent of calories consumed (FAO various years). In a report published in 2012, the World Food Programme stated that food insecurity is prevalent in Ethiopia, with rural communities accounting for over a third of the population. As a result, Ethiopia has imported different critical staple crops such as wheat, rice, and others to supplement local production over the years (MoFA, 2015 and 2016; Bogale, 2012). However, the report points out that rice and wheat imports, in particular, have continually climbed over time, a trend that has economic ramifications. Because of the need for high-yielding crop types, agricultural markets have also not favored indigenous crop varieties over the years, resulting in a reduction of the genetic basis. This has consequences for the large range of food crops required to ensure nutritional and food security. Considering the challenges posed by rural food insecurity, it is critical that the country promotes the widespread use of these often-underutilized crops as part of its efforts to solve the problem (Bogale, 2012).

In different parts of Ethiopia, there are several underutilized vegetable and root crops that are used as a food, cultural, social, and economic crop for farming communities. In Ethiopia, there are insufficient studies and written information on these neglected crops. Despite their significant contributions to food security, income generation, food energy provision, and resource base conservation, the food potential of various vegetables, root, and tuber crops has not yet been fully exploited and utilized in all parts of Ethiopia (Guinand and Lemessa, 2000).

Even in the same environmental conditions, there is a difference in the type and amount of crop production in western Ethiopia, such as Guto Gida district. In some kebeles, the population produces only high yielding cereal crops with high intensification farming systems, whereas in other kebeles, they produce a diverse range of crops such as root and tuber crops or underutilized crops with local resouces. As a result, Guto Gida is the greatest sample woreda for examining production variances within the same agro-ecology household. This study intends to utilize resource or local opportunities-based concepts, with a focus on the NUCS advantages, to improve household food security and livelihood. The report also aims to encourage debate among policymakers and relevant players in the research region, as well as in the zonal agriculture sector, to find a place for this important topic. It also communicates with all other stakeholders who identify with and are involved in NUCS-related research to raise awareness of the resource's importance.

1.2. Statement of the Problem

For many years, chronic food insecurity has been a production trend as well as shocks or condition variation in various sections of Ethiopian regions. Around 29% of rural households are food insecure, as evidenced by very low food production and consumption patterns or trends. Most agricultural development interventions have centered on the deployment of high-input, high-output technology that are not sustainable or adaptable by the rural poor. In various sections of the country, there are numerous underutilized and underexplored crop species that might be researched for income creation, family nutrition, and long-term sustainability. Cereal crops are the primary source of sustenance for the majority of Ethiopians. Despite their significant contributions to food security, income generation, food energy provision, and resource base conservation, the food potential of underutilized crops such as vegetables, root and tuber crops has not yet been fully exploited and utilized in Ethiopia's most severely food insecure areas. Furthermore, even within the same agroecology, the consumption and production of these underutilized crops is not uniformly exploited.

Low agricultural productivity, recurrent drought, and socio-political factors have all played a role in Ethiopia's critical food shortages, owing to the country's over-reliance on a few highly rain-fed cereal crops. As a result, the integration of underutilized crops into the people's food system should be given serious consideration. Through social and economic analysis, the research and development program's priorities should be altered to explore local prospects and identify restrictions for exploiting undervalued crop species. In this study, social analysis was used to identify societal barriers that prevent such crop species from being exploited, while economic and food security status analysis was used to analyze the household's livelihood situation. In order to address food security, policies and strategies for promoting and supporting the production and utilization of underutilized crops were examined. In addition, the needs of small farmers were studied in order to boost agricultural production by diversifying crops using underutilized or neglected species. This study promotes and draws attention to the utilization of underused crops as potential sources of various nutrients and high stress tolerant crops to combat food insecurity and improve household livelihoods.

1.3. Objectives

The overriding objective of this study was to explore the major underutilized crops species and examine the significant contribution of underutilized crops to food and nutritional security among the population of Guto Gida district.

More specifically, the study aspires to:

- identify the major underutilized crops (vegetables, root and tuber crops) prevalent in the Guto Gida district
- analyze the relationship between use of underutilized foods with food security status of the household
- investigate the socio-economic contributions of the underutilized crops
- assess the challenges and opportunities for exploitation of the underutilized crops in Ethiopia

1.4. Research Questions

This research intended to answer the following basic questions which are derivatives of the above-mentioned research objectives:

1) What are the underutilized crops/identification of the promising underutilized crops in the farming system of smallholder farms?
2) What are the socio-economic, demographic and institutional factors influencing production of underutilized crops in the smallholder farms?
3) Are households with high underutilized crops producers having more income and more food secure?

4) What are the agricultural policies and strategies guiding the promotion, production and utilization of underutilized crops in the study area/ region?

1.5. Scope and Limitation of the Study

The study has limited spatial scope i.e., Guto Gida woreda. The study area was selected purposively. Only smallholder farming households from the research kebeles' zones are considered. Research also includes a delimitation in that it was limited to looking into the subject under study solely through the lens of the role of underutilized crops in enhancing farmers' food security and livelihoods. As one of the few preliminary studies, this study has limitations in generalizing findings to a broader scope. Because of the restricted financial and time resources available, this study may have limitations in terms of data acquisition (in terms of quantity and time horizon).

1.6. Significance of the Study

At the international, national, regional, and global levels, various studies have been undertaken on the role of crop diversity in increasing food security and livelihoods. However, in Ethiopia, there are no or just a few empirical studies on the significance of underutilized crops in providing food security and boosting livelihoods. As a result, the findings of this study filled a knowledge vacuum in local and institutional solutions to increase food security by diversifying crops and promoting underutilized crops. Based on practical facts from the study region, it has assisted in demonstrating a synergy between crop diversification with underutilized crops and food security. Other researchers benefited from the study's output since it adapted and improved approaches for investigating the relationship between the two issues: food security and crop diversification with underutilized crops. The study's findings have benefited policymakers, local administrations, and farmers by providing them with empirical and scientific proof for the readers. In general, the goal of this research is to add to existing academic knowledge by investigating the function of agricultural diversification methods with underutilized crops in enhancing household food security at the local level.

1.7. Outline of the Thesis

This thesis consists of five chapters. Chapter one presents the general introduction of the thesis that includes: background of the study, statement of the problem, objectives and research questions, significance of the study, scope and limitation of the study. The second chapter devoted to a review of related literature through which various concepts relevant to the study are discussed. The third chapter deals with methodological issues, under which the general descriptions of the study area, the data sources and acquisition techniques as well as method of data collection and data analysis are discussed. The fourth chapter also devoted to results, discussion and analysis based on the processed primary and secondary data of the study. Finally, the fifth chapter is focused to conclusion and recommendation based on the findings of the study.

CHAPTER TWO: RELATED LITERATURE REVIEW

2.1. Theories of Food Security and Livelihood

Food security is a multi-faceted and flexible term, as seen by the numerous attempts by various organizations and individuals to define and interpret it (Maxwell et al, 1992). "A scenario arises when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that fits their dietary needs and food preferences for an active and healthy life," according to the definition of food security (WFS, 1996; FAO, 2002). For many rural households in Sub-Saharan Africa who rely on agriculture as their primary source of income, food insecurity remains a big worry. Gross et al. (2000) identified two types of determinants that influence the framework for food security and livelihoods: physical and temporal determinants. The food flow is the physical determinant: availability, accessibility, and utilization. Availability is accomplished when enough food is available for people to eat. All houses and individuals inside those households have sufficient resources to access appropriate foods for a nutritious diet (via production, purchase, or donation). The ability of the human body to ingest and metabolize food is referred to as adequate utilization. Food consumption is ensured by nutrient-dense and safe diets, a healthy biological and social environment, and effective health care to prevent diseases. Most of the time, usage is discussed solely from a biological standpoint.

Stability refers to the temporal determinant of FNS and affects all three physical elements. It is important to distinguish between chronic food and nutrition insecurity (e.g., repeated food shortages before harvest "seasonality" or lack of caring during harvest) and transitory food and nutrition insecurity (e.g., due to natural and man-made disasters) (Gross et. al., 2000). The three other dimensions access, utilization, and stability came into the discussion starting in the 1980s.

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“seasonality” or lack of caring during harvest) and transitory food and nutrition insecurity (e.g., due to natural and man-made disasters) (Gross et. al., 2000).

According to Baa-Poku (2020) stated, sustainable development can only be realized by using all of a state's resources effectively and efficiently. As a result, local resources are a valuable asset to an organization or a state (Barney, 1991; 2002). To be regarded valuable, a resource must be able to provide opportunities and improve livelihoods; it must also be scarce among competitors; and it must not be easily duplicated or substituted by another resource. The NUCS are one of the most important strategic indigenous plant resources available to the agriculture sector that has not been fully exploited, despite their acknowledged significance to resolving household food insecurity and improving the population's livelihood situation. NUCS (Neglected and Underutilized Crop Species) are an important aspect of agro-biodiversity for increasing food security and community livelihoods (FAO, 2010; Mabhaudhi et. al., 2017).

Livelihood is defined as having sufficient food and cash stocks and flows to meet fundamental necessities. Security refers to having secure ownership of or access to resources and income-generating activities, such as reserves and assets, in order to mitigate risks, smooth out shocks, and fulfill eventualities. The phrase "sustainable" refers to the long-term maintenance or improvement of resource productivity. ‘Livelihood security' is a notion that situates the issue of food access in a broader framework in which people are concerned about non-food costs as well as the preservation of resources necessary to sustain their livelihood in the future (Maxwell, 1991b; Thomson, 2001). There is no single event or condition that causes food insecurity. To eradicate hunger and poverty, there is no simple solution. Every circumstance is different, and it is influenced by both domestic and international factors (Barraclough, 1991).

Food security, according to Sen (1981), can be defined as the ability to obtain sufficient quantities of nutritious food. Food security policies must therefore take a holistic approach, focusing on food availability at both the macro and micro levels, as well as access to and distribution of food and income, as well as enhanced household production and income. This viewpoint emphasizes broad-based development and income growth in order to improve household food security. It's critical to have a holistic understanding of rural livelihood systems so that the complex interconnections between the various components of such systems, such as local organization, rural-urban linkages, gender roles and activities, livelihood strategies, and rural safety-net measures, can be properly recognized. These livelihood methods are notable for their broad-based approach to ensuring survival and food security. However, no strategy, program, or campaign to end hunger will be successful unless it prioritizes food producers and the domestic economy. Women are solely responsible for the production of food for home consumption in most of Sub-Saharan Africa. Women should play a critical part in any effort to boost food production and food security since they provide food and care for children.

2.2. The Basic Concept and Importance of Underutilized Crops

The concept of underutilized crops refers to beneficial plant species that are overlooked by researchers, breeders, and policymakers (Burlingame, 2000; Maanda and Bhat, 2010). They are non-commodity crops that are part of a diverse biodiversity category that includes thousands of domesticated, semi-domesticated, and wild species. Many of those local, traditional crop species and variations have been replaced by high-yielding staple crop cultivars generated by contemporary breeding programs as a result of the Green Revolution. In one country, the crop is a well-established big crop, while in another, it is a neglected or minor crop. Furthermore, agricultural statistics and studies in certain countries do not differentiate between NUS and other crops. NUS are fundamentally different from staple crops. They are typically handled using conventional techniques, rely on unofficial seed sources, and have a strong gender component (Maanda and Bhat, 2010).

For a variety of agronomic, genetic, economic, social, and cultural reasons, these crops have long been overlooked by conventional agriculture, but they are now gaining traction due to their potential role in risk mitigation in agricultural production systems. In the last five years or more, a growing number of programs have focused on the importance of NUS in boosting nutrition, producing money, sustaining ecosystem health, empowering the poor and disenfranchised, and encouraging cultural variety (Maanda & Bhat, 2010).

According to the Food and Agriculture Organization FAO (1996), neglected, underused, or orphan crops (NUCs) are plant species that have lost their relevance over the last 500 years due to societal, agronomic, or biological factors. NUCS are small or promising crops that have been missed by researchers, agricultural officials, policymakers, and producers, according to the FAO (2017). For the purposes of this debate, NUCS are crops and species that have not been classified as selected or key staple crops, are not widely used at the moment, and are primarily limited to smallholder farming regions. Some neglected crops' original function or potential applications have been downplayed over time, while others have been virtually forgotten. They are plant species that have played an important part in indigenous peoples' and local communities' agriculture and food supply. In many cases, their neglect was due to the deliberate repression of self-sufficient lifestyles that defined traditional civilizations (FAO, 1996).

Agriculture currently has to look into nontraditional pathways, such as underutilized crops (NUCs) as future crops. This is based on findings that NUCs are adaptable to a variety of agro-ecologies, are nutrient-dense, and provide greater prospects in marginal producing areas. Drought-tolerant, pest- and disease-resistant, and adapted to semiarid and arid conditions, neglected crops could help poor rural populations diversify their diets and treat nutritional shortages (Padulosi and Hoeschle, 2004; Mabhaudhi, et. al., 2017).

The underutilized crop is a crucial resource that is not being handled fairly by those who matter, either deliberately or unconsciously, despite its known importance to addressing food insecurity. As a result, a well-thought-out plan that sets goals and assures resource use is critical. NUCS have been demonstrated to have an essential role in the promotion of local livelihood, nutrition, and food security among indigenous groups in several studies conducted in remote parts of emerging countries (Nyadanu et. al., 2014; Magbagbeola et. al., 2010; Bhattacharjee, 2009). NUCS have been recorded as a source of food and medicine throughout Asia and the Pacific countries like as India, Nepal, Malaysia, and the Philippines. NUCS is also widely used in Sub-Saharan African countries like Malawi, Nigeria, Cote d'Ivoire, Uganda, and Zimbabwe (Padulosi et. al., 2013; FAO, 2010).

As a result, NUCS present a unique opportunity for the agriculture industry to capitalize on in order to combat food insecurity among indigenous or rural communities. NUCS role to resolving the food insufficiency crisis has been validated in several research, including Nyadanu et. al., (2014) and Magbagbeola et. al., (2010). In terms of resources being scarce and providing competitive advantages, NUCS have some unique agronomic qualities that allow them to survive in a variety of ecological niches and in adverse conditions such as poor soils and drought (Shackleton, 2009). NUCS can also be used as a backup crop if the main crop fails or is unavailable, according to Mabhaudhi et. al. (2011). NUCS are likewise one-of-a-kind and non-replaceable. Although NUCS can be found in both tropical and temperate climates, their function and significance are not widely recognized in many nations (Padulosi et. al., 2013; FAO, 2010). As a result of the preceding debates, it is clear that NUCS as a plant resource has not been completely exploited by Ethiopia's agricultural sector, and that it requires immediate attention.

2.2.1. Empirical Studies of Underutilized Crops

Agriculture is the economic backbone of several nations in Sub-Saharan Africa (SSA), such as Ethiopia, employing over 60% of the workforce and contributing an average of 30% of GDP (FAO, 2013). For many years, chronic food insecurity has been a production trend as well as shocks or condition variation in various sections of Ethiopian regions. Approximately 27% of rural households are food insecure, as measured by their food production and consumption habits or trends (Lebot, 2009). Most agricultural development interventions have centered on the deployment of high-input, high-output technology that are not sustainable or adaptable by the rural poor. In various sections of the country, there are numerous underutilized and underexplored crop species that might be researched for income creation, family nutrition, and long-term sustainability.

This, as a result of growth, creates an attitude of ignoring local alternatives such as sweet potato, anchote, taro, and Oromo Dinch, which have long been farmed with particular adaptations to various ecosystems (Tufa et. al., 2008). Traditional crops that are generally undervalued and underutilized have evolved over time through a rigorous natural selection process, making them suited to native agro-ecological conditions and naturally resistant to a wide range of diseases, pests, and unfavorable weather conditions. These food crops are also low-input crops that can provide desirable yields by altering low-input technology, notably irrigation, fertilizers, and plant protection chemicals (Mengesha et. al., 2012).

A joint study by Farm Concern International and The World Vegetable Center highlights the potential for underutilized crops in Sub-Saharan Africa. According to this study, in 2003, Eastern Africa's consumption of African leafy vegetables was only 31 tons worth USD 6,000, but by 2006, consumption had nearly doubled to 600 tons for USD 142,860. According to a yield and profitability analysis, monocropping on 1,000 m2 could produce 3,409 kg of spider plant, 7,500 kg of amaranth, 2,841 kg of cowpea (Vigna species), 2,841 kg of African nightshade (S. scabrum), and 2,273 kg of Jew's mallow, for a total of 18,864 kg worth USD 2,515, with a net profit of USD 1,539. (Mwangi and Kimathi, 2006). In the past, leafy vegetables may have been considered only as food for the poor, unclean, and, therefore, not safe to eat (Mwangi and Kimathi, 2006).

As a result, green vegetables were mostly used as a source of food for the poor (Weinberger and Swai, 2006). Leafy vegetables native to Africa have begun to appear in Eastern African supermarkets. According to this survey, 44 affluent urban households acquire around 40% of their products from the market. Native veggies, when properly exploited, can provide excellent commercial potential. In Arusha and Tanzania, for example, African eggplant has gained commercial significance and is now available in supermarkets (Weinberger and Swai, 2006). Leafy vegetables cultivated in Africa are no longer farmed solely to augment the family's diet (Kennedy and Oniang, 2007). The advantages of these species are numerous, as they contribute to household livelihoods, poverty alleviation through the creation of new markets for value-added products, food security, and nutrition maintenance (Hoeschle and Bordoni, 2003; Taylor et. al., 2009).

According to Garn and Leonard (1989), there are between 300,000 and 500,000 plant species, with 30,000 being edible. Only 7000 of the 30,000 edible plants have been cultivated or harvested for food throughout history. Even more concerning is the fact that only 20 species have supplied 90% of the world's food needs, with wheat, maize, and rice accounting for 60% of man's diet (Wezel and& Bender, 2003). As a result, tens of thousands of edible plant species are underutilized in terms of their ability to contribute to the world's growing food demand. Consequently, there has been a decrease in agricultural genetic diversity, as well as the displacement of indigenous species by more profitable commercial crops. NUCS have been displaced due to a number of issues, including a lack of study, a lack of information on their manufacturing, and socio-economic factors that influence dietary choices, among others (Alvarez et. al., 2016).

In Ethiopia the most indigenous and underutilized crop are Anchote and Oromo Dinich. Anchote is an endemic root crop of Ethiopia and it is a unique root crop in its uses and the parts consumed. All parts of anchote: storage root, leaves and the immature fruit are consumed even though the storage root is the most economic concern in most growing areas of Ethiopia. In addition to its nutritional importance, anchote is a cultural and medicinal crop widely used in growing areas. According to Abera (1995), juice of anchote root is used to treat cancer, tuberculosis, skin eruptions and gonorrhea by traditional medicine practitioners of Ethiopia. The consumable parts: root, leaf, and fruit are rich in protein, calcium, iron, and potassium and it can be used as a useful crop to fight malnutrition. According to Koller (2008) other Coccinia groups such as grandis and indica are also widely used to treat gonorrhea, asthma, skin eruptions, diabetes and eye diseases and they are rich in calcium, potassium, iron and protein. The productivity of Anchote per hector of land is 20-25 t ha^{-1} (Daba, 2012). A farmer in Western parts of Wollega usually plants 400 to 600 square meters of anchote, mainly for home consumption (Amare, 2003).

In different growing areas of Ethiopia, different vernacular names are used for P. edulis. Among these are ‘Dinicha Oromo’ in Oromia, meaning “potato of the Oromo people” (Abdissa, 2000), ‘Wolaita Dinich’ (potato of the Wolayita people) around Wolaita (Endale, 1997), ‘Agew Dinch’ (potato of the Agew people) in the northwest and ‘Gurage Dinich’ (potato of the Gurage people) around Gurage zone (Westphal, 1975).

Such crops have traditionally played an important role in ensuring community and household food and nutrition security by providing healthy alternatives when the primary crop fails or during the time between harvests (Fan et. al., 2012; Liebman et. al., 2013). The availability of knowledge on NUCS' agronomy, water use, drought resistance, and nutritional and economic relevance will be critical in reintroducing them as alternative food sources in agriculture. There is now a scarcity of information on the growth, development, nutritional value, and economic impact of neglected and indigenous crops. When such material does exist, it is frequently hidden in indigenous knowledge systems and other ancient literature that is difficult to access. Furthermore, there hasn't been much coordination on NUCS investigations, both regionally and internationally. The lack of coordination and standardization of an umbrella word could also explain why there is so little information on NUCS in terms of environmental, food, and nutritional security, as well as economic value (Amsalu et. al., 2008).

Underutilized crops are an important part of local culture, are used in traditional food preparations, and are the focus of current culinary revival trends; they have advantages over staple crops in that they have been adapted to stressful environments and can be grown with low input and biological techniques. These crops are frequently overlooked by policymakers and excluded from research and development agendas, but if we are to survive future climate change and food production challenges, we must make special efforts to improve their cultivation, management techniques, harvesting and post-harvesting processes, as well as conduct better nutritional research and develop secure policies and legacies (Mayes et. al., 2011).

Ecotypes or landraces are examples of underutilized crops that require genetic improvement. Unfortunately, due to modern agricultural dependency and industrialization, traditional knowledge of neglected crops is rapidly eroding (Padulosi and Hoeschle, 2004). Although these crops are represented in ex situ gene banks, efforts to save and protect the genetic diversity of these neglected species are essential. These species will remain little understood unless they are thoroughly characterized and evaluated (Mabhaudhi, et. al., 2017). Ex situ and in situ (on-farm) conservation initiatives must be performed in cycle (Padulosi and Hoeschle, 2004). Conservation via usage is another strategy for encouraging the use of underutilized crops. Neglected crops are also known for having weak seed supply systems, so efforts must be undertaken to provide farmers with planting material in order to make the cultivation of neglected species more practicable and long-term sustainable (Mabhaudhi, et. al., 2017).

Only four key crops, namely maize, potato, rice, and wheat, now provide more than 60% of human energy intake (Baldermann, et. al., 2016). It has become obvious that a lack of diversity in the human diet as a result of focusing on fewer crops can have detrimental repercussions, such as malnutrition and diet-related disorders. Because neglected crops are high in nutrients and health-promoting substances that help avoid malnutrition and some chronic diseases, as well as the ability to thrive in harsh environments, they have a lot of potential for boosting nutrition in local populations. Diversifying the food chain to include these underappreciated species could be a useful technique for improving human nutrition and health (Baldermann, et. al., 2016).

To alleviate food poverty and malnutrition in Africa, particularly in Ethiopia, attention must be focused not just on staple foods but also on diet-relevant neglected crops (Raji and Ahemen, 2011). Sub-Saharan Africa is home to 9% of the world's population and is characterized by a high prevalence of food and nutrition insecurity, which is exacerbated by a lack of crop variety. Neglected crops, in addition to playing an essential role in the African diet, can also contribute to the local economy and are employed in traditional medicine, as the leaves of particular crops are used as both food and medicine. The majority of the plants used are native to the wild or are grown on a limited basis. As a result, both production and availability are restricted (Raji and Ahemen, 2011).

2.3. Crop Diversification through Expanding Underutilized Crops

Aside from food production, diversity within an ecosystem plays a variety of responsibilities, such as regulating the hydrological cycle, pest management, and nutrient recycling (Altieri, 1999). Distinct species play different roles in an ecosystem; nevertheless, the diversity of species outnumbers the diversity of roles in an ecosystem, thus different species may fulfill the same job. The presence of numerous species that have comparable roles within a system provides for ecosystem redundancy (Lin, 2011). As global temperatures continue to change, it is difficult to forecast the effects on ecosystem functionality, multiple species responses, and roles that may become more important as a result (Vandermeer et al., 1998). Crop diversity boosts the ability to cope with climatic problems by allowing the development of multiple species with different sensitivities to environmental changes. This promotes resiliency within an agricultural system and provides insurance against environmental instabilities (Yachi and Loreau 1999; McCord et. al. 2015).

To maintain crop performance and yield, modern agricultural systems are becoming increasingly reliant on external input, which has a negative impact on the environment (Altieri, 1999). Agriculturally reliant communities have few other options for securing their livelihood or means to engage in adaptation techniques, making them more vulnerable to changes in weather patterns (Altieri, 1999). Crop diversity decreases the need for economic, labor, and chemical inputs, enhancing agricultural systems' resilience to fulfill a community's food and non-food demands while also safeguarding livelihoods in the long run (Makate et al., 2016).

All domestic crops can be traced back to a series of carefully planned domestication and selective breeding of wild species (Altieri, 1999). Increased genetic similarity among today's key crops has resulted from a long process of domestication. The loss in the diversity of plant species that meet our food and non-food needs has been attributed to modern agriculture (Khoury et. al., 2014). For example, four potato varieties account for 72 percent of potatoes farmed in the United States, whereas three cotton variants account for 53 percent of cotton grown globally (Altieri, 1999; National Academy of Science, 1972).

Around the world, vast populations of diverse and adaptable landraces and wild crop cousins harbor a wealth of genetic resources (Altieri, 1999). These are the crops that aren't getting the attention they deserve. Locally adapted plant species that are important contributors to the food and customs of the places where they are cultivated by farmers are referred to as underutilized crops (Mayes et al. 2012). Most of these crops' resiliency, as well as their capacity to thrive on marginal areas and in adverse conditions, is a crucial factor in promoting their widespread adoption (Massawe et. al., 2016).

Diversification enables growers to make the most of existing agro-ecological resources, resulting in a localized system that ensures food security (Chaifetz and Jagger, 2014; Njeru, 2013).

2.3.1 Diversifying Crops for Food and Nutritional Security by Using Underutilized Crops

Consumer eating behaviors are currently being shaped by global affluence and globalization. Food production must meet the needs of not only a growing population, but also an expanding middle class with preferences for processed and easily accessible foods (Massawe et. al., 2016). Eating demands are becoming increasingly comparable across borders, and life and food trends are no longer regional (Khoury et. al., 2014; Massawe et. al., 2016). Increased global trade, urbanization, and the expansion of transnational food firms are all influencing consumer preferences, with increasingly common diets across countries (Hawkesworth et. al., 2010). Between 1961 and 2006, worldwide rice consumption climbed at a rate of over 4.5 percent per year (Seck et. al., 2010). Rice consumption has increased significantly throughout Africa as a result of urbanization and changing lifestyles (Africa Rice Center, 2008). Furthermore, the widespread adoption of energy-dense diets based mostly on meat, dairy products, and plant oils has had a substantial impact on how we raise food, with an increased reliance on a small number of crops.

In the last five decades, grain yields of the major staple crops have at least doubled (Godfray et. al., 2010). This has helped to support earlier population surges to some measure, but it may not be enough to meet the escalating demands of a worldwide population of nine billion people by 2050. (Godfray et. al., 2010). Furthermore, grain prices have been continuously rising, with a 40 percent increase in rice prices observed over the last few years (Africa Rice Center, 2008). The development of a high-yielding rice variety adapted to African temperatures was motivated by the rising expense of rice and wheat imports, as well as the economic and political concerns they brought (Kijima et. al., 2011). However, acceptance of the technology was slow, with an estimated 50% of farmers in Africa and Ethiopia who had accepted other technologies abandoning them in the last few years (Kijima et. al., 2011). This high rate of dropout was linked to low crop profitability due to rainfall variability and poor seed quality produced by farmers (Kijima et. al., 2011; Serunkuuma, 2008). Kijima et al. (2011) advocated for changes that target suitable farming areas and extension systems that distribute relevant knowledge on farming methods like seed production.

This necessitates alternate strategies to improve food security and long-term livelihoods, such as promoting and expanding the use of underutilized and underexploited food sources. Although underutilized crops are an important element of many people's meals around the world, their worldwide importance remains low (Tadele and Assefa, 2012). The four basic characteristics of food provision must be addressed for food security to be achieved: availability, stability, access, and utilization (FAO 2012; Kang et. al., 2009). Food security can be improved by increasing output, but this does not address food access and usage on a local level (Altieri et. al., 2012). Furthermore, climate change and environmental concerns pose a danger to food stability, which has repeatedly manifested as short-term shocks undermining food security. Crops cultivated in marginal lands are more resistant to harsh climates and situations like drought, waterlogging, and damaged soils, and hence have the potential to increase food availability and stability.

In order to ensure nutritional security, FAO (2012) recommended that food diversity and nutrient content be improved in addition to raising the quantity of food. To prevent non-communicable diseases (cancer, diabetes, obesity, and cardiovascular disease), as well as other negative health effects of micronutrient deficiencies such as blindness and birth defects, the FAO/WHO recommends a daily diet of 400g or more of fruits and vegetables. To achieve nutritional security, increasing availability of horticulture products and other non-grain crops will be required to promote diverse diets and boost micronutrient intake (McIntyre et al., 2009). Many African countries' Agricultural Study Councils (ARCs) promoted vegetable cultivation by doing specialized research on cultivation practices, water efficiency, and plant nutrition of local vegetables including amaranths and okra (Bvenura and Afolayan, 2015). As a result, vegetable farming rose in specific areas, and the diet and health of the targeted communities improved (Bvenura and Afolayan, 2015).

In developing countries, the consumption of staple foods has expanded significantly among the urban poor (Pellegrini and Tasciotti, 2014). Most urban African and Asian households' diets are deficient in essential vitamins and minerals, such as iron, as indicated by the growing prevalence of iron deficiency anemia in Sub-Saharan Africa (Frison et. al., 2006). Furthermore, in today's globalized market, developing countries are heavily reliant on food imports to meet rising demand for essentials, making them subject to global market price instability (Pellegrini and Tasciotti, 2014).

Rural households, on the other hand, may be more reliant on local production due to the settlements' isolation and high transportation expenses (Pellegrini and Tasciotti, 2014). When local production in such places is limited to a small number of crops, rural households' diets are deficient in basic micronutrients, leading to a slew of medical problems (Pellegrini and Tasciotti, 2014). Thus, the most pressing issue is access to local production of diverse horticulture items that are higher in micronutrients, fiber, proteins, and fats (FAO, 2012).

Malnutrition has been recorded in Pakistan's and Nepal's mountainous regions as a result of local communities forsaking traditional crops such as millet, taro, yam, and wild vegetables in favor of a limited number of crops (Adhikari et. al., 2017). Crops like finger millet have long been farmed in Africa and Asia, providing a rich source of various minerals, proteins, and vitamins while also having a high nitrogen usage efficiency (Onyango, 2016). Complementing present grain crop output (wheat, rice, maize, soybean) with a diverse variety of horticulture and other high value crops will improve food quality while also strengthening livelihoods and improving purchasing power through higher economic returns from higher value products (Makate et. al., 2016; Kang et. al., 2009). Crop diversification has a trickle-down effect. Not only do the farmers prosper financially, but there are also more options for local agro-processing, resulting in a value chain for the product that includes jobs and higher-value goods (FAO, 2012). Moringa is an excellent example of multi-functionality, as its fruits, nuts, and leaves can be eaten, while other portions of the plant can be used for firewood or to produce oil and other cosmetics (Dou and Kister, 2016). When different crops are grown regionally, physical and economic access to fresh healthy food, as well as economic opportunities, will improve.

2.3.2 Diversifying Crops for Climate Resilient Agriculture

Agriculture is particularly vulnerable to the effects of climate change because it is a weather-dependent activity. Tropical regions are the most vulnerable, especially in developing countries where a major section of the population depends on climate-dependent resources. By 2050, Ethiopia is anticipated to see a temperature rise of 1.5 to 3 degrees Celsius, as well as more extreme weather patterns like droughts (Tadele, 2016). In certain African countries, the drought of 2015 was the worst in 35 years, with Swaziland, Lesotho, Malawi, Namibia, and Zimbabwe declaring national disasters (Dzama, 2016).

Climate change has a significant influence on agriculture, and poverty exacerbates the problem by restricting the ability of local populations to predict and adjust to the effects of climate change (Berg et. al., 2013). Furthermore, when the rate of population expansion accelerates, these communities' ability to meet their food needs in the face of climate change is strained even more. Climate change and its implications necessitate a rethinking of agricultural production in order to discover which crops species are best suited to the current climate. For example, species that are suited to marginal lands that were previously thought to be inappropriate for crop cultivation must be considered. Agriculture has contributed to environmental degradation thus future food must be produced in a sustainable manner with minimal negative environmental consequences. Subsistence farmers plant underutilized crops on marginal terrain with few or no agricultural inputs. These are typically local crops that are farmed in their natural habitats and exhibit the adaptive characteristics required for climate-resilient agriculture.

Temperature variations have a deleterious impact on crop performance, especially if they occur during blooming and fruiting (Lin, 2011). Tropical regions are particularly vulnerable, and estimates anticipate that staple crop production would drop as temperatures rise, accelerating phenology, shortening the crop growing period, and reducing biomass (Berg et. al., 2013). This will have a direct impact on crop yield and quality, and yield losses are thought to be proportionate to temperature increases (Berg et. al., 2013). Furthermore, rising temperatures may cause soil deterioration as well as an increase in insect and disease prevalence (Kang et. al., 2009). Improving crop output in these places will be tough, and it will necessitate better farming practices, land and water management, and careful consideration of the diversity of crops grown (FAO, 2012).

On the other hand, agriculture in temperate zones, may benefit from higher temperatures and longer growing seasons (Berg et. al., 2013). Even in tropical areas, some estimates expected improved agriculture due to the "carbon dioxide enrichment effect," which is ascribed to rising carbon dioxide levels stimulating plant growth (Kang et. al., 2009). Modeling the influence of climate change (2- and 4-degrees Celsius warming, 20% decrease and increase in rainfall, and doubling of carbon dioxide) on wheat, maize, rice, and soybean yields revealed that doubling carbon dioxide resulted in higher crop yields (Rosenzweig and Parry, 1994). Although the increased carbon dioxide levels could benefit crop performance, the threshold for temperature increase was 4°C, with yield declines reported from that level.

In research by Hochman et al., (2017) modeling wheat farming in Australia, CO2 enrichment prevented a 4% loss in potential yields in 2015 compared to 1990, despite a 28% decrease in rainfall and a 1.05°C increase in temperature. Furthermore, the scientists noted a decrease in potential yields (a 27 percent drop) throughout that time span, even though actual yields remained consistent (Hochman et. al., 2017). Improved farming practices such as integrated weed management and reduced tillage were credited with the capacity to collect 55 percent of possible yield in 2015, compared to 37 percent in 1990. (Hochman et. al., 2017). Nonetheless, it is expected that the accelerated consequences of climate change would outweigh the benefits of continual improvements in farming practices. Given an increase in actual output to 80% of theoretical yield by 2041, a drop in harvested tons of wheat per hectare of 11% is predicted (Hochman et. al., 2017).

Crop rotation or intercropping of different crop species are popular farming strategies in several regions, and they have been shown to offer benefits. Intercropping finger millet with pigeon pea and groundnut was found to considerably boost yields in a study done in West Bengal by Maitra et al., (2000). When intercropped alongside staples like maize and taro, Bambara groundnut has been shown to improve the environment and provide benefits (Alhassan and Egbe, 2014; Jacob et. al., 2014; Mabhaudhi and Modi, 2013). Agroforestry has a good impact on communities that use it on various levels (Leakey and Asaah, 2013). Smallholders' lives were improved and good environmental consequences were found in a Cameroon experiment that saw leguminous bushes and shrubs intercropped with indigenous fruit and nut trees (Leakey and Asaah, 2013).

2.3.3 Crop diversification, Crop Performance and Hydrological Cycle

Water availability is already strained as a result of population growth and pollution. Furthermore, climate change and the consequent changes in precipitation patterns endangers water supply and the hydrological cycle as a whole (Kang et. al., 2009; Droogers and Aerts, 2005). Precipitation patterns are more difficult to forecast than temperature variations (Droogers and Aerts, 2005). Extremes in precipitation patterns, such as flooding and droughts, are more plausible scenarios than normal precipitation changes (Droogers and Aerts, 2005). Droughts affect more people than other natural disasters on a global scale, resulting in the biggest economic and environmental consequences (Burchfield and Gilligan, 2016; Wilhite and Vanyarkho, 2000). Droughts have a significant impact on agriculture as a water-dependent activity, which is exacerbated by poor soil conservation measures, inadequate water infrastructure, and poverty (Midgley and Methner, 2016). Changing precipitation patterns and global temperatures will have a direct impact on soil evaporation and transpiration, altering the water balance in the soil (Kang et. al., 2009).

Different cropping and irrigation strategies will be required as soil water storage and moisture status, as well as groundwater levels, change (Kang et. al., 2009). Eitzinger et al., (2003) used the CERES-wheat model to show that changes in soil water balance had a direct impact on crop productivity under various climate scenarios, negatively affecting sustainable agricultural production. The agriculture sector in different African countries were severely impacted by the drought of 2015/2016, with losses of 50–100% of wheat and 15% of fruit per farm (Midgley and Methner, 2016). Meanwhile, farms in the same location that used land management strategies to keep soil moisture at a constant level produced adequate production to avoid losses (Midgley and Methner, 2016).

Reduced precipitation patterns, increasing soil moisture stress, increased reliance on irrigation systems, and the impact of socio-economic variables all contribute to water scarcity (Burchfield and Gilligan, 2016). Increased irrigation can boost yields, but it can also increase runoff in heavier soils (Holden and Brereton, 2006). In Russia, for example, water availability is predicted to grow, yet runoff is expected to increase as well, affecting the region's food production capability equally (Alcamo et. al., 2007).

Because the expected short-term consequences of climate change differ from the long-term effects, the impacts of climate change are not proportionate across time. A drop in precipitation patterns is expected in arid zones from 2020 to 2049, whereas an increase is expected from 2070 to 2099. (Berg et. al., 2013).

Drought-tolerant crops will not provide a long-term answer to addressing short-term climate change. Between 1985 and 2005, a 2.5 percent increase in crop diversification in farming fields, a 7% increase in harvesting frequency, and a 20% rise in crop yields resulted in a 28 percent increase in overall crop production (Ray et. al., 2012). This shows that extending crop production areas and intensifying agricultural activities will not be enough to fulfill our growing food needs, and will have a negative impact on food security as a result of environmental degradation and greater water resource mismanagement. Researchers and policymakers are increasingly advocating for slowing the expansion of farmed lands, as shown by SDG 15, which calls for sustainable land management, crop diversification and zero deforestation (UN, 2016; Byerlee et. al., 2014).

In a recent study assessing global patterns of crop yield growth Ray et al., (2012) reported yield stagnation of the big crops in more than a quarter of their production areas, 37% of wheat, 35% of rice, 26% of maize and 23% of soybean. Increasing crop diversification will allow for adaptation to a vast range of scenarios, offering a more pragmatic solution that captures the full story of climate change as we plan for long-term agricultural adaptation. Amaranth, beans and pearl millet are examples of drought-tolerant crops that are adapted to marginal lands, as evidenced by Chivenge et al., (2015) to be more drought tolerant than the big three crops. A diverse crop portfolio increases options for farmers who may face droughts and improves the agro ecosystem's resiliency to water scarcity (Burchfield and Gilligan, 2016). As a result, developing more crop varieties will allow for better agricultural techniques, boosting tolerance to changing environmental patterns as well as deteriorated soils in order to fulfill rising food demands (Kang et. al., 2009).

2.3.4 Pest and Pathogen Control vs. Crop Diversification

The resistance of farming systems to pest and pathogen infections is a clear indicator of their stability. Pests and pathogens lower agricultural output and drive-up pest and disease management costs

(Chakraborty et. al., 2000). Diseases are strongly influenced by weather patterns, such as precipitation, which has a direct impact on the life cycle and distribution of infections, vectors, and hosts, as well as the emergence of illness symptoms (Anderson et. al., 2004; Chakraborty et. al., 2000). However, it is difficult to estimate the impact of climate change on disease since a variety of factors, including the morphology and physiology of the hosts as well as the nature of the pathogen, can influence the occurrence and severity of diseases (Scherm and Yang, 1995; Chakraborty et. al., 2000).

The spread of warmer zones and the shortening of winters may facilitate the spread of virus-carrying vectors, increasing the risk of disease infection (Anderson et al. 2004). The prevalence of fungal illnesses like as powdery mildew and Cercospora leaf spot may be aided by the warmer winters and summers (Patterson et. al., 1999). Furthermore, climatic extremes may tip the scales in favor of the spread of some diseases, such as viruses and insects in dry areas and fungal and bacterial infections in moist areas (Anderson et. al., 2004). Higher temperatures are likely to help insects thrive, which could lead to increased insect population growth and migration (Lin, 2011). Furthermore, pests may be able to adapt to climate change at a faster rate than current crops in the environment due to their shorter life cycles and rapid reproduction (Bale et. al., 2002; Lin, 2011).

Susceptibility to pests and viruses’ manifests when our farming methods focus on crop output rather than total resilience (Altieri, 1999). In monocultures, the extensive use of genetically similar types has increased our reliance on external inputs for pest and pathogen control, as well as disease susceptibility. Disease resistance spans across a spectrum in different types even within the same species, hence intraspecific crop diversification can provide a barrier for disease transmission control (Finckh et. al., 2000). Intercropping genetically diverse rice in China, as demonstrated by Zhu et al. (2000), reduced rice blast by 94 percent and boosted output by 89 percent when compared to monocultures with no genetic heterogeneity. Interspecies crop diversity provides additional benefits, as evidenced by Midega et al.

(2010), who intercropped millet with green leaf disodium and improved Striga management and yield. Furthermore, mixed cropping systems improve soil fertility and system functionality at a broader scale, particularly when nitrogen-fixing crops and/or cover crops are included (Smith and Read, 2008).

Agroforestry has a bigger impact since it promotes the number of natural enemies, such as insectivorous birds, which help to control pests (Perfecto et. al., 2004). Biodiversity ecosystems have a built-in self-regulation mechanism that allows them to maintain a diverse range of flora and fauna, allowing them to interact with their surroundings and respond to changes (Altieri, 1999). These systems work in a variety of ways to boost productivity, including strengthening natural enemies, decreasing weed development, breaking disease cycles, and changing the microenvironment (Makate et. al., 2016). As a result, higher diversification helps to improve agricultural system resiliency, notably in terms of pest and disease suppression and overall crop production (Lin, 2011).

2.3.5. Crop Diversification's Contribution to Poverty Alleviation and Livelihood

Farmers on small plots of land are at a disadvantage when it comes to investing in climate change adaptation techniques. They are also becoming more subject to fluctuations in main grain availability and prices, as shown during the 2008 food crisis (Mayes et. al., 2012). Crop diversification with underutilized crops, especially among smallholder farmers, is an adaptation technique that lowers economic risks, raises household incomes, and boosts their purchasing power (Weltin et. al., 2017). It increases the capacity to deal with market pressures as well as better respond to environmental issues that result in food shortages (Saenz and Thompson, 2017). In most developing countries, agricultural growth is a critical instrument for escaping poverty, particularly among the rural poor who have small or no land (World Bank, 2008). Agricultural growth creates jobs while also improving local food access at lower prices, boosting the rural economy (Kassie et. al., 2011).

Cash crops have an advantage in that their product value is higher, resulting in increased household income (Govereh and Jayne, 2003). Specialization on cash crops, on the other hand, poses an even greater threat to household livelihoods when these revenue crops replace food crops (Saenz and Thompson, 2017). The benefits of cash crops can be fully realized by incorporating them into a variety of farming systems, reducing production risks and climate change vulnerability (Orr, 2000). According to Michler and Josephson (2017), there is a direct correlation between growing portfolio diversification and a lower likelihood of continuing in poverty. They looked at the households' crop diversity in relation to their village practices, and included a diversity count of 50 distinct crops in their analysis, including staple crops like teff and maize, as well as cash crops like sesame, linseed, coffee, chat, and enset. Michler and Josephson (2017) showed that crop diversity reduced the likelihood of living in poverty by 16.9% for households over the poverty line, and by 18.3% for those already in poverty, in their study on the effects of crop diversification in Ethiopian households. To promote the biodiversity of crops farmed, they recommended expanding crop diversity rather than developing specialization in cash crops.

Diversification was cited by several authors as a favorable farming strategy for increasing agricultural production and improving lifestyles in various areas. When farming vegetable crops, Van den Berg et al. (2007) found a link between diversification and increased income returns for traditional rice farmers in China. Diversified farming strategies have also been reported to boost rice farmers' incomes in Vietnam (Nguyen, 2017). Farmers with a broad crop portfolio reported higher technical efficiency and production complementarity, according to the authors (Nguyen, 2017). Furthermore, rice monocultures have been found to reduce the production of pulses, vegetables, and spices in Bangladesh, posing a threat to the environment and the farming system's long-term viability (Rahman, 2009). It was observed that growing rice monoculture agriculture displaced non-rice crops as well as traditional rice varieties, resulting in more intense farming and decreased net cultivated acreage (Rahman, 2009). As a result, government policies in

Bangladesh are increasingly supporting diversification as a means of improving the agricultural sector's profitability through better farming practices (Rahman 2009). Taken together, these case studies from throughout the world demonstrate the value of diversification as a contributor to agricultural development resilience.

2.4 Crop Diversification with Underutilized Crops: Factors Influencing Adoption

Crop diversification has been slowed to a large extent by technological and scientific support for large crops (e.g., maize, rice, wheat, and potato), broad-scale monoculture adoption, and economic incentives for certain crops. Sustainable agriculture practices are becoming increasingly popular around the world (Samberg et. al., 2016). However, the farming practices and characteristics of rural poverty vary depending on the prevalence of smallholders across Africa, Asia, and Latin America. This should be a primary concern when devising policies and technology to increase production and effectively uplift the rural poor (Kassie et. al., 2011).

2.4.1 Systems of Resources and Knowledge

Because of the large-scale production of the major crops, much attention has been placed on research into these crops, such as disease infection and resistance patterns (Anderson et. al., 2004). As a result, the study of underutilized crops and their function in their communities is neglected (Cheng et. al., 2017). Our existing knowledge of underused crops will have a big impact on their domestication and introduction. Crop development programs are reliant on having access to information about the variability of germplasm collections (Aliyu et. al., 2016).

This gap in our knowledge can even be apparent in research on agronomic agricultural production strategies and their response to climate change. Agronomic approaches of neglected crops are still being researched, while precision agriculture of key crops has seen significant advancements that allow for better irrigation and chemical input management (Mayes et. al., 2012). Dedicated models, such as CERES-wheat and CERES-rice, have been developed to anticipate cropping results under various climate change scenarios (Lin, 2011). Despite the fact that these models are quite strong, with the ability to forecast various climate change scenarios as well as various agricultural production systems, little research has been done on the reaction of underutilized crops (Karunaratne et. al., 2010). The canopy development and biomass generation of Bambara groundnut was modeled and utilized to construct simulations of the plant response to abiotic challenges in research by Karunaratne et al., (2010) and Karunaratne et al., (2011).

However, the availability of general information may not necessarily be a stumbling block to agricultural diversification system adoption. Greater access to general information and increased years of agricultural experience were found to be adversely connected to diversification system adoption in a study by Makate et al., (2016), with a 29.7% and 5.5 percent decrease in the probability of diversification recorded, respectively. In contrast, a positive link was found between land size and crop diversification adoption (Makate et. al., 2016).

2.4.2 Advancement of Technology

The scientific community's consensus that climate change will have a negative influence on crop productivity has been a driving force behind today's agricultural technological advancements. The majority of these breakthroughs have been in crop improvement programs using biotechnology to generate drought-resistant crops (Lin, 2011). While this strategy may be effective in protecting agricultural performance, it ignores the fact that a huge number of farmers will be unable to embrace these innovations due to their high costs (Lin, 2011). These technologies are designed with a broad audience in mind, with little respect for local conditions and needs of small-scale farmers (Kremen et. al., 2012). The failure to recognize the importance of locally tailored procedures and crop varieties is a major shortcoming of these technologies. Furthermore, as with most scientific progress, such biotech-led discoveries cannot be hastened, raising worries about their availability at a time when they are most needed for climate adaption.

Advancements in technology have primarily benefited large-scale crops, with little regard for the range of other crops accessible. Molecular technologies have yielded a wealth of information about the major crops, such as gene expression in response to abiotic stressors (Bonthala et. al., 2016). Unfortunately, technologies like microarrays have yet to be developed for underutilized agricultural research. However, by implementing additional technologies like as Next Generation Sequencing, existing knowledge on major crops can be combined to generate data on lesser-known crops (Mayes et. al., 2012).

Technologies can play a pivotal role in reducing rural poverty by improving resilience and closing the potential-actual yield gap. This requires broader investment in agricultural research as well as policy support to allow for more effective research uptake and technology adoption by the communities (Kassie et. al., 2011). Moreover, for agricultural research to be beneficial to the rural poor, it must be demand-driven and consider the structural differences between farming communities across the different continents.

2.4.3 Farming Techniques

Monoculture farming techniques are becoming increasingly reliant on external input and infrastructure in modern agricultural systems (Altieri, 1999). In general, these systems see biodiversity integration as a resource rivalry that stifles productivity (Kremen et. al., 2012). Adoption of these agricultural systems on a large scale has enhanced biomass production, but at a high environmental cost. As a result of soil erosion and increased run-off from chemical fertilizers and pesticides, such systems limit biodiversity while depleting natural resources.

Farming procedures that are mechanized minimize labor costs and timeframes, but they are only effective when single crops of uniform variety are grown, as tasks like planting, watering, and harvesting can be done consistently (Lin, 2011). In the near term, this improvement has resulted in increased crop yield and price stability, and it is now the norm for modern agricultural techniques. Such techniques will continue to gain precedence over sustainable agricultural farming systems as long as national and global interests are only focused on raising immediate output rather than the functionality and well-being of the agro ecosystem. National policies that emphasize yield have a detrimental influence on food sovereignty because they discourage the development of indigenous crops that are better adapted to the local climate and less vulnerable to global economic forces (Kijima et. al., 2011). Smallholders are harmed by policies that encourage intensification and the use of external farmed inputs, and they show little respect for community needs (Dawson et. al., 2016).

Smallholder farms make up 30% of the worldwide agricultural sector, and they play a critical role in meeting the food needs of vulnerable communities (Samberg et. al., 2016). Sustainable cropping systems that satisfy social, economic, and environmental needs are common in these systems (Samberg et. al., 2016; Kremen et. al., 2012). It's a methodical technique that takes into account the system's functional biodiversity and biotic interactions. As a result, they can coexist with vulnerable and marginal landscapes while maximizing the advantages of ecosystem services for a viable and long-term agricultural system (Kremen et. al., 2012).

2.4.4 Financial Assistance and Investment

Monoculture farming methods have traditionally been favored by national economic incentives, with government subsidies available for a limited number of key crops. The United States, for example, provides subsidies for the cultivation of rice, wheat, maize, soybeans, and cotton (Lin, 2011). According to Boody et. al. (2009), these crops received 89 percent of agricultural subsidies from 1995 to 2002, with maize and soybean receiving 56 percent of the subsidies. Furthermore, these subsidies, which are distributed based on the acreage of crop produced, incentivize maximal production of single crops.

Such policies are not unique to the United States. African governments have also put a lot of effort into increasing agricultural output by implementing subsidy programs for specific crops, especially maize (Saenz and Thompson, 2017). Zambia's government recently acknowledged the policy's influence on increasing production risk as a result of greater specialization on input-dependent crops (Saenz and Thompson, 2017). In an area that has seen multiple drought spells as a result of climate change, Sri Lanka's national emphasis on rice has encouraged its farmers to focus on the production of this water-intensive crop (Prasanna et. al., 2011; Burchfield and Gilligan, 2016). Rice cultivation will continue to be difficult for households because there are no subsidies available for less water-intensive crops.

Farmers are now subject to worldwide changes in produce prices due to the liberalization of agricultural regulations and markets, independent of domestic conditions (Pellegrini and Tasciotti, 2014; Dawson et. al., 2016). As a result, small farmers growing global crops compete with huge producers in the worldwide market, which is flooded with cheap imported grains. Crop diversification tackles this issue and reduces big players' external influences by encouraging small farmers to grow a variety of crops for their local market. However, due to the increased acquisition of farmland by foreign investors, this external influence is intruding on smallholders' holdings.

Foreign governments, such as China, Qatar, and Saudi Arabia, which are concerned about food security, are buying thousands of hectares in poorer countries, especially in Africa, South America, and Southeast Asia (Cotula et. al., 2009). Between 2004 and 2009, Cotula et al. (2009) reported acquiring about 2.5 million hectares of land in Sudan, Ethiopia, Madagascar, Mozambique, and Tanzania. These developments bring with them both opportunities and risks. Such investments could boost GDP and revenue, improve infrastructure, technology, and market access, and help rural areas flourish economically (Cotula et. al., 2009). Furthermore, greater agricultural investment may support growth of the underinvested agricultural sector in recipient nations as they transition away from commodity dependence, such as oil in Sudan (Arezki et. al., 2012).

2.5. Literature Gaps

In explaining the core concepts of the resource based underutilized crops as relates to the importance of effective resource utilization, Mahoney (1995) notes that a firm essentially will not create economic value and be successful mainly due to the presence of internal resources but rather its ability to utilize or manage the resources it possesses effectively and innovatively. However, much of this reported potential is currently premised on unreliable evidence with limited robust, empirical, and comparable information (Mabhaudhi et. al., 2016b). Thus, there is a need to promote evidence-based approaches that can assist in developing policy and increased research focuses to support NUS.

Even though further research on the matter is needed, there appears to be some level of both variable and empirical proof of the usefulness of NUCS to rural households in various sections of the country. Although there is empirical evidence of the use of this vital resource in addressing food security and improving rural livelihoods in other Sub-Saharan African nations, NUCS does not appear to be receiving the attention it deserves from Ethiopia's agriculture sector.

It's worth noting, however, that NUCS production and use are hampered by a number of issues. In Ethiopia, there are insufficient studies and written information on these neglected crops. In other words, there is a scarcity of basic information on their genetic potential, agronomy, water requirements, and nutrition, which is a barrier to their development and promotion. ‘There is a growing acceptance at national and international levels of the crucial significance of less-used crops and species in sustainable farming systems and human well-being, particularly in less favorable and marginal soils.

Despite their substantial contributions to food security, income production, food energy provision, and resource base conservation, the food potential of various vegetables, root, and tuber crops has not yet been fully tapped and utilized in all parts of Ethiopia (Guinand and Lemessa, 2000). There is no suitable legislative framework; there is a dearth of information on the influence of markets on food security issues; there is no guidance for agrochemical applications; there are no land use policies; and traditional knowledge of indigenous crops is being lost.

2.6. Conceptual Framework

Some underutilized agricultural species are found all throughout the world, but their production and consumption are limited to a more localized system. Many of these underutilized crops, which are grown for food, fiber, fodder, oil, and traditional medicine, serve a critical part in local people' livelihood and are frequently of exceptional social, cultural, and medicinal importance. They are a key element of the local food of communities, delivering nutritious components that are often lacking in staple crops due to their excellent adaptation to sometimes marginal land. Food sources that are currently underutilized, such as minor grains and pulses, root and tuber crops, fruits and vegetables, and non-timber forest products, have the potential to contribute significantly to food and nutrition security, protect against internal and external market disruptions, and improve ecosystem functions and services, thereby enhancing production.

In general, diversifying farming systems with underutilized crops helps to develop a resilient environment, provide food security, and improve household livelihoods in stressful situations. It improves food availability, accessibility, use, and stability, as well as nutritional security. Maintaining biodiversity with underutilized crops in agriculture is important for providing regulatory ecosystem services by reducing the use of agrochemicals, improving biological control, lowering greenhouse gas emissions, and controlling hydrological processes, in addition to providing food and nutrition. Because it is produced on marginal ground and produces high productivity on a small piece of land, it is also utilized to boost land output and productivity. Crop diversification increases dietary diversity, which improves human health. Diversification with underused crops is critical for the preservation of indigenous knowledge, social culture, and local resources for conservation and future usage. The cultivation of underused crops has led to increased genetic richness, as well as the well-being and health of the population and the environment. This is especially critical in a world with restricted resources to provide food and nutritional security for the current growing population. The following is a summary of the study's key concept:

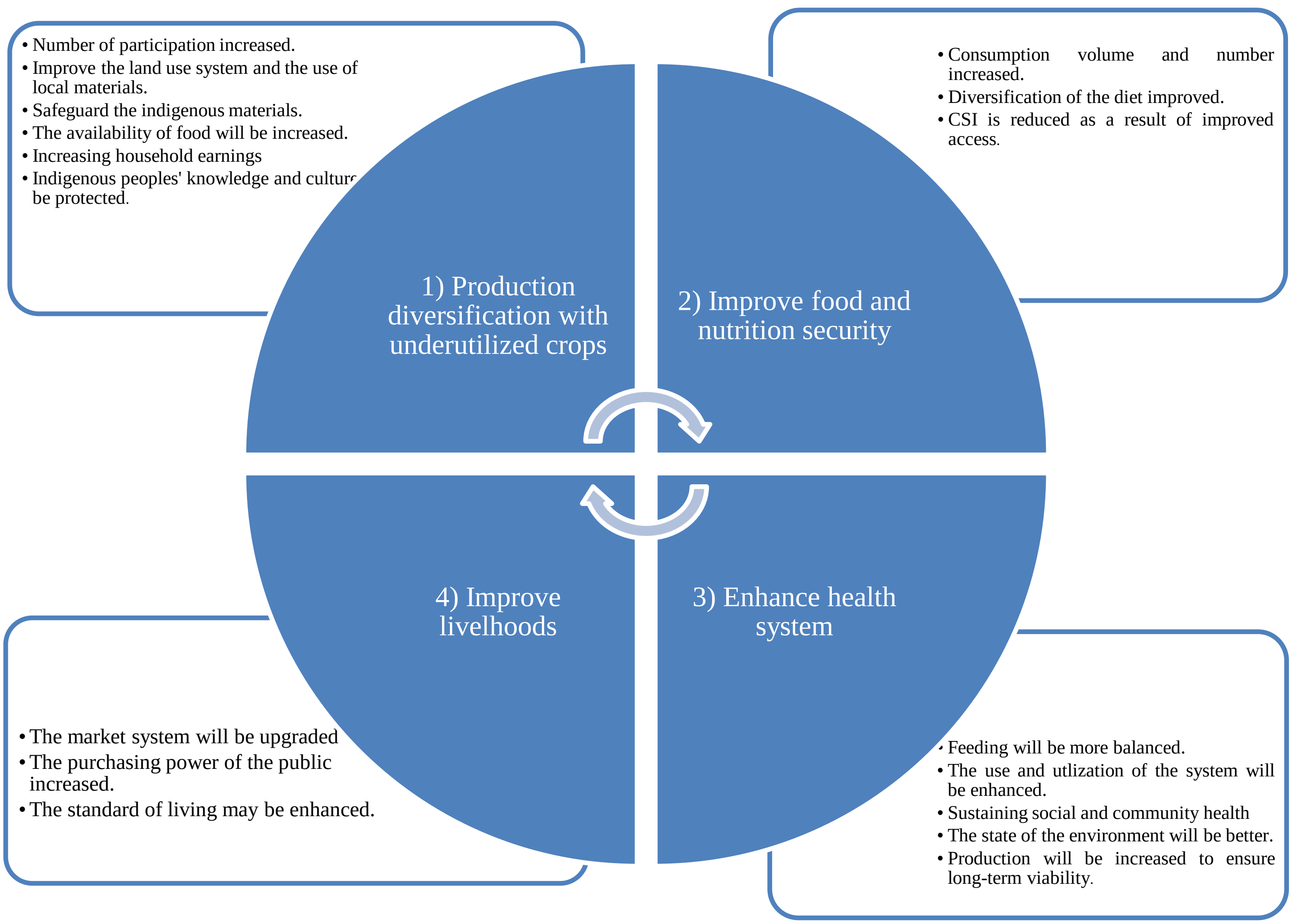

Figure2.1. Conceptual framework of production diversification and food security (Source: prepared by the researcher).

In order to ensure household food security and improve the livelihood of the population, the researcher intends to conduct this research to investigate how farmers utilize, produce, and how different bodies give emphases for the production of these underutilized crops in East Wollega zone Guto Gida district. In this study, social analysis was used to identify social barriers to the exploration of such crop species, while economic analysis was used to appraise farmers, and police analysis was used to promote and encourage underutilized crops in order to increase food security.

CHAPTER THREE: METHODOLOGY

3.1. Description of the Study Area

Guto Gida is a district located in Ethiopia's Oromia Region. It is a part of the Wollega East Zone. It is bordered on the east by Wayu Tuka, on the west by Sasiga and Diga, on the north by Gida Ayana and Gudaya Bila, and on the south by Leka Dulacha. This area surrounds Nekemte city, the seat of the East Wollega zone, which is roughly 331 kilometers from Addis Ababa. Agricultural, semi-agriculture, and mixed agriculture are the primary occupations of the residents. The study area encompassed Nekemte city and is located between latitudes $8^0$57'00" N-$9^0$32'00" N and longitudes $36^0$26'00" N-$36^0$44'00" N. The altitude of the sample kebeles ranges from 900 to 1800 meters above sea level. Nitosoil is the most common soil type found in this area (Tilahun et. al., 2014).

The 2007 national census reported a total population for this woreda of 89,906, of whom 45,810 were men and 44,096 were women. The majority of the inhabitants observed Protestantism, with 53.11% reporting that as their religion, while 30.16% observed Ethiopian Orthodox Christianity, and 14.61% were Moslem

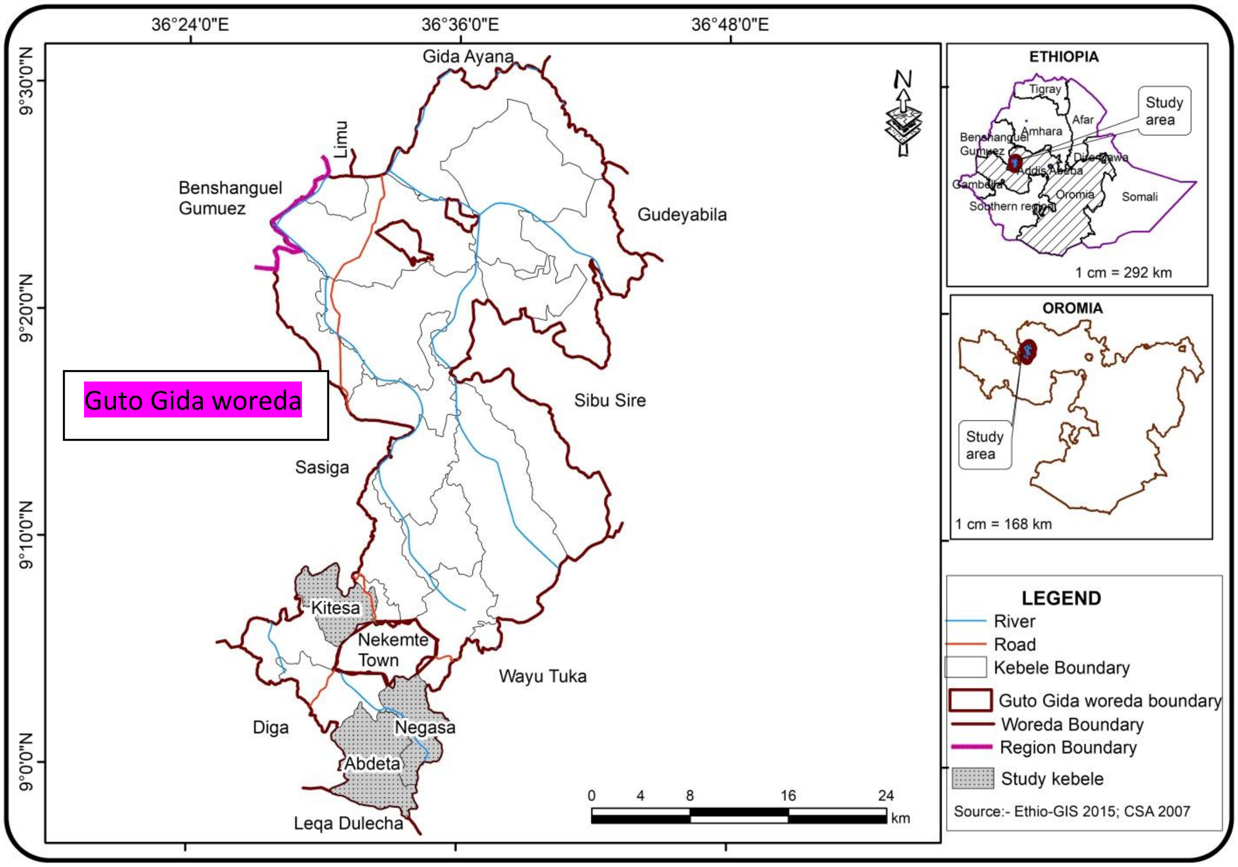

Figure3.1. Guto Gida woreda, Oromia, Ethiopia (Source: Authors' own construction).

3.1.1. Climate of Study Area

The study surrounding is one of the highest rainfall regions of Ethiopia. The mean annual rainfall in the area ranges from 1,376 to 2,100mm and has a high annual and inter-annual variability. The annual maximum and minimum temperature vary between 20^0C - 33^0C and 6.5^0C - 19^0C, respectively (www.jstor.org/stable/41966012).

3.1.2. Economic Activities of the Study Area

In the study area, mixed agriculture is the primary source of income. Crop and livestock production take precedence in this system. Rain-fed maize, sorghum, millet, and teff are the principal sources of food in the farming system, while sesame and niger seed are mostly farmed for sale. Maize + haricot bean

(Phaseolus vulgaris), Maize + pumpkin (Cucurbite maxima), Maize+ Cabbage (Birassica oleracea), Maize + Sweet potato + Anchote + Oromo Dinich + Taro are some of the mixed cropping methods found in the research area. However, households in the study region produce a limited amount of underutilized and neglected crops such as Dinnicha Oromoo (Coleus edulis), Anchote, sweet potato, Taro, Mungbeans, certain Legume crops, Amaranths, some leaf vegetables, some pulses, Pumpkins, Inset, Millet, and Forest products crops (Negasa, 2013).

There is a concentration of neglected and underutilized crops in the Guto Gida district, as well as a variety of crop production types among the farmers. Wollega Zones are historically significant farming areas with a significant number of underutilized root crops (Desta, 2010). The Guto Gida district was chosen for this study because it is located in the east Wollega zone, which has several farming regions with underutilized crops.The research was carried out from March to May 2021 in the Nekemte (Guto Gida) district, which mostly represents the Midland and Upper Midland agro-ecological zones. The study sites in Nekemte (Guto Gida districts) were chosen to represent a range of agro-biodiversity production levels in terms of cereal crops and underutilized root crops.

3.2. Research Design

Cross-sectional and multistage research designs was used that focuses on production and utilization level of local crop diversity with underutilized crops. This study design is selected because there was a variation on the crop production type and level in the same environmental condition and there were great food insecurity and income differences in the same environment. The study was in first step East Wollega Zone was selected purposively, and second step Guto Gida Woreda was selected to address food security through crop diversification, then purposively selected three villages (Abdata, Nagassa and Qitesa kebele) in order to cover the above-mentioned different production characteristic of producers and none producer of underutilized crops or less crop-diversity with underutilized crops and crop-diversity with underutilized crops. This is because in this study area there is a difference in crop production type, in some kebeles the population produce only high yielding cereal crops, in some kebeles they produce different diversity of crops including underutilized crops like root and tuber crops and the others. The study was sampled according to district village lists with the production history documented of households per village applying a 'probability proportional-to-size' approach Strauss and Thomas, (1998) with larger villages given a greater chance of selection than smaller villages.

3.3. Sampling Technique

Guto Gida woreda is one of the woredas in East Wollega zone, Oromia National Regional State (ONRS). According to the data obtained from the woreda administration office, there are 18 rural kebeles and one urban center (Lugo town) in the woreda. The researcher focused on this woreda because, the area as the report of zonal agriculture office has great variations in food security and income level of the households. In addition, incidence of rural living status varies from household to household in this area. The study will apply multi-stage sampling technique that focus on underutilized crop producers and non-producers of local producers. The sample kebeles in the district will be stratified based on their crop production types focusing on underutilized crops with comparison of the other crops. Then purposive sampling technique will be employed to select 3 rural kebeles from the total 20 rural kebeles in the woreda. The kebeles' study zones, households are purposely selected based on underutilized crop producers and non-producers' households. This ensures most representation stratum than the total population and results in more reliable and detailed information. These kebeles are **Abdata, Qitesa and Nagasa**; they are in the mid altitude it ranges from 900m to 1800m above sea level. The sample kebeles are in the same environment but great variation in their crop production amount and type they produce according to the data obtained from the woreda agricultural office of 2020/21 production year.

3.4. Sampling Size Determination

According to the information obtained from Guto Gida Administration Office (GGAO), the total number of farming households in the three sample kebeles is 2,512. Then the number of sample households (the number of respondents for the household questionnaire survey) was determined to be about 120 of the required sample or adequate sample of the total households in the three kebeles) households with ±5% precision level and 95% confidence interval according to Israel (2012)'s established table sample for sample size determination. The total sample size was distributed to each sample kebele based on the proportion of total number of households in each selected kebele (See Table 1). This calculator uses the following formula for the sample size n:

$n = N*X / (X + N – 1)$,

Where, $X = Z_{\alpha/2}^2 * p * (1-p) / MOE^2$, n and $Z_{\alpha/2}$ are the critical value of the Normal distribution at α/2 (e.g., for a confidence level of 95%, α is 0.05 and the critical value is 1.96), MOE is the margin of error, p is the sample proportion, and N is the population size.

Since it was stratified sampling, the number of participants sampled from each stratum was calculated proportionally to the total population. So, the total a population of the selected kebele are 2512 people live in three villages, with 40% in village Abdeta, 35% in Qitesa and 25% in village Nagasa. For this study the required sample size was 120. In order to stratify our sample, we need to calculate 40%, 35% and 25% of 120. Number of people from village Abdeta in sample = 120 * 0.4 = 48 people, number of people from village Qitesa in sample = 120 * 0.25 = 30 people and number of people from village Nagasa in sample = 120 * 0.35 = 42 people.

3.5. Techniques of Data Collection

For the project's outcome investigations, a combination qualitative and quantitative research approach was applied. The identification of study literatures relevant to Ethiopian underused or indigenous agricultural species was prioritized. The keywords or words often used to refer to underutilized crops in Ethiopia and other east African nations were initially found using an online literature search. (i) underutilized crops, (ii) indigenous crops, (iii) traditional crops, and (v) neglected crops were found as the four most frequently and generally used phrases. This terminology search was based on the findings of the initial research (Joshi et. al., 2020). Google and Google Scholar, ScienceDirect, and SpringerLink search engines were used to conduct online searches. Articles about Ethiopia were of particular interest, and other African nation literature was used to narrow down the results. Only findings reflecting at least one of the following specific terms were found in the online searches: underutilized, indigenous, traditional, and neglected crops. The results of the online search were then divided into three categories: scientific, public, and online publications. Research papers, theses, conference proceedings, and technical reports were among the types of scientific articles published.

The underutilized and local resource identification was done as the first step toward developing a search method and developing a database for valuable information on underutilized crops in Ethiopia using the first phase identified I common underutilized crops in Ethiopia and other east African countries. i. Groundnut (Vigna subterranea (L.), amaranth (Amaranthus sp.), bottle gourd (Lagenaria siceraria), eggplant, African yam bean, maize landraces (Zea mays), sweet potato (Ipomoea batatas), taro (Colocasia esculenta), sword bean (Canavalia gladiate), anchote (Anchote esculenta), an (Cocinia abysinia),Oromo dinich (Plectranthus edulis), spider plant (Cleome gynandra), finger millet (Eleusine coracana), nightshade (Solanum nigrum), cocoyam (Xanthosoma spp.), sunberry (Solanum nigrum), wild water melon (Citrullus lanatus), wild mustard (Sinapis arvensis), sorghum (Sorghum bicolor), and sesame (Sesamum indicum L.).

In the second half, a multi-stage sampling technique was used to target underutilized crop producers and non-producers among local farmers. The district's sample kebeles was stratified according to their crop production types, with a focus on underutilized crops and a comparison of the other crops. Then, from the total of 20 rural kebeles in the district, a purposive sample technique was used to select three rural kebeles. Households in the research zones of the kebeles are purposefully chosen from underused crop producers and non-producers. This ensures that more strata of the population are represented, resulting in more accurate and complete data. Abdata, Qitesa, and Nagasa are kebeles in the mid-altitude range, ranging from 900m to 1800m above sea level. According to statistics collected from the district agricultural office for the 2019/20 production year, the sample kebeles are in the same environment yet have a wide range of crop output amounts and types.

Primary data was obtained from the study area population and agricultural officials for the other criteria in order to discover relevant variables that may affect household food security and the contribution of underutilized crops in food security and enhancing family livelihoods. A semi-structured questionnaire was utilized to collect quantitative data from household heads in three kebeles: Abdeta, Nagassa, and Qitesa, in order to generate primary data. A total of 120 households were chosen for the survey (90 male headed households and 30 females headed households). A survey of underused crop producers and non-producers was undertaken once. In order to obtain primary data, the study used a home questionnaire survey, focus groups, key informant interviews, and field observation.

3.5.1. Questionnaire Survey

Questionnaire-based survey was administered to sample farming households by using a standard questionnaire after obtaining the consent of the respondents as a research ethics. The questionnaire was translated in to *Afan Oromo* for the purpose of simplicity and ease of communication between the enumerators and the respondents. On each farm the head of the household or his/her representative was interviewed by using a semi-structured questionnaire to collect data on: (1) Basic demographic and socio-economic household characteristics, (2) names, production data and uses of food plant and livestock species/varieties produced on the farm, and (3) products of plant and livestock species consumed by households. (4) Explore the reasons why the interview participants chose to grow food, who they shared it with, and the impact of crop diversification with underutilized crop on their health and well-being, the role of underutilized foods in improving production and productivities, conservation and improving livelihood. Food security measurement was done by data of household size, education level Food consumption score (FCS) and Copying strategies index (CSI) was computed as (Swindale and Bilinsky, 2006; Messay, 2011; WFP, 2008).

In addition, policies and guiding strategies for promotion and enhancement of underutilized crops were collected. In order to maintain the quality of data, scientific principles and guidelines during questionnaire designing, data collection, data filling, encoding, data entry and processing was applied. Three data collectors for each kebele were oriented on issues related to data collection procedures and ethics. Five pilot study was undertaken for pre-testing the questionnaire in order to estimate the time needed to complete and implement it. The questionnaire was edited in the light of the results of the pilot study. Computer-based data cleaning was carried to check for the completeness, consistency and accuracy of data and to identify errors that may occur during data collection or coding process.

3.5.2. Key Informant Interview (KII)

In addition to the cross-sectional survey to be carried out, some key persons (model farmers, DA and officer) in sample kebeles and the woreda was interviewed to obtain relevant information. This is because the key informants’ interviews are useful for exploring an individual’s beliefs, values, understandings, feelings, experiences and perspectives of an issue. These interviews also allowed the researcher to ask into a complex issue, learning more about the contextual factors that govern individual experiences. The indepth interview was focused on organizing formal interview with the aim of facilitating open interaction between the key informant and the researcher through inviting key figures in the respective areas relevant for the issue under discussion to participate in open dialogue forum. The KII was done face-to-face. An individual interview was a conversation between people that has a structure and a purpose. It was designed to elicit the interviewee's knowledge or perspective on a topic.

3.5.3. Focus Group Discussion (FGDs)

Three focus group discussions were carried out with a mix of participants such as agriculture officers and DAs, practicing households (elders and women-headed households) and the farmers. A focus group discussion was an organized discussion between 6 to 8 people. Focus group discussions provide participants with a space to discuss a particular topic, in a context where people were allowed to agree or disagree with each other. Topics related to issues of managements land for crop diversification, awareness on crop diversification and underutilized crops, awareness on contribution of underutilized crops in food security, income generation and sustainability of production, policies and guiding strategies followed in crop diversification with the local crop species, livelihood opportunities and challenges, environmental protection, land distribution and adequacy, food insecurity, and the existing support from the government and NGOs were addressed. Focus group discussions were allowed you to explore how a group thinks about an issue, the range of opinions and ideas, and the inconsistencies and variations that exist in a particular community in terms of beliefs and their experiences and practices. The participants were respectfully requested for their consent, time and the information.

3.5.4. Field Observations

In addition to the above data collection methods, a field visit was executed by the researcher to validate and expand the information obtained through other primary and secondary data collection tools.

Biophysical and socioeconomic conditions of the area were explored through the field observation. In the meantime, experts and administrators in the woreda and kebeles were briefly interviewed.

3.5.5. Secondary Data Sources

Besides the abovementioned data collection techniques and procedures, intensive desk review of published and unpublished literatures such as books, journals, articles, reports and e-resources were carried out. Documents from various Oromia bureaus, Ministry of Agriculture, different websites of food production and promote, income generation, policies and strategies reviews and sustainable production were reviewed.

3.6. Crop Diversification Index Measurement using Underutilized Crops

We used the Crop Diversification Index (CDI) to quantify crop diversification with underutilized crops of a certain crop. The CDI is a concentration index that has a direct relationship with crop diversity, with a value of zero indicating specialization and a value greater than zero indicating crop diversification. It was then simple to identify those farmers who practice crop diversification and those who do not practice crop diversification with underutilized crops using the CDI index. The CDI is calculated by subtracting one from the Herfindahl index (HI) (1-HI). The CDI is computed exactly as follows:

$$S_i = \frac{A_i}{\sum_{i=1}^{n} Ai}$$

Where, S_i = proportion of i^{th} crop; A_i = area under i^{th} crop; $\sum_{i=1}^{n} Ai =$total cropped area; and i = 1, 2, 3, 4… n (number of crops)

But HI=$\sum_{i=1}^{n} S_i^2$ therefore CDI becomes 1-$\sum_{i=1}^{n} S_i^2$ =1-HI

The crops diversity index was calculated using twelve regularly used cereal and underused crops among smallholder farmers in Guto Gida district. Cereals (maize, barley, wheat, tef, and sorghum), pulses (soybean and common bean), vegetables, and underused crops were among these crops (amaranth, anchote, taro, Oromo dinich and sweet potatoes, groundnut, cowpea). When it came to underutilized crops, households that grew at least two underutilized crops per season were termed underutilized crops growers.

3.6.1. Measuring the Impact of Underutilized Crops on Food Security

The study uses an ordinary least squares (OLS) model to analyze the contribution of underutilized crops to household food security and livelihood outcomes. We chose OLS regression because the crop diversity index (CDI) with underutilized crops is a continuous variable, and the Food Security outcomes FCS and Coping strategy index (CSI) are dependent variables (all continuous variables). According to Isik-Dikmelik (2007), using OLS to analyze the contribution of a continuous variable on another continuous variable, such as in our instance, is highly solid and correct. The OLS model is defined as follows:

$$Y_i = \sigma_0 + \sigma_1 x_{i1} + \sigma_2 x_{i2} + \cdots + \sigma_7 x_{i7} + e$$

Where Yi denotes the outcome of family food security (either FCS or CSI), Xi1 = crop diversification, Xi2 = underutilized crops (1 = yes; 0 = no), Xi3 = cattle owner (1 = yes; 0 = no), Xi3 = household size, Xi4 = access to land (1 = yes; 0 = no), Xi5 = household head's education (1 = at least primary education; 0 = otherwise), Xi6 = age of household head, and Xi7 = access to support 0 denotes the intercept, 1 to 7 denotes the coefficients, and e denotes the error term. The variables included in our analysis are described in Table2.

The study used the FCS technique to measure food security, which was calculated according to EFSA recommendations (2015). Dietary diversity, eating frequency, and the relative nutritional value of nine different food groups were used to calculate FCS. The FCS is intended to reflect the quantity and quality of a person's diet at home. A weighted sum depending on the food type and frequency of eating over a seven-day period yields a composite score. Dietary recall questions were utilized to collect data on the consumption of a variety of food groups that are common in Ethiopia (Guto Gida district). The interviewees were asked about their eating patterns during the previous seven days. The FCS was computed using an EFSA-proposed formula (2015). FCS is calculated by multiplying the weight of each food group/type by the frequency (number of days) that these food groups/types were ingested; the values for all food types consumed throughout the 7-day recall period were added together to generate the FCS. The following is an example of the formula:

$$\text{FSC}=a \times f(\text{cereal and or tuber}) + a \times f(\text{pulse}) + a \times f(\text{milk}) + a \times f(\text{fruit}) + a \times f(\text{meat and or fish}) + a \times f(\text{sugar}) + a \times f(\text{vegetables}) + a \times f(\text{codiments})$$

Where FCS stands for Food Intake Score, f stands for frequency of food consumption (the number of days each food group was consumed in the previous 7 days), and a stand for a weighted value representing the nutritional value of selected food groups (2015). Different weights were allocated to different food groups based on their nutritional density. Poor food consumption (0–21), borderline food consumption (21–FCS 35), and acceptable food consumption (FCS > 35) are the consumption categories defined by the FCS (2015). The FCS was chosen because it is a more accurate indicator of the quality of a household's diet. Furthermore, it takes into account the nutritional worth of food as well as the number of various kinds of food ingested. The FCS, on the other hand, has some flaws, primarily because it does not account for foods consumed outside the home and does not provide information on intra-household food distribution. The 7-day recall makes it difficult to estimate the amount of food consumed. Despite its flaws, FCS is still regarded as one of the most useful household food security indicators (O’Connor et al., 2017).

3.7. Data Analysis Techniques

An analysis of variance was performed on the data. STATA MP 15 was used for the statistical analysis. The Ordinary Least Significant Difference (OLSD) with a significance level of 5% was used to separate the means. The coefficients of variation were calculated using the means, standard errors (SE), and least significant differences (LSD) (Singh et al., 1997). To determine the relationship between all parameters, linear correlation was used. The STATA computer software package was used to evaluate the quantitative data gathered mostly from household surveys.

3.8. Ethical Consideration

In case of data collection, ethical considerations must be seriously taken into account to ensure the protection, integrity, anonymity, consents and other human elements of the informants. In this study, the respondents are not identified by names and their consent will be required during interview and discussions. As argued by Kitchin and Tate (2000) research ethics are considered with the extent to which the researcher is ethically and morally responsible to his/her participants, the research sponsors and other concerned bodies who have a contribution in his/her research. Taking this idea into consideration, before starting to conduct the study, ethical consideration has been seriously taken into account by the researcher and the researcher tried to be ethical in a manner that not disappoint the respondents and officials of different government organizations. First of all, initial contacts have made with those higher government officials and sample populations to introduce myself and explain the purpose of the research. Then after, the discussants and respondents were met and asked their willingness to conduct FGD and interview. On the other hand, during field observation and KII data collection as well as the collection of secondary materials such as reports and other related documents, the researcher assured permission with formal letter.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Identification of Underutilized Crops and Research Gaps

The first phase of the literature search revealed that “indigenous crops” was the most prevalent keyword in Ethiopia, with almost 180 articles, followed by “traditional crops” with 105 publications and underutilized crops with only 59. Indigenous crops became the most prevalent term in Ethiopian plant species studies after results were filtered to only display results that included at least one of the specific words "underutilized/indigenous/traditional/neglected."

The most explored themes on underutilized crops in Ethiopia were agronomy, food and nutrition security, with 87, 42, and 36 publications, respectively, according to the results of the underutilized crop identification (Table 4.1). Post-harvest, therapeutic characteristics, and breeding of these crops were prominently included (>25 papers), while climate change, biotechnology, people's attitudes, and commercialization were covered to a lesser level (23 publications). This backed up previous findings that pointed to crop improvement and the development of value chains or marketing as major roadblocks to NUS promotion in Sub-Saharan Africa and elsewhere (Mabhaudhi et. al., 2017). As a consequence of this study, more than 95% of these underutilized crops are located in our country, particularly in the study area or in the western portion of the country. Furthermore, in this study area, two other highly common and very popular and socially culturally important crops (Anchote and Dinicha Oromo) are farmed very routinely and frequently, but as this study revealed, there has been very little research on these crops (Table 4.1). Because there was relatively little research and promotion done on these crops, the results showed that they were underutilized crops. As a result, substantial work has been done to manage abiotic and biotic challenges (drought and heat) and assure food and nutritional security; nonetheless, there is a need to concentrate on crop improvement and promotion for these underutilized commodities, as well as increasing their markets and value chains.

Furthermore, this finding revealed that there are insufficient research outputs for these underutilized cereals, vegetables, fruits, root and tuber crops, as well as their importance in addressing food security and micronutrient deficiencies in impoverished rural people's diets. Sweet potatoes and landrace maize were the most researched crops with 40 and 33 publications, respectively. The large number of publications on sweet potatoes also fits with international initiatives to promote the underutilized crop led by the Underutilized Crops Network (Modi & Mabhaudhi, 2016).

Table 4.1: List of underutilized crops, research types and number of research done under Ethiopia resource identification search

Crops	Nutrition	Agronomy	Food security	Seed quality	Breeding	perception	Resilience of Climate change	Post-harvest	commercialization	Medicinal properties	Biotechnology	Total
Groundnut	1	2	3	0	1	0	3	2	0	0	1	13
Amaranth	2	3	6	0	2	1	0	3	1	2	2	22
Bottle gourd	0	1	3	0	1	0	0	1	0	1	0	7
Maize landraces	6	3	8	5	2	0	2	4	1	2	0	33
Cowpea	2	2	6	1	0	0	2	0	1	2	0	16
Sweet potato	4	5	9	0	5	2	2	4	3	4	2	40
Taro	1	2	5	0	0	0	1	2	0	4	1	16
Sword bean	0	1	0	1	0	0	0	0	0	0	0	2
Anchote	3	2	5	0	1	0	0	1	0	2	1	15
Dincha Oromo	2	3	4	2	0	2	0	0	0	1	1	15
African yam bean	0	0	0	1	0	0	0	2	0	0	0	3
Marama bean	0	1	2	0	2	0	1	2	1	2	1	12
Eggplant		0	0	0	0	2	0	0	1	1	1	5
Spider plant	1	1	2	0	1	0	1	2	0	1	0	9
Finger millet	2	3	4	1	1	1	0	1	1	0	0	14
Nightshade	0	0	2	1	1	0	0	0	0	0	0	4
Cocoyam	2	2	3	2	2	1	1	2	1	2	2	20
Sunberry	0	0	2	1	1	0	0	1	0	1	1	7
Wild water melon	2	2	4	1	0	0	1	1	0	1	1	13
Wild mustard	3	2	4	1	0	0	1	1	0	1	0	13
Sorghum	3	4	8	3	2	0	2	3	2	1	2	30
Sesame	2	3	7	3	3	3	2	3	3	4	2	35
Total	36	42	87	23	25	12	19	35	15	32	18	344

Source: Developed by the researcher from a literature review, 2021

As this study revealed, maize landraces and sweet potatoes had the highest number of publications among cereal crops; nevertheless, these studies did not all focus on one or two specific characteristics of the crops. Sweet potato (40 articles), taro (17 publications), and anchote (17 publications each) attracted the most scientific interest among root and tuber crops (Table 4.1). Furthermore, the results revealed that underutilized cereal crops sorghum and maize landrace (35 and 33 publications respectively were observed (Table 1). As this study revealed, the rest of the crops had a relatively small number of reported studies, indicating that they are underutilized and receive little academic attention. Increased research outputs could be linked to the effective commercialization of taro in various African countries (T Mabhaudhi & Modi, 2012). Sweet potato research has recently developed, owing to the promotion of orange-fleshed sweet potatoes as a source of beta carotene (Motsa et. al., 2015). In general, as this study revealed, all of these crops have not been developed, promoted, or used to their full potential, hence they are considered underutilized crops in Ethiopia, as well as maybe in other Sub-Saharan African countries. One of the main reasons for the poor investment in this area of study is the wrong belief that they provide lower returns on investment than the major crops (Nelson et. al., 2004). Tafadzwanashe Mabhaudhi et. al. (2017) stated that this barrier may be addressed by finding a few selected underutilized crops with useful qualities like drought and heat tolerance and nutrient density, that have certain benefits over major crops, and that have a good chance of succeeding.

As this literature research showed the most common underutilized or unprompted crops in the study area as well in the most part of this country as well in the east African countries were identified that included groundnut (Vigna subterranea (L.), amaranth (Amaranthus sp.), eggplant, African yam bean, maize landraces (Zea mays), cowpea (Vigna unguiculata (L.) Walp), sweet potato (Ipomoea batatas), taro (Colocasia esculenta), sword bean (Canavalia gladiate), anchote (Cocinia abysinia), Oromo dinich (Plectranthus edulis), spider plant (Cleome gynandra), finger millet (Eleusine coracana), sunberry

(Solanum nigrum), wild water melon (Citrullus lanatus), wild mustard (Sinapis arvensis), sorghum (Sorghum bicolour), and sesame (Sesamum indicum L.) are the most common production for some of the farmers, according to the review the listed crops are undeveloped and very limited information are available on them, so they are underutilized crops in Ethiopia and in the western part of our country especially in Guto Gida district (Table 4.1). As this survey showed these crops were not got enough research or development and promotion programs, it didn't get enough funding for the development. Even though these crops were potential in nutrition and promising food security, they were not guided by policy and strategies for the development and promotion. Still these crops were restricted to a specific growing area or they were underutilized in Ethiopia.

4.2. Descriptive Statistics Comparisons of Underutilized Crops Producers and Non-Producers in Guto Gida District

Table 4.2. Household population size and sampled households.

Kebeles	Total households			Total Sampled size			Underutilized crop producers			Non-underutilized crop producers		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
Abdeta	720	270	990	38	10	48	18	6	24	20	4	24
Qitesa	513	170	683	24	6	30	11	4	15	13	2	15
Nagasa	629	210	839	28	14	42	13	8	21	15	6	21
Total	1862	650	2512	90	30	120	42	18	60	48	12	60

Source: Computed from authors' field survey, 2021

The survey study showed that the participant for underutilized crop producers and non-producers were similar and also the gender equality distribution for the producers and non-producers were almost similar (Table 4.2). The production land, educational level, age, family number and the cattle owning proportion were considered has no significance difference between the producers and non-producers (Table 4. 2 and

4.3). The descriptive statistics of variables used in our analysis are shown in Table 4.3. The statistics are based on a sample of 120 farming households from Guto Gida wored, Ethiopia

Table 4.3: Summary statistics of variables used for analysis

Variable	Variable description	Underutilized crop producers				Non underutilized crop producers			
		Mean	SD	Min	Max	Mean	SD	Min	Max
Educational background	Educational level	Grade 8		Grade 3	Diploma	Grade 7		Grade 2	Diploma
Family numbers	Household family number	6	7.76	1	12	6	7.76	1	12
Production land area	Production land in hec.	1.625	1.95	0.25	3	1.625	1.95	0.25	3
Socioeconomic contribution of underutilized crops	Total production(kg)	5653.33	95.04	5560	5750	2450.0	104.4	2380	2570
	Total consumption (kg)	3418.33	159.8	3021.1	3815.4	1136.0	54.61	1000.3	1271.6
	Total sale (kg)	2200.00	50.00	2150	2250	1312.3	90.22	1226	1406
	Total expenditure for food (birr)	5425.00	149.0	5265	5560	7371.0	254.0	7153	7650
	Total Income (birr)	6440.33	77.95	6358	6513	4372.3	217.5	4217	4621
FCS	Food Consumption Score of the household	29.87	15.8	12	43	22	12	10	33
CSI	Coping strategies index	8.00	2.000	6	10	12.33	2.517	10	15

Source: Computed from authors' field survey, 2021 * Significant at 5%, FCS (Food Consumption Score), CSI (Coping Strategy Index)

The average household sizes at the time of the survey have no statistically significant difference between family members of underutilized crop producers and non-producers. The smallest home size recorded was one person, and the largest household size recorded was eleven. Between underutilized crop producers and non-producers, there is no substantial difference in age, educational level, household members, amount of cultivation land, or other economic activity (Table 4. 3). The result indicates that underutilized crop producers with other cereal crops had shown higher levels of crop production (22.48 percent), consumption (11.73 percent), and total annual sale (19.32 percent) in the Guto Gida district of nearly the same production area of land, the same other economic background of the sampled respondents (Fig 4.1) than the non-producers. Non-producers of diverse crops, on the other hand, spend (31.43 percent) more money than diversified produce with underutilized crops (Fig 4. 1). On the other hand, the survey found that producers of non-underutilized crops in the tested homes had a relatively low ratio of production, consumption, total annual sale, and revenue generation. In the physical year of the study, just 21% of households compute with the underutilized crop producers.

The income generated from the production differences of these crops varied among the group of smallholder farmers sampled in the Guto Gida district of the study area based on production diversity (Table 4.3). The number of households has a favorable impact on the amount and kind of crops produced because most of these crops are grown in the gardens of the homes, on a small plot of land, and it allows the entire family to participate in the agricultural activities. More than 60% of the respondents or producers reported that the production of these neglected crops provided them with a higher level of income. Non-producers of underutilized crops, on the other hand, were not earning enough cash per year for these producers (Table 4.3).

According to the survey, underutilized crop producers earn on average 30% more than non-producers in terms of production, consumption, and income creation (Fig 4.3). According to the findings of this study, non-diversified crop producers spend more money on food each year than diversified crop producers (Table 4. 3). This study also found that diversification using neglected crops produced better productivity and yield than non-diversified crops in the same amount of land. In terms of educational background, the results indicate that the level of education in the study area is positively correlated, which makes the producers more knowledgeable and any other production and marketing-related information from various sources easily understandable by smallholder farmers. Furthermore, the farmers were found to be quite young, with an average age of 46 years. The home group's minimum and maximum ages were discovered to be 19 and 82 years old, respectively. Another factor investigated was whether the households owned or rented agricultural or production land. The findings demonstrate that nearly all of the studied smallholders, both producers and non-producers, had access to their own land for production.

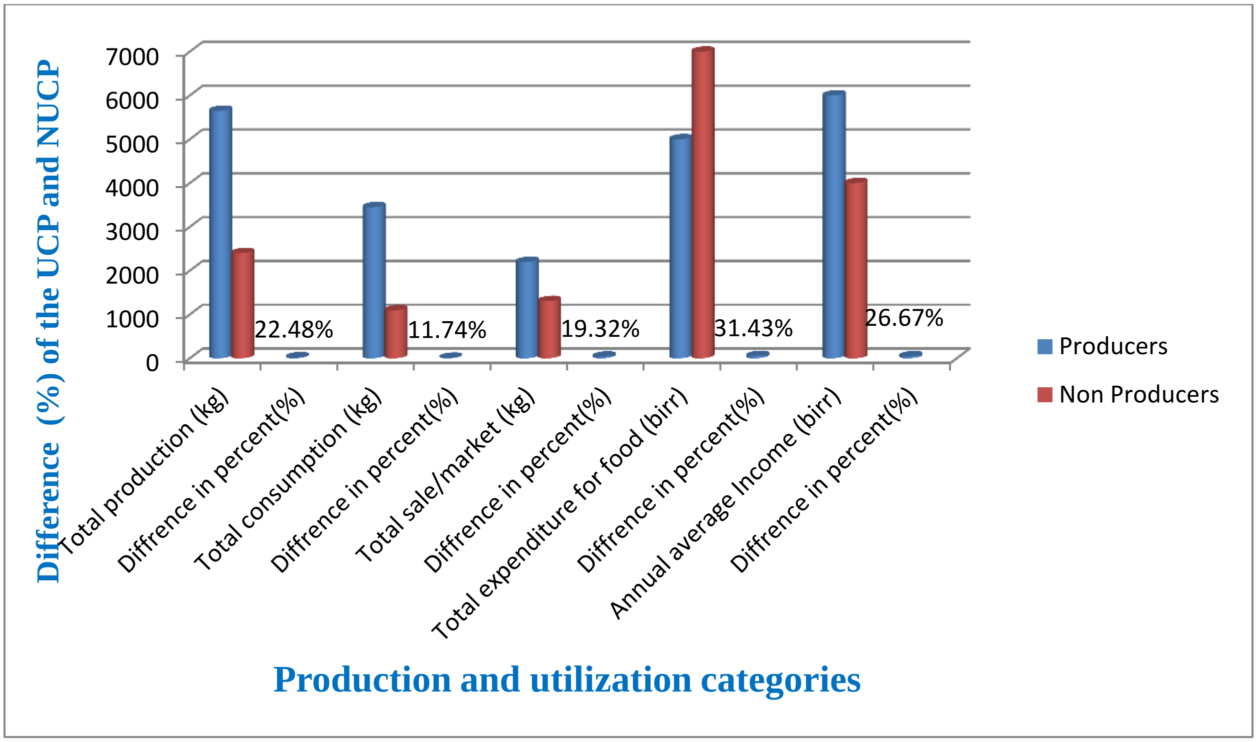

Figure 4.1: Socioeconomic contribution of underutilized crops (Source: Computed from authors' field survey, 2021)

This study was in agreement with the study on taro and other underutilized crops; underutilized crop food has a significant economic relevance as a cash crop and foreign exchange earner on many large islands in the Pacific area, such as Samoa and Fiji (Hanson and Imamuddin, 1983). Some underutilized products, like as taro and sweet potatoes, can be exported; their production not only pays farmers but also provides the government with significant foreign exchange. These Pacific Island governments have made significant profits from underutilized products such as taro exports, primarily to Australia and New Zealand. Many additional countries are interested in participating in taro exports. People of Pacific Island ancestry continue to eat taro wherever they live in the world, not so much because there are no other food options, but rather to stay connected to their culture. Because of their cultural commitment to taro, ethnic Pacific Islanders in Australia, New Zealand, and western North America have developed a thriving taro export business (FAO, 1999). Traditional medicine makes use of various parts of the taro plant. Traditional medicine uses taro corms and leaves, demonstrating the people's historical relationship with the plant (Pancho, 1984).

According to a study conducted by Farm Concern International and The World Vegetable Center, in 2003, consumption of African leafy vegetables in Eastern Africa was just 31 tons worth USD 6,000, but by 2006, consumption had nearly doubled to 600 tons worth USD 142,860. According to a yield and profitability analysis, monocropping on 1,000 m^2 could produce 3,409 kg of spider plant, 7,500 kg of amaranth, 2,841 kg of cowpea (Vigna species), 2,841 kg of African nightshade (S. scabrum), and 2,273 kg of Jew's mallow, for a total of 18,864 kg worth USD 2,515, with a net profit of USD 1,539 (Hughes, 2008). In the past, green vegetables may have been thought of as poor people's food, dirty, and hence unfit to eat (Hughes, 2008).

NUCS are a significant plant resource with various benefits and qualities that make them relevant and useful to the ease of production, money generation, and environmental health, as described by (Roshetko, 2013) NUCS are able to thrive in harsh environments where other plants would perish, making them valuable in climate change mitigation and sustainable food production (Lobell et al., 2006). NUCS also play an important role in the preservation of cultural variety among indigenous peoples due to the cultural importance they place on them (Williams, 2002). NUCS have been found to have an essential role in improving local livelihood, nutrition, and food security among indigenous groups in several research conducted in remote locations of emerging countries (Baa-Poku & Research, 2020). NUCS have been recorded as a food and medical source in Asia and the Pacific countries such as India, Nepal, Malaysia, and the Philippines. NUCS is also widely used in Sub-Saharan African nations such as Malawi, Nigeria, Cote d'Ivoire, Uganda, and Zimbabwe (Baa-Poku, 2019).

NUCS have been demonstrated to have an essential role in the promotion of local livelihood, nutrition, and food security among indigenous groups in several studies conducted in remote parts of emerging countries (Nyadanu et. al., 2014; Magbagbeola et. al., 2010; Bhattacharjee, 2009). NUCS have been recorded as a source of food and medicine throughout Asia and the Pacific countries like as India, Nepal, Malaysia, and the Philippines. NUCS is also widely used in Sub-Saharan African countries like Malawi, Nigeria, Cote d'Ivoire, Uganda, and Zimbabwe (Padulosi et. al., 2013; FAO, 2010).

As a result, NUCS present a great opportunity for the agriculture industry to capitalize on in order to combat food insecurity among indigenous or rural communities. NUCS role to resolving the food insufficiency crisis has been validated in several research, including Nyadanu et al., (2014) and Magbagbeola et. al., (2010). In terms of resources being scarce and providing competitive advantages, NUCS have some unique agronomic qualities that allow them to survive in a variety of ecological niches and in adverse conditions such as poor soils and drought (Shackleton, 2009). NUCS can also be used as a backup crop if the main crop fails or is unavailable, according to Mabhaudhi et. al. (2011). NUCS are likewise one-of-a-kind and non-replaceable. Although NUCS can be found in both tropical and temperate climates, their function and significance are not widely recognized in many nations (Padulosi et. al., 2013; FAO, 2010). As a result of the preceding debates, it is clear that NUCS as a plant resource has not been completely exploited by Ethiopia's agricultural sector, and that it requires immediate attention.

4.3. Household Food Security status of Producers and Non-Producers of Underutilized Crops in Guto Gida District

Both metrics of food security show distinct patterns as well as similarities. According to the two metrics (FCS and CSI), at least 78 percent of families have a moderate to acceptable food security situation. In an attempt to link the two food security metrics, FCS and CSI, to crop diversification with underutilized crops, it was discovered that the majority of diversification producers with underutilized crops are more food secure, ranging from borderline food secure to acceptable food secure. One point to note is that average indices per food security status category (high FCS and low CSI) are above 55%, showing that crop diversification and relative food security are higher than non-diversification with underutilized crops (Fig 4.3 and 4. 4).

Table 4.4: Household food security and crop diversification index with underutilized crops

Food security/insecurity indicator	Underutilized crop producers		Non underutilized crop producers	
	% Of households in category	Average CDI by index category	% Of households in category	Average CDI by index category
FCS				
Poor FCS	10	0.56	14	0.38
Borderline FCS	16	0.6	25	0.43
Acceptable FCS	34	0.63	21	0.41
CSI				
Food secure	32	0.58	15	0.49
Mild to moderate food insecure	20	0.58	25	0.45
Severely food insecure	8	0.55	20	0.41

Source: Computed from authors' field survey, 2021

Crop diversification was found to have a favorable impact on FCS and a negative impact on CSI, as measured by the index (Table 4.45). The CDI coefficient is substantial at 5%, indicating that it has a favorable impact on household FCS. Households with higher crop diversification intensities with underutilized crops are more likely to have food crop diversity and consumption diversification that can be consumed inside the household, justifying the positive association. This suggests that agricultural diversification enhances food consumption in the Guto Gida district, implying that underutilized crop producers with other crops were better off than non-producers in terms of food security. Furthermore, households with a wider range of crops had utilized a lower level of CSI (Table 4.4). The CDI coefficient, on the other hand, is substantial at 5% and has a negative impact on CSI (Table 4.4). This suggests that households with higher crop diversification intensities with underutilized crops used less coping strategy index than those with lower crop diversification intensities. The findings suggest that crop diversification with underutilized crops reduces food insecurity and CSI usage (Table 4.4). Households with a greater variety of crop species are less likely to resort to desperate food crisis coping mechanisms.

Farmers who increase crop diversification with underutilized crops are better off than their counterparts, as diversification is positively related to food consumption and negatively related to food insecurity, owing to the benefits of crop diversification, which include increased farm productivity, increased income, and reduced production costs and price risks, all of which are easily produced by cultural knowledge. It improves the use of organic fertilizers and the biological pest management system. It has the potential to improve a sustainable food production system that is also environmentally friendly. Similar several studies have found crop diversification to impact positively on food security of the household (Mango et. al., 2018) and (Adjimoti et. al., 2018). Crop diversification's benefits in boosting food security can be seen in better price and production risk management (Frison et. al., 2011). This is achievable because, compared to less diversified farming companies, cultivating multiple crop species in a single season on a small area of production land affords the farmer options that allow him or her to better manage pricing and production risks. Crop diversity protects farmers from disasters such as floods, droughts, and other stressors. Statistics show that Ethiopia has seen more than a dozen weather-related disasters in recent years, including droughts and floods (Chaiken & Health, 2017; Mohamed & Policy, 2017). Smallholder farmers in Ethiopia face serious challenges in adopting modern crop diversification strategies. Furthermore, if smallholder farmers continue to plant more traditional maize and sorghum at the expense of more drought and flood tolerant crops, drought and flood impacts on food security may worsen (Aryal et. al., 2019). As a result, the favorable impact of crop diversity with underutilized crops on sustainable production for FCS and the negative impact on CSI is justified (Mango et. al., 2017).

4.4. Contribution of Underutilized Crops in Improving Food Security and Livelihoods of the Households

Statistics analysis of the Food Consumption Score (FCS) and Coping Strategy Index (CSI) revealed that household FCS averaged 36 percent, indicating acceptable food consumption levels for underutilized crop producers, whereas 12 percent of non-diversification producers of underutilized crops can only reach acceptable levels of food consumption. Households who produce non-underutilized crops received the lowest score (12%), while those that grow varied crops with underutilized crops received the highest score (36%). (Fig 4. 2). According to FCS, the majority of households (57%) are food secure, 36% have borderline food consumption, and 26% have low food consumption. In terms of CSI, the data show that 32% of UCP and 15% of NUCP families were food secure or used low CSI, 20% of UCP and 25% of NUCP households used medium CSI, and 8% of UCP and 20% of NUCP households used high level CSI in Figure 4.3.

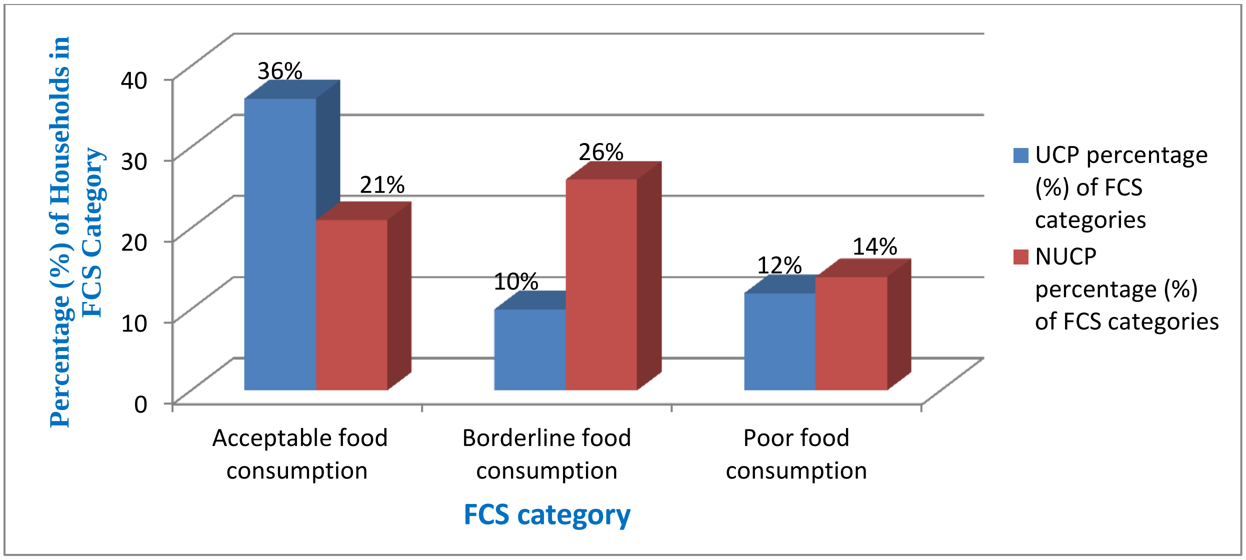

Figure 4.2: Distribution of households in Guto Gida district based on food consumption score (FCS**),** (Source: Computed from authors' field survey, 2021)**.**

Diversification with underutilized resources in Guto Gida district or Ethiopia was proven to have a substantial impact on the FCS (Fig 4.2). At 5%, the coefficient of production is considerable and has a positive relationship with the food consumption score. Producers of underused crops have a key role in increasing family food consumption in a variety of ways. The findings reveal that households who generate crop variety have higher FCSs than those who do not (Fig 4.2 and 4.3). This survey revealed that underutilized foods were created using local ingredients and could be easily grown on a small plot of land. Second, this production or farming systems are important as a productivity-boosting input in farming operations since they may produce organic matter and composts, as well as improve the recycling of various organic resources (Mabhaudhi, et. al., 2017). Furthermore, these crops are nutrient-dense and provide a source of food for the household by providing essential nutrients (Hawkesworth et. al., 2010). It provides a good probability of employment for the entire home and also provides a source of money for the members of the household. To back up this conclusion, Crop diversification with underutilized crops, according to Bandula (2016), is a significant aspect that contributes to food security since it adds to subsistence household needs, income, and nutritional requirements with other food sources.

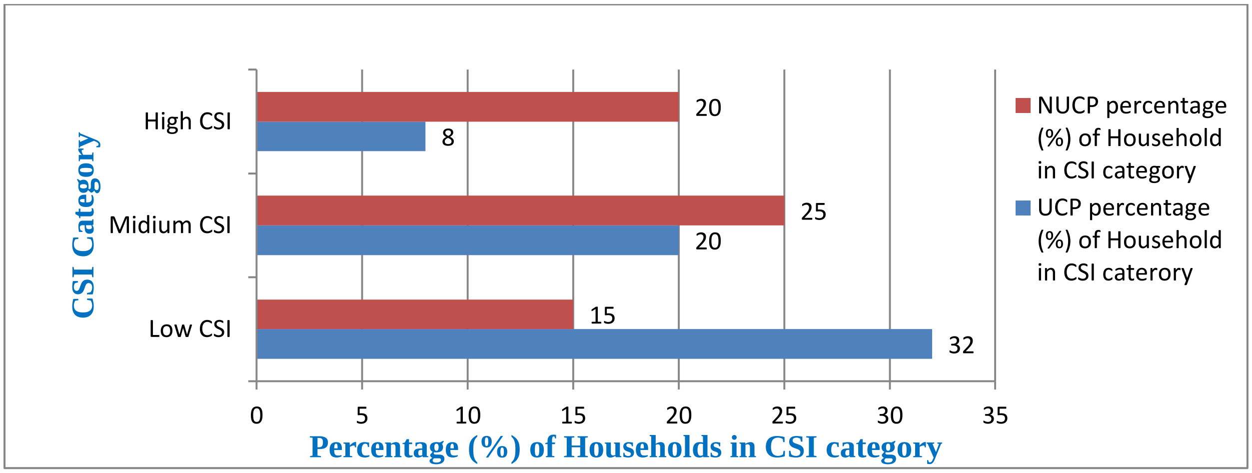

Figure 4.3: Distribution of households in Guto Gida district based on Coping Strategies Index (CSI), (Source: Computed from authors' field survey, 2021)

4.5. Challenges and Opportunities for Full Utilization of Underutilized Crops

Following the exercise in developing and promoting underutilized crops, various open-ended questioners, group discussions, key informant interviews, and personal observations from the study area, district and zone agricultural offices were used to assess the challenges, barriers, and opportunities for all activities and development opportunities. On the general obstacles and prospects of implementing underused crops, 15 informant persons from households, professionals, and officers were interviewed, as well as six group discussions and eight key informant interviews. The primary goal was to identify the major issues for NUS in terms of research, development, and innovation, which would serve as a roadmap for future national promotion and funding. Second, to find ways to promote and grow the contribution of these underused crops in such a way that the national development plan and food security challenges are addressed.

The challenges identified were a lack of awareness, institutional and organizational involvement, limited sources of founding, limited sources of production materials, a lack of emphasis from concerned bodies, farmers' adaptation to crop diversification, and limited firm policies and strategies on the development and promotion of crop diversification (Fig 4.4). On the other hand, the characteristics of its opportunities were identified: it is easily produced in a small area of land, easily cultivated in local materials, has a short maturity stage, has a high productive or yield potential, is drought and stress tolerant, contains dense and good nutrition value, has high demand and high market value, has high social and cultural value, and creates job opportunities (Fig 4.4).

4.5.1. Challenges

According to the results of this survey, the most problematic problems for professionals, offices, and even farmers themselves are a lack of firm development and promotion policies and strategies for crop diversification with underutilized crops (Fig 4.4). The most challenging problem in the research area as well as the country was the lack of government attention to the farming system, particularly crop diversifications. According to the findings of this study, government policies, plans, and follow-up concentrated solely on cereal crop production and a specialization agricultural system, rather than crop diversification. Furthermore, 71 percent of respondents said that a lack of production resources, such as improved and readily available seed and other inputs, was one of the most difficult problems in this region (Fig 4.4). The greatest challenge in this area, according to 50% of respondents, is a lack of awareness and excellent information of the overall implementation of crop diversity.

Furthermore, as this result demonstrates, the lack of participation of various institutions and organizations, as well as a lack of financing sources for the development of this field, is another problematic issue in the research area as well as for the country. The promotion of NUS policy and strategy can only be successful if it is backed up by, linked to, and connected with international, regional, and national policies (RISDP, 2015). The National Integrated Growth and Development Planning (IGDP) (2010), the National Department of Agriculture, Forestry and Fisheries (DAFF) Strategic Plan for 2016–2020, the National Food Security Production Programme, and the National Policy on Food and Nutrition Security are all aligned with the high yielding crops promotion strategy (2014). All of these programs emphasize the importance of increasing smallholder participation in mainstream agriculture and the adoption of sustainable farming techniques to promote food and nutrition security in households.

As a result, NUCS present a unique opportunity for the agriculture industry to capitalize on in order to combat food insecurity among indigenous or rural communities. NUCS role to resolving the food insufficiency crisis has been validated in several research, including Nyadanu et. al., (2014) and Magbagbeola et. al., (2010). Despite the fact that some of these qualities may have a "new" meaning, NUS are frequently portrayed as new crops, despite the fact that they have been used in traditional methods by local inhabitants for generations. This statement is critical in emphasizing the significance of these animals in our lives (Bhag Mal 1994). In terms of resources being scarce and providing competitive advantages, NUCS have some unique agronomic qualities that allow them to survive in a variety of ecological niches and in adverse conditions such as poor soils and drought (Shackleton, 2009). NUCS can also be used as a backup crop if the main crop fails or is unavailable, according to Mabhaudhi et. al. (2011). NUCS are likewise one-of-a-kind and non-replaceable. Although NUCS can be found in both tropical and temperate climates, their function and significance are not widely recognized in many nations (Padulosi et. al., 2013; FAO, 2010). As a result of the preceding debates, it is clear that NUCS as a plant resource has not been completely exploited by Ethiopia's agricultural sector, and that it requires immediate attention.

There is now a scarcity of information on the growth, development, nutritional value, and economic impact of neglected and indigenous crops. When such material does exist, it is frequently hidden away in indigenous knowledge systems and other ancient literature that is difficult to access. Furthermore, there has been little coordination on NUCS-related investigations, both on a regional and international basis. Because of the lack of coordination and uniformity of an umbrella word, there is little information available in search of environmental, food, and nutritional security, as well as economic impact on NUCS (Amsalu et. al., 2008).

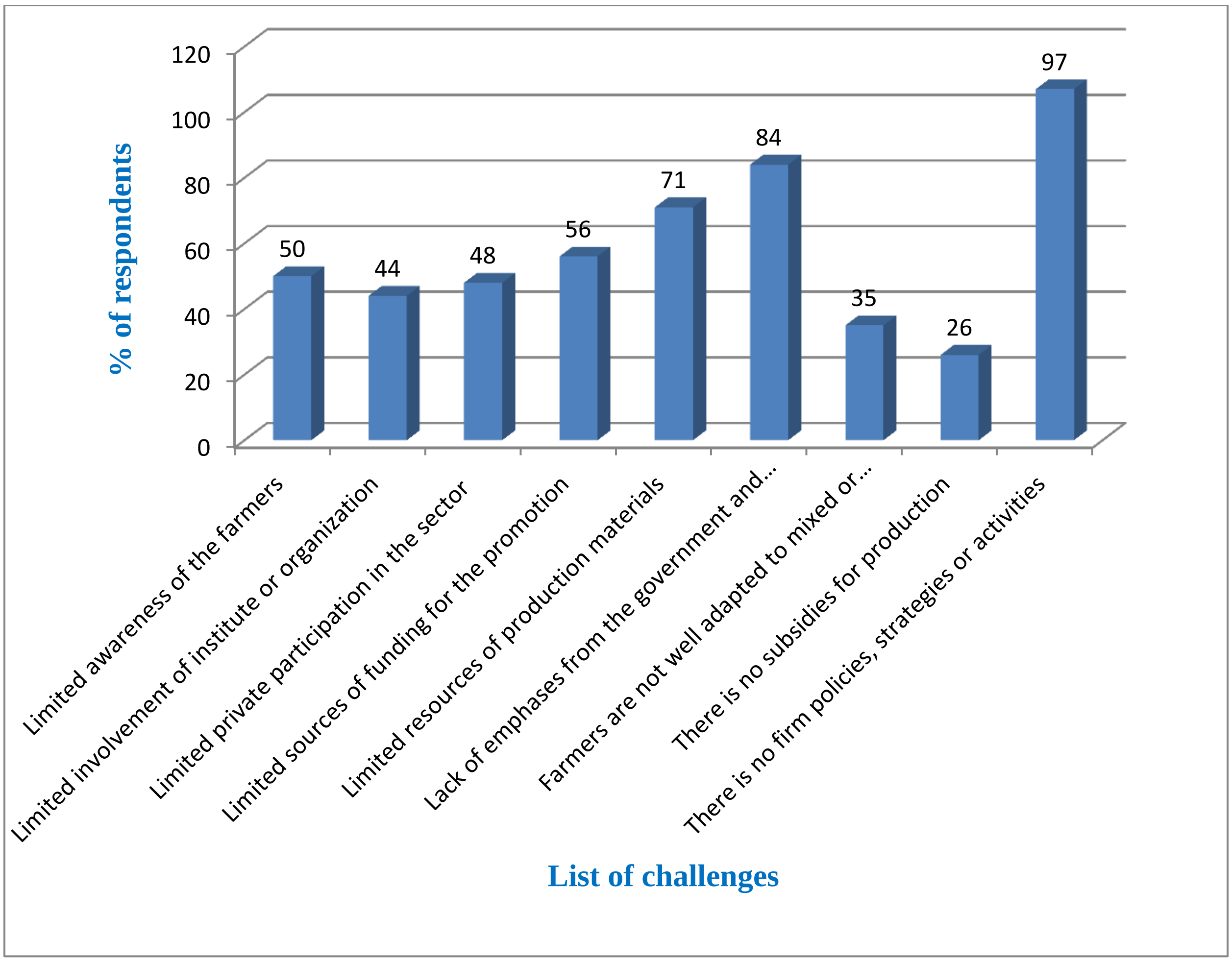

Fig 4.4: Challenges in underutilized crop production and promotion in Guto Gida district (Source: Computed from authors' field survey, 2021)

4.5.1.1. Policies Gaps

According to the results of this survey, existing policies do not expressly recognize NUS as a feasible option for attaining policy goals. In order to integrate NUS into mainstream agriculture, the existing institutional and policy environment must acknowledge the prospects for rural economic development that NUS provides. The results of a targeted research survey on identified and priority NUS, as well as demonstrated successes, will be used to develop a policy framework that (I) encourage a stable and underutilized crop and regulatory environment for NUS, and (ii) encourages a stable and underutilized crop and regulatory environment for NUS. (ii) supports NUS capacity development, (iii) offers appropriate financial and material support for NUS RDI, and (iv) encourages NUS to innovate in agro-processing technology. (vi) administration of resources, knowledge, and culture (v) increasing stakeholder involvement (IV) managing the market and value chain Increased access to empirical data on NUS could be used to push for existing policies to be updated and/or strengthened so that they are explicit about the importance of Ethiopian agro-biodiversity—NUS. For example, the strategic grain reserves system, which now prioritizes maize and wheat, may be changed to include a larger range of underutilized crops in addition to the cereals and legumes crops already mentioned. Through the formal acknowledgement of a broader selection of crops, such inclusion would likewise address dietary diversity. Another example is ensuring that cross-cutting issues like the water-energy-food nexus, poverty, unemployment-inequality nexus, water-food-nutrition-health nexus, and agriculture-environment-health nexus are mainstreamed into new policies now being developed. NUS could become more widely recognized for the various functions that they can perform as a result of this mainstreaming.

4.5.2. Opportunities

Various prospects for the promotion and growth of underutilized crop production have been reported or observed in the Guto Gida district, as well as in Ethiopia. The survey found that there is favorable production land and human power, that there is good/dense nutritional value, that there is high demand and high market value, that there is high social and cultural value, that it is safe for the environment, that it is tolerant to drought and stress conditions, that it is high productivity, that it is produced with local materials on a small area of land, and that it creates job opportunities for all members of the household (Fig 4.5). NUCS have been demonstrated to have an essential role in the promotion of local livelihood, nutrition, and food security among indigenous groups in several studies conducted in remote parts of emerging countries (Nyadanu et. al., 2014; Magbagbeola et. al., 2010; Bhattacharjee, 2009). NUCS have been recorded as a source of food and medicine throughout Asia and the Pacific countries like as India, Nepal, Malaysia, and the Philippines. NUCS is also widely used in Sub-Saharan African countries like Malawi, Nigeria, Cote d'Ivoire, Uganda, and Zimbabwe (Padulosi et. al., 2013; FAO, 2010). Interest in NUS stems from a variety of concerns and needs, including their contribution to agricultural diversification, better use of marginal land and changing environments, food security and a more balanced diet, better safeguarding of our agrobiodiversity and associated cultural heritage, agricultural system self-sufficiency, additional source of income for farmers, and job opportunities (Padulosi, 1998a).

There are calls for a paradigm shift in agriculture, with non-traditional pathways such as underutilized crops (NUS) being explored as potential future crops (Massawe et. al., 2015). This is based on findings that NUS are adaptable to a variety of agro-ecologies, are nutrient dense, and offer greater chances in low-yielding locations (Mayes et. al., 2012; Chivenge et. al., 2015; Massawe et. al., 2015). Several NUS are drought- and heat-tolerant, pest- and disease-resistant, and adapted to semi-arid and arid climates (Mayes et. al., 2012; Chivenge et. al., 2015; Chimonyo et. al., 2016; Chibarabada et. al., 2017; Hadebe et. al., 2017; Mabhaudhi et al., 2017). Furthermore, most NUS are nutrient dense (Padulosi and Hoeschle-Zeledon, 2004), and may be effective in dietary diversification (Mayes et al., 2012) and correcting micronutrient shortages in disadvantaged rural areas (Chibarabada et. al., 2017; Govender et. al., 2017;

Hadebe et. al., 2017). As a result, their promotion in marginal agricultural production areas may increase rural people's availability and access to nutritious food (Williams and Haq, 2000). Their promotion in rural regions could also lead to the development of new value chains, which could lead to rural economic development (Mabhaudhi et. al., 2016a, 2017).

Importantly, NUS, which contain crop wild cousins, are a valuable source of germplasm for future crop advances such as nutritional value and abiotic and biotic stress tolerance (Castaeda-Alvarez et al., 2016). Underutilized crops are an important part of local culture, are used in traditional food preparations, and are the focus of current culinary revival trends; they have advantages over staple crops in that they have been adapted to stressful environments and can be grown with low input and biological techniques (Mayes, et. al., 2011).

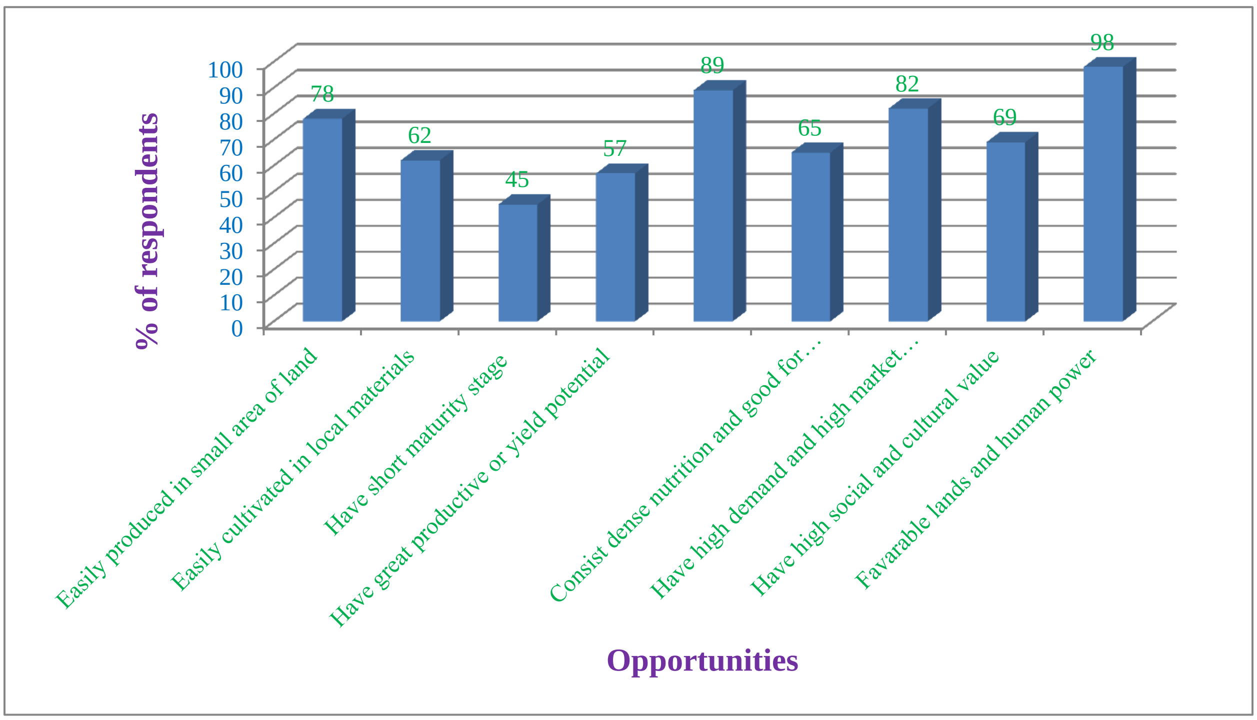

Fig 4.5: Opportunities for underutilized crop production and promotion (Source: Computed from authors' field survey, 2021)

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

In the Guto Gida district, this study looked at the impact of crop diversification on household food security and livelihoods. The FCS and the CSI were utilized as household food security measures in this study. Crop diversification is positively connected with the FCS and negatively correlated with the CSI, according to the OLS data. This indicates that households with more crop diversification with underutilized crops are more likely to have a more variety diet and are less likely to resort to copying methods in times of extreme food crisis. Farming households that plant more than one crop are more secure in terms of food supplies and revenue, and hence are better equipped to meet their households' food needs than those that grow fewer crops. Crop diversification with underused crops thus enhances food security and livelihoods by increasing food supplies in terms of quantity and variety, as well as increasing money from the sale of crops cultivated from a variety of crop species, which is then used to change consumption patterns.

The findings imply that the household head's education, the number of households, and the ownership of other animals are all important elements in ensuring food security in Guto Gida. As a result, crop diversification with underutilized crops, among other factors, is a viable option in smallholder farming for building resilient and affordable agricultural systems that can significantly contribute to household food security, livelihoods, improved health and nutritional patterns, and ecological sustainability. This is due to the fact that crop variety increases household food availability as well as income, which leads to increased food consumption through food purchases. Crop diversification using these neglected crops benefits the farmer primarily in the sense that farming multiple crop species helps to manage both price and production risks, resulting in more food alternatives and livelihoods for the household, as well as money from surpluses sold at market. Crop diversification also benefits smallholder farmers since it can increase farm-level crop productivity, resulting in more sustainable and healthy production.

In terms of policy, the findings imply that the Ethiopian government should promote crop diversification with underutilized crops in smallholder farming, particularly among those who are currently under-diversified, in order to improve rural people's food security. Furthermore, policies to promote the promotion and prioritization of research-based activities, as well as a resource management system, are critical for the growth of these underutilized crops. The activity of stakeholder organizations and smallholder farming households in collaboration is a critical aspect in the growth of these crops. For the development and marketing of this region to succeed, access to resources, education, and credit are also recommended. Improved and widely available agricultural materials, pre- and post-harvest processing technologies, and the internal and external market chain or value chain should all be given special attention, with policy and strategies guiding them.

5.2. Recommendations

- According to this literature review and survey study, the following overall gaps were identified: (a) land and human power use techniques and management, crop adaptation ecology information, (b) post-harvest handling and storage, (c) nutritional content, (d) marketing, and (e) product development and development. These should serve as the foundation for future study and be prioritized for development, promotion, and funding.
- For the promotion and development of these NUCs, robust and clear policies and plans are required.
- Resource, culture, and knowledge management, as well as awareness-building methods, are critical to the sector's growth.

- The private sector, diverse organizations, and all stakeholders should contribute in the development of this sector
- The development of technology, particularly agro-processing and post-harvest technologies, is highly crucial for developing this sector.
- Developing markets and value chains is a fantastic way to promote these neglected commodities.
- Linking increasing NUS production to nutrition and health outcomes. Consistent with the paradigm shift needed in agriculture, the development of NUS should seek to address the agriculture-environment-health relationship as this is where they have the most potential to make impact. This should include research on nutrient content, nutritional yield and water productivity, and bio-availability of nutrients in NUS.

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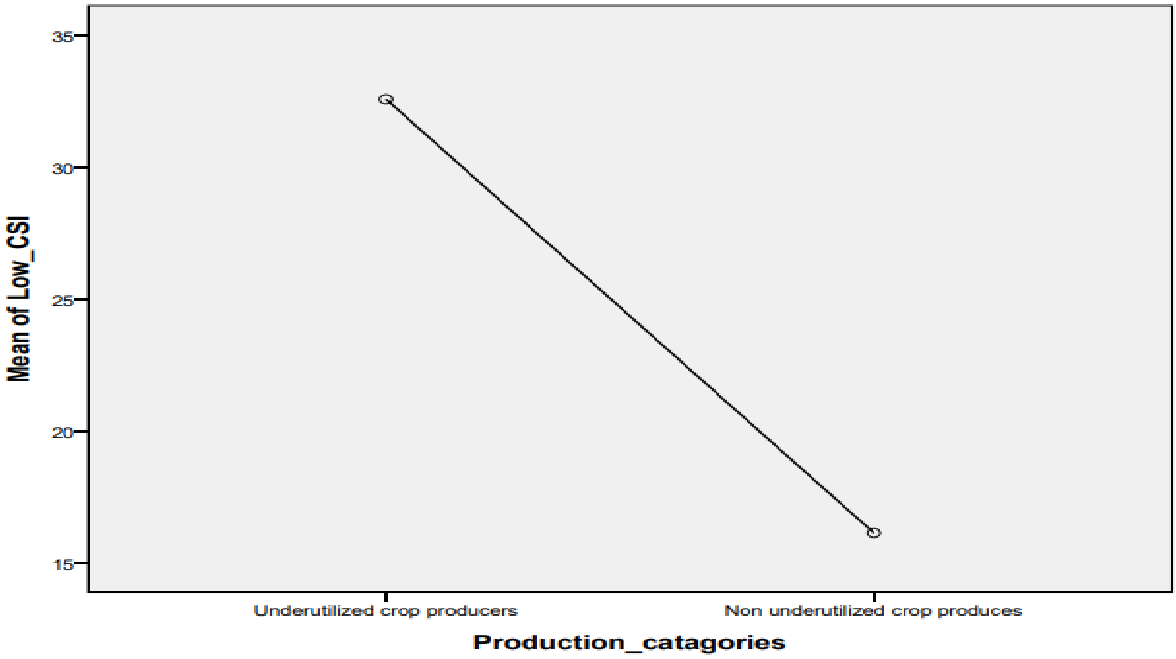
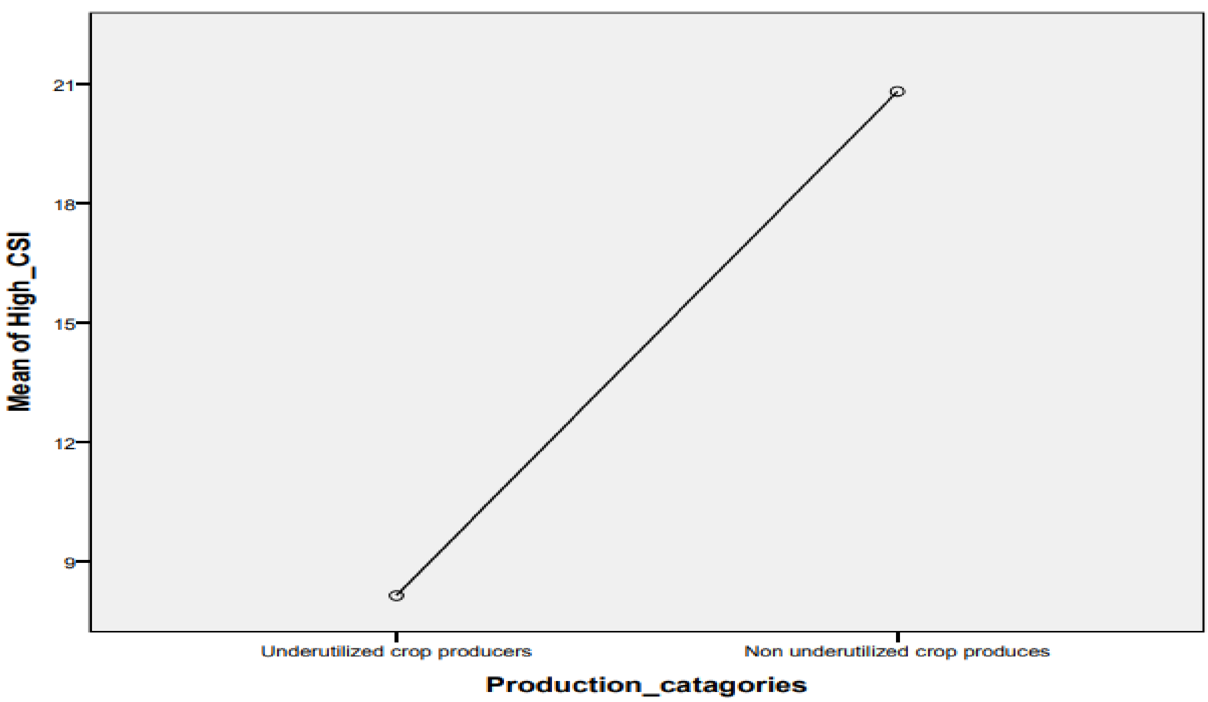
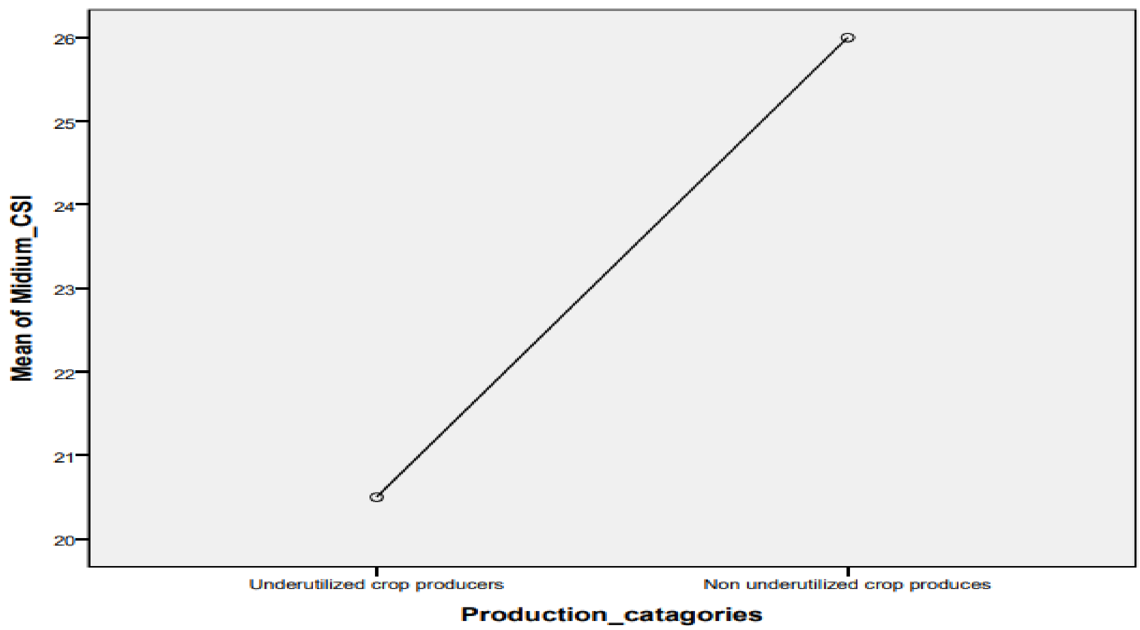
Appendix 1:

Means Plots







ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Low_CSI	Between Groups	405.082	1	405.082	655.119	.000
	Within Groups	2.473	4	.618		
	Total	407.555	5			
High_CSI	Between Groups	240.667	1	240.667	403.352	.000
	Within Groups	2.387	4	.597		
	Total	243.053	5			
Midium_CSI	Between Groups	45.375	1	45.375	95.526	.001
	Within Groups	1.900	4	.475		
	Total	47.275	5			

Parameter Estimates

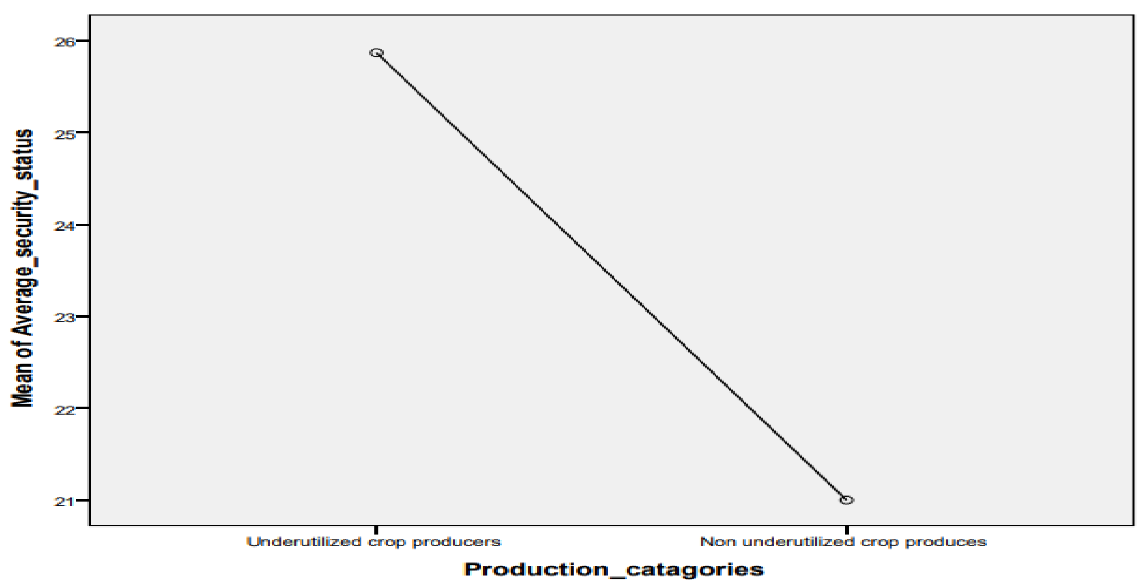
Dependent Variable	Parameter	B	Std. Error	t	Sig.
Low_CSI	Intercept	16.133	.454	35.536	.000
	[Production_catagories=1]	16.433	.642	25.595	.000
	[Production_catagories=2]	0^a	.	.	.
Midium_CSI	Intercept	26.000	.398	65.341	.000
	[Production_catagories=1]	-5.500	.563	-9.774	.001
	[Production_catagories=2]	0^a	.	.	.
High_CSI	Intercept	20.800	.446	46.640	.000
	[Production_catagories=1]	-12.667	.631	-20.084	.000
	[Production_catagories=2]	0^a	.	.	.

Parameter Estimates

Dependent Variable	Parameter	95% Confidence Interval		Partial Eta Squared
		Lower Bound	Upper Bound	
Low_CSI	Intercept	14.873	17.394	.997
	[Production_catagories=1]	14.651	18.216	.994
	[Production_catagories=2]	.	.	.
Midium_CSI	Intercept	24.895	27.105	.999
	[Production_catagories=1]	-7.062	-3.938	.960
	[Production_catagories=2]	.	.	.
High_CSI	Intercept	19.562	22.038	.998
	[Production_catagories=1]	-14.418	-10.916	.990
	[Production_catagories=2]	.	.	.

Appendix 2:

Means Plots



Parameter Estimates

Dependent Variable	Parameter	B	Std. Error	t	Sig.
Acceptable_level	Intercept	21.000	.577	36.373	.000
	[Production_catagories=1]	15.000	.816	18.371	.000
	[Production_catagories=2]	0[a]	.	.	.
Borderline	Intercept	26.000	.577	45.033	.000
	[Production_catagories=1]	-12.000	.816	-14.697	.000
	[Production_catagories=2]	0[a]	.	.	.
Poor	Intercept	13.000	.577	22.517	.000
	[Production_catagories=1]	-3.000	.816	-3.674	.021
	[Production_catagories=2]	0[a]	.	.	.