



**WOLAITA SODO UNIVERSITY
GRADUATE STUDIES DIRECTORATE**

**Enhancing Dietary Diversity in Southern Ethiopia: Unearthing the Role of
Neglected and Underutilized Crop and Wild Edible Plant Species In Case
of Wolaita and Dawuro Zones**

MSc Research Proposal

BY: BIRUK WOLASA

College: Agriculture

Department: Rural Development and Agricultural Extension

Program: Rural Development and Planning (Regular)

Advisor: Debalke D. (Asst. Prof.)

April, 2024

Wolaita Sodo, Ethiopia

APPROVAL SHEET

Enhancing Dietary Diversity in Southern Ethiopia: Unearthing the Role of Neglected and Underutilized Crop and Wild Edible Plant Species In Case of Wolaita and Dawuro Zones

This is to certify that the thesis proposal prepared by Biruk Wolasa, submitted in fulfillment of the requirements for the degree of MSc in Rural Development and Planning. This thesis proposal complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

Submitted by:

_____	_____	_____
Name of Student	Signature	Date

Approved by:

1. _____	_____	_____
Name of Major Advisor	Signature	Date

2. _____	_____	_____
Name of Co-advisor	Signature	Date

3. _____	_____	_____
Name of Evaluator/Examiner	Signature	Date

TABLE OF CONTENT

TABLE OF CONTENT.....	ii
LIST OF TABLES.....	iv
LIST OF FIGURES.....	v
LIST OF ABBREVIATIONS (ACRONYMS AND ABBREVIATIONS).....	vi
1. INTRODUCTION.....	1
1.1. Background of the Study.....	1
1.2. Statement of the Problem.....	3
1.3. Objectives of the Study.....	5
1.4. Research Questions.....	5
1.5. Significant of the Study.....	5
1.6. Scope and Limitation of the Study.....	6
2. LITERATURE REVIEW.....	7
2.1 Theoretical Literature Review.....	7
2.1.1. Definition and concepts.....	7
2.1.2. Importance of dietary diversity for nutritional health.....	9
2.1.3. Challenges to achieving dietary diversity in developing countries.....	10
2.1.5. Factors Influencing Consumption of NUCS and WEPs in Ethiopia.....	12
2.2. Empirical Literature Review.....	14
2.2.1. Dietary Diversity in Southern Ethiopia.....	14
2.2.2 Common Staple Foods in the Southern Regions.....	15
2.2.3. Challenges Specific to Dietary Diversity in Study Region.....	15
2.2.4 Prevalence of Malnutrition and Micronutrient Deficiencies.....	16
2.2.5 Utilization of Neglected and Underutilized Crops (NUCs) and Wild Edible Plants (WEPs) in Ethiopia.....	17

2.2.6. Consumer Preferences and Perceptions of NUCs and WEPs and Gaps in Knowledge Regarding Consumer Preferences and Perceptions in Ethiopia.....	19
2.3. Conceptual Framework of the Study.....	20
3. RESEARCH METHODOLOGY.....	23
3.1. Description of the Study Area.....	23
3.2. Research Design and Sampling Technique.....	24
3.3. Data Types and Sources.....	26
3.4. Data Collection Methods.....	26
3.5. Data for Household Dietary Diversity (HDD).....	28
3.6. Data Analysis.....	28
4. WORK PLAN AND BUDGET.....	31
4.1 Work Plan.....	31
4.2 Budget Breakdown.....	32
References.....	34

LIST OF TABLES

Table 1: Basic features of the target districts.....	24
Table 2: Sampling Frame and Sampled Households.....	26
Table 3: Work Plan Lasts for 1 Year.....	31
Table 4: Stationary Costs.....	32
Table 5: Personal Costs.....	33

LIST OF FIGURES

Figure 1: The Relationship between NUCs and WEPs Consumption and HDD.....	22
---	----

LIST OF ABBREVIATIONS (ACRONYMS AND ABBREVIATIONS)

DDS	Dietary Diversity Score
FAO	Food and Agriculture Organization of the United Nations
MDD-W	Minimum Dietary Diversity Score for Women
MDPI	Multidisciplinary Digital Publishing Institute
NUCs	Neglected and Underutilized Crops
SDG2	Sustainable Development Goal 2 (Zero Hunger)
SNNPR	Southern Nations, Nationalities, and Peoples' Region
TK	Traditional Knowledge
UN	United Nations
WEPs	Wild Edible Plants
WFPs	Wild Food Plants

Executive summary

*In Southern Ethiopia, Neglected and Underutilized Crops (NUCs) and Wild Edible Plants (WEPs) offer a promising solution for future food security and healthier diet. Despite this fact, research and development efforts have largely sidelined these drought resilient and nutrient-rich crops and plants. To this end, this study aims to address the following specific objectives: (a) to identify, prioritize and document NUCs and WEPs, (b) to analyze the perception of rural households towards NUCs and WEPs consumption (c) to analyze the consumers' preference on NUCs and WEPs and (d) to evaluate the implication of NUCs and WEPs consumption on improving households' dietary diversity. The study will apply a convergence research design, which involves collecting and analyzing both qualitative and quantitative data at the same time frame following the multistage sampling technique. Descriptive and inferential statistics with econometrics model will be used to analyze the study data. The study findings will provide valuable insights in to the promotion of neglected and underutilized crops and wild edible plants with their multiple effects in enhancing dietary diversity, food and nutrition security and positive biodiversity impacts in the study area and beyond. Moreover, the study results could guide policy decisions and implementation strategies for better nutrition and sustainable food systems. The study is expected to cost **ETB 366,445**.*

1. INTRODUCTION

1.1. Background of the Study

Addressing hunger and all forms of malnutrition is a key objective of the second Sustainable Development Goal (SDG2): Zero Hunger (UN, 2015). Around the world, our food systems are increasingly moving towards homogenization, marked by an overdependence on a restricted variety of plant species. Presently, the global food system relies on a mere handful of species (FAO, 2019). This move towards monoculture, coupled with the subsequent disregard of diverse, nutrient-rich plant species, is resulting in widespread nutritional deficiencies (Rapsoman, *et al* 2014). Neglected and Underutilized Crops (NUCs) and wild edible plants (WEPs), once appreciated for their nutritional value and adaptability to local environments, have been sidelined in contemporary agricultural practices (Padulosi, *et al.*, 1993). Nevertheless, these species possess untapped potential to augment dietary diversity, enhance nutrition, and bolster food security (Hunter, *et al.*, 2017). Wild Food Plants (WFPs), through diversification, have the capacity to render global food production more sustainable and resilient (Bharucha, & Pretty, 2010).

Food security is a global challenge, but Africa grapples with a unique set of difficulties. Factors such as poverty, dependence on rain-fed agriculture, climate change, and rapid population growth exacerbate the situation (FAO, *et al.*, 2021). This leads to malnutrition, often tied to a lack of dietary diversity, which impacts two out of every five children in regions like West and Central Africa. Sub-Saharan Africa, in particular, faces severe food and nutrition insecurity, a problem amplified by climate extremes, economic downturns, conflict, and other destabilizing factors (Headey, *et al.*, 2020). To mitigate these challenges, experts advocate for diet diversification and the exploration of alternative food sources (Fan, *et al.*, 2020). A promising strategy is the promotion of Neglected and Underutilized Crops (NUCs) of crops and wild edible plants (Aisha, *et al.*, 2022). These NUCs, often overlooked in favor of more common crops, hold significant potential. They can enhance dietary diversity, improve nutrition, and provide a buffer against food insecurity. Furthermore, they are often well-adapted to local conditions, making

them a resilient choice in the face of climate change. Therefore, harnessing the contributions of these NUCS could be a key step towards improving food security in Africa (Aisha, *et al.*, 2022).

Ethiopia, a country rich in agricultural biodiversity, is ironically faced with persistent food insecurity (Beza, *et al.*, 2021). Despite significant advancements in cereal production, the challenge of achieving diverse diets remains. This is manifested in the country's struggle with hidden hunger, a form of micronutrient malnutrition that continues despite a reduction in child undernutrition. This dietary vulnerability stems from a reliance on a limited range of staple crops, leading to nutrient deficiencies (Gemedo, *et al.*, 2023). Neglected and Underutilized Crops (NUCs), despite their resilience, nutritional value, and cultural significance, are often sidelined by mainstream agriculture and research (Adugna *et al.*, 2023).

The limited diversity in food systems, particularly the scarcity of nutrient-rich options, poses a significant challenge for achieving dietary diversity in Ethiopia. Traditional open-air markets, which serve as the primary source of food for many Ethiopians, often lack a variety of essential food groups (Alemu, *et al.*, 2016). This limited diversity can contribute to malnutrition and other diet-related health issues.

Neglected and Underutilized Crops (NUCs) of crops and wild edible plants (WEPs) offer a promising solution to address these food environment issues. WEPs are readily available, inexpensive, and require minimal agricultural inputs, making them accessible to a wider population (Awas, *et al.*, 2020). Additionally, their resilience to drought and pests contributes to food security, especially in vulnerable regions. Studies have shown that NUCs, including WEPs, possess high nutritional value, potentially improving dietary diversity and overall nutritional health (Eyayu, *et al.*, 2016). For instance, a study in northwest Ethiopia revealed a diet dominated by cereals, with a significant lack of nutrient-rich options like vegetables, fruits, and lean meat (Geleta, *et al.*, 2019). Encouraging the utilization of NUCs and WEPs can address these dietary gaps and promote healthier food consumption patterns.

Situated in Southern Ethiopia, the Wolaita and Dawuro Zones are regions abundant with cultural heritage and agricultural diversity. These zones, nestled within the South Ethiopia Regional State, are home to a plethora of unique crops and wild edible plant species (Berhanu, & Bekele, 2019). However, many of these species remain underutilized and overlooked, often eclipsed by

more commonly cultivated crops (Alemerew, & Ayenew, 2020). These neglected species, embodying an untapped reservoir of nutritional diversity, hold immense potential to significantly enhance dietary variety in the region. They could also serve as a crucial pillar in strengthening food security, offering a safeguard against crop failure and seasonal food shortages (Awasthi, *et al.*, 2016). Having this in mind, this study aimed to unearth the role of Neglected and Underutilized Crops (NUCs) and wild edible plants in diversifying diets and enhancing nutrition in the study area thereby contributing to a sustainable and resilient food system.

1.2. Statement of the Problem

Healthy diets are fundamental for preventing malnutrition and promoting overall well-being. However, achieving dietary diversity, a key component of a healthy diet, remains a challenge in many regions, particularly where access to a variety of nutritious foods is limited (Fanzo et al., 2013). Factors like cost, cultural preferences, and local food production practices can significantly restrict dietary choices. Neglected and Underutilized Crops (NUCs) of crops and wild edible plants offer a promising, yet often overlooked, solution to this challenge. NUCs encompass a wide range of forgotten or underutilized plant resources with the potential to significantly enhance dietary diversity and improve nutritional outcomes (Padulosi et al., 2013). These species are often rich in essential vitamins, minerals, and other bioactive compounds, making them valuable additions to staple food diets.

However, despite their potential, NUCs face significant barriers to wider utilization. The dominance of monoculture farming practices focused on high-yielding varieties of a few staple crops often relegates NUCs to the margins of agricultural systems (NUCs, 2018). Additionally, a lack of research and policy support for NUCs cultivation, processing, and marketing hinders their integration into mainstream food systems (MDPI, 2020). Furthermore, the erosion of traditional knowledge and loss of genetic diversity associated with NUCs pose challenges for their continued use and improvement. Finally, NUCs may face difficulties in accessing markets due to limited infrastructure and consumer awareness, and their inherent vulnerability to climate change adds another layer of complexity (NUCs, 2018). Addressing these constraints is crucial to unlock the full potential of NUCs for enhancing dietary diversity and promoting food security in vulnerable regions.

While substantial research has been undertaken on the potential of NUCs and wild edible plants, a gap often exists between recognizing this potential and comprehending how to actualize it into tangible solutions. This study aims to bridge this gap by adopting a more holistic approach that builds on existing knowledge. Previous studies, such as those by (Abebe *et al.*, 2023) and Li *et al.* (2020), have underscored the promising nutritional content of NUCs and their potential role in food security. (Aragaw *et al.*, 2021) further delved into this topic by analyzing the nutrient composition of underutilized species in Ethiopia. However, these studies were primarily focused on documenting the potential of these plants. This current study advances this research by not only identifying NUCs and wild edible plants in specific study areas but also exploring their practical applications. (Li & Siddique, 2019) emphasized the broad potential of NUCs as future food sources (Future Smart Food - FSF). However, their work was largely theoretical. This study adopts a more pragmatic approach, focusing on a specific region to examine the practicalities of NUCs adoption as investigated by (Ngigi PB, *et al.*, 2023) in Kenya and Ethiopia. By scrutinizing consumer preferences and the impact of NUCs on dietary diversity, this research extends beyond merely identifying NUCs as a solution. It probes into the feasibility and efficacy of promoting NUCs consumption within a specific community.

This study's holistic approach encompasses several key aspects not addressed in previous research. It transcends the mere cataloging of potential NUCs species and pinpoints specific plants with potential in the target region. It investigates consumer preferences using methods like pit sorting, yielding vital information for understanding the marketability and potential adoption of these NUCs by local communities. Moreover, it doesn't merely rely on the theoretical promise of these plants' nutritional value. It assesses their actual nutritional content and analyzes the impact these crops can have on enhancing household dietary diversity. This combined approach provides a comprehensive understanding of the potential and challenges of NUCs in enhancing dietary diversity.

In essence, this study bridges the gap by providing a more detailed and practical exploration of NUCs and wild edible plants. It moves beyond theoretical potential and investigates their actual impact and feasibility in specific study areas. This approach offers valuable insights that can guide policy-making and implementation towards improved nutrition, illuminating a hopeful future where dietary diversity and sustainability are harmoniously intertwined. Therefore, this

study aims to address this critical gap by investigating the prospects of NUCs crops and wild edible plants in South-Western Ethiopia. This study, therefore, not only fills a critical research gap but also contributes to the broader goal of achieving improved nutrition through the wider utilization of NUCs and wild edible plants.

1.3. Objectives of the Study

The general objective of the study is to investigate the role of neglected and underutilized crops and wild edible plants in improving households' dietary diversity in the study area

The specific objectives of the study are:

1. To identify, prioritize and document NUCs and WEPs in the area
2. To analyze the perception of rural households towards NUCs and WEPs consumption in context of HDD
3. To analyze the consumers preference on NUCs and WEPs
4. To evaluate the implication of NUCs and WEPs consumption on improving households dietary diversity

1.4. Research Questions

- ✚ What are the NUCs and WEPs exists in the area?
- ✚ How do rural households perceive consumption of NUCs and WEPs in context of its effect on diet diversity?
- ✚ Why and which groups and priorities of NUCs and WEPs are frequently consumed by rural households?
- ✚ To what extent and how does consumption of NUCs and WEPs influence HDD

1.5. Significant of the Study

This study's findings will provide valuable insights into the promotion of Neglected and Underutilized Crops (NUCs) and wild edible plants. These insights could enhance food security and dietary diversity, not just in Ethiopia, but also in other regions facing similar challenges. The study explores the challenges and opportunities associated with their sustainable use, with the ultimate goal of improving regional nutrition and well-being. The results of this study could guide policy decisions and implementation strategies for better nutrition and sustainable food

systems. This research underscores the importance of sustainability in the utilization of NUCs and wild edible plants.

1.6. Scope and Limitation of the Study

This study focuses on the Wolaita and Dawuro zones in Southern Ethiopia, aiming to uncover the role of Neglected and Underutilized Crops (NUCs) and wild edibles in enhancing dietary diversity in these specific zones. The research will explore the variety of NUCs and consumer preferences using methods like pit sorting. However, the study's applicability is limited to these zones due to resource constraints that may limit the selection of plants and consumer sampling, time restrictions that may hinder comprehensive cultural or economic analyses, and external factors such as weather or policy changes that could affect the results. Despite these limitations, the study aims to provide valuable insights and lay the foundation for future research and policy recommendations to encourage broader use of NUCs and wild edibles for enhanced dietary diversity in the region.

2. LITERATURE REVIEW

2.1 Theoretical Literature Review

2.1.1. Definition and concepts

2.1.1.1. Definition and concepts of dietary diversity

Dietary diversity is a comprehensive concept that encapsulates the range and variety of different food groups and individual foods consumed over a specific time frame, usually a day or a week. This concept extends beyond the mere intake of sufficient calories. It emphasizes the consumption of a broad spectrum of essential nutrients, contributing to a balanced and nutritious diet (Assefa, *et al.*, 2018).

The concept of dietary diversity is often quantified using specific metrics. The Dietary Diversity Score (DDS) is one such metric that measures the number of food groups consumed over a 24-hour period. Another commonly used metric is the Minimum Dietary Diversity Score for Women (MDD-W), which assesses the dietary diversity of women of reproductive age. These metrics provide valuable insights into the nutritional quality of diets and can help identify potential nutritional deficiencies (Zheng and Ma., 2023). In essence, dietary diversity is a critical component of nutritional adequacy and is associated with better health outcomes. It encourages the consumption of a variety of foods to ensure a well-rounded intake of essential nutrients.

2.1.1.2. Concept and Definition of Neglected and Underutilized Crops (NUCs) and Wild Edible Plants (WEPs)

Neglected and Underutilized Crops (NUCs) are crop species that have been traditionally used but are not widely cultivated or incorporated into mainstream agriculture (FAO, 2019). Despite their potential benefits for food security, nutrition, health, and income generation, these species have received less attention in research and development compared to major crops. They are often used locally and receive little or no attention from researchers and policymakers. These species include wild or domesticated varieties and non-timber forest species that are adapted to particular, often quite local, environments (FAO, 2019). Many of these varieties and species,

along with a wealth of traditional knowledge about their cultivation and use, are being lost at an alarming rate (Johns, *et al.*, 2009).

Wild edible plants (WEPs) are a fascinating category of flora that offer a natural bounty readily available in the wild. These unsung heroes encompass various plant species that grow spontaneously in uncultivated areas. From leafy greens to fruits and even roots, different parts of WEPs can be consumed by humans, providing a valuable source of nutrition. Throughout history, diverse cultures have relied on WEPs for sustenance, recognizing their nutritional and medicinal properties (Johns, *et al.*, 2009).

The concept of WEPs goes beyond mere sustenance. It highlights the crucial role of biodiversity and traditional knowledge in maintaining a healthy and balanced ecosystem. By incorporating WEPs into our diets, we contribute to the preservation of this biodiversity. Furthermore, the knowledge passed down through generations about identifying, preparing, and utilizing these wild plants strengthens cultural continuity and connection to the natural world. WEPs serve as a bridge between humans and their environment, promoting a deeper appreciation for the ecological tapestry we inhabit.

Key Differences between Neglected and Underutilized Species and Wild Edible Plants

While both NUCS and WEPs are underutilized resources with the potential to enhance food security and dietary diversity, a key distinction lies in their relationship with human cultivation practices:

Neglected and Underutilized Crops (NUCs): These encompass a broader category of plants, including both cultivated and potentially cultivable species (Padulosiet *al.*, 2013). While NUCS have a history of traditional use their cultivation is often limited compared to major crops. This limited cultivation can be due to various factors, such as lack of research and development investment (Padulosiet *al.*, 2013), lower yields compared to major crops (Anegbehiet *al.*, 2009), or socio-economic factors that favor the cultivation of other crops. However, NUCS can potentially be brought back into wider cultivation with appropriate support and promotion.

Wild Edible Plants (WEPs): In contrast, WEPs are not traditionally cultivated. These plants grow naturally in the wild and are collected for consumption (Johns *et al.*, 1999). This makes

them readily available in certain regions, but their abundance can be dependent on seasonal variations and environmental factors (Ettiene&Ekpo, 2014). While some WEPs might show potential for future cultivation (Shackleton *et al.*, 2007), the emphasis remains on their collection from natural ecosystems (Johns *et al.*, 1999)..

2.1.2. Importance of dietary diversity for nutritional health

A diverse diet acts as a conductor, harmonizing a symphony of nutrients within your body to achieve optimal health. Here's how incorporating a variety of food groups creates this beneficial effect:

Nutrient Adequacy: Different food groups serve as unique orchestra sections, each playing a vital role. Fruits and vegetables provide a vibrant array of vitamins, minerals, and phytonutrients that act as antioxidants and support overall health. Whole grains offer a steady stream of complex carbohydrates, fueling your body with sustained energy. Protein sources, like fish, legumes, and lean meats, provide the building blocks for cell growth and repair. By incorporating a wide range of these "sections," you ensure your body receives a complete spectrum of nutrients to function optimally (Gibson & Ferguson, 2008).

Reduced Risk of Chronic Diseases: A diverse diet acts as a shield, potentially lowering your risk of developing chronic diseases. Fruits and vegetables, rich in antioxidants and fiber, may help combat inflammation linked to heart disease and certain cancers (Boeing *et al.*, 2014). Whole grains, with their sustained energy release, can aid in weight management, a crucial factor in preventing obesity-related conditions like type-2 diabetes (Aune *et al.*, 2017). By consuming a varied diet, you provide your body with the tools it needs to defend itself against chronic illnesses.

Improved Gut Health: Your gut microbiome, a complex ecosystem of trillions of bacteria, plays a critical role in digestion, immune function, and even mental health (Cryan *et al.*, 2019). A diverse diet acts as a fertilizer for this ecosystem, fostering the growth of beneficial gut bacteria. These bacteria aid in nutrient absorption, food breakdown, and production of essential compounds that support overall health and well-being (David *et al.*, 2014).

Enhanced Cognitive Function: Just as a well-tuned engine requires high-quality fuel, your brain thrives on a diverse diet. Foods rich in omega-3 fatty acids, found in fatty fish, and B vitamins, abundant in legumes and whole grains, may positively impact cognitive function and memory (Ballard *et al.*, 2011). By providing your brain with a variety of essential nutrients, a diverse diet can help you stay sharp and focused throughout the day.

2.1.3. Challenges to achieving dietary diversity in developing countries

Attaining dietary diversity in developing nations like Ethiopia is a multifaceted challenge with numerous hurdles, as various factors contribute to the limited variety in diet.

1. Socioeconomic Constraints

Poverty: Limited income restricts access to a wider variety of nutritious foods. Staple crops, often less expensive, may become the mainstay, leading to deficiencies in essential vitamins and minerals (World Bank, 2023).

Market Access and Infrastructure: Poor infrastructure and limited access to markets, particularly in rural areas, can create a situation where diverse, nutrient-rich foods are either unavailable or unaffordable (Gillespie & Harris, 2011).

Food Insecurity: Unreliable access to sufficient and nutritious food due to factors like conflict, climate change, or economic instability further limits dietary choices (FAO, 2023).

2. Environmental and Agricultural Factors

Seasonality and Climate Change: Dependence on rain-fed agriculture makes these regions vulnerable to weather fluctuations. Droughts and unpredictable rainfall patterns can disrupt crop yields, leading to limited availability of diverse food groups throughout the year (FAO *et al.*, 2018).

Unsustainable Practices: Overgrazing, deforestation, and soil degradation can reduce land productivity and biodiversity, limiting the variety of foods available for cultivation and consumption (Pretty *et al.*, 2010).

3. Cultural and Knowledge Gaps

Traditional Practices and Beliefs: Certain cultural preferences, taboos surrounding specific foods, or traditional food preparation methods can limit the acceptance and consumption of diverse foods (Aregheore&Oniang'i, 2016).

Limited Nutritional Knowledge: Lack of awareness about the importance of a balanced diet and the nutritional value of different foods can hinder informed dietary choices within households (Gillespie & Harris, 2011).

4. Political and Policy Issues

Ineffective Policies: Inadequate government policies or insufficient investment in promoting dietary diversity and healthy food systems can hinder progress (FAO, 2023).

Food Price Volatility: Global market fluctuations and speculation can lead to sharp increases in food prices, particularly for nutritious options, further impacting access for low-income populations(Headey& Fan, 2010).

2.1.4 Potential Benefits of NUCS and WEPs for Dietary Diversification in Ethiopia

Ethiopia faces challenges in achieving dietary diversity, particularly in rural areas. Neglected and Underutilized Crops (NUCs) and Wild Edible Plants (WEPs) offer a promising solution through the following ways.

1. Nutritional Values

Rich in essential vitamins, minerals, and dietary fiber, many NUCS and WEPs can address micronutrient deficiencies that are often lacking in staple Ethiopian diets. Studies by Alem and Asfaw (2017) support this. They can contribute significantly to overcoming deficiencies in iron, vitamin A, and other micronutrients prevalent in the country, as noted by Maroyi (2017). Specific Ethiopian studies documenting the high vitamin and mineral content of indigenous vegetables like *Moringaoleifera* are valuable resources. Including a reference here would strengthen the argument.

2. Resilience for Food Security

Adaptability: NUCS and WEPs are often well-adapted to Ethiopia's diverse ecological zones (Alemet *al.*, 2017). This makes them suitable for cultivation or collection in various regions, enhancing dietary diversity across the country.

Drought Resistance: Many NUCS and WEPs are drought-resistant, requiring minimal external inputs like fertilizers and pesticides (Maroyi, 2017). This characteristic makes them ideal for resource-limited farmers, particularly during droughts or other climatic disruptions, contributing to food security.

3. Cultural Significance and Knowledge

Traditional Staples: Many NUCS and WEPs have been traditionally utilized in Ethiopian cuisine and hold cultural significance in various communities (Alemu&Asfaw, 2017). This cultural connection can facilitate wider acceptance and integration into existing food systems.

Preserving Knowledge: Local knowledge about the cultivation, processing, and preparation methods of NUCS and WEPs has been passed down through generations (Maroyi, 2017). Leveraging this traditional knowledge can promote wider utilization of these resources and contribute to the preservation of valuable food systems.

2.1.5. Factors Influencing Consumption of NUCS and WEPs in Ethiopia

While NUCS and WEPs offer significant potential for dietary diversification, several factors influence their consumption patterns in Ethiopia. Here's a breakdown of key influences:

1. Socioeconomic Factors

Income: Low income can limit access to diverse foods, including NUCS and WEPs, which may require processing or preparation before consumption (Assefaet *al.*, 2018). Additionally, purchasing power might favor readily available staples over NUCS, even if they offer higher nutritional value (Gillespie & Harris, 2011).

Access to Markets: Limited access to markets, especially in rural areas, can restrict the availability of NUCS. Even if NUCS are cultivated locally, poor infrastructure and transportation networks can hinder their connection to market centers. This can limit consumer choices and discourage wider utilization (FAO, 2023).

2. Cultural Beliefs and Perceptions

Traditional Knowledge and Practices: Traditional knowledge about the preparation, processing, and use of NUCS and WEPs can be a significant factor. Loss of this knowledge due to changing lifestyles or lack of intergenerational transmission can lead to decreased utilization of these resources (Aregheore&Oniang'i, 2016).

Cultural Preferences: Cultural preferences and taste can influence NUCS and WEP consumption. Some NUCS might be associated with negative connotations or considered "famine foods," leading to lower consumption despite their nutritional value (Aregheore&Oniang'i, 2016).

3. Availability and Seasonality of NUCS and WEPs

Seasonality: Many WEPs are naturally available only during specific seasons. This seasonal dependence can limit their year-round consumption and necessitate alternative food sources during off-seasons (Maroyi, 2017).

Habitat Degradation and Overexploitation: Unsustainable harvesting practices or environmental degradation can lead to the depletion of wild NUCs and WEP populations, impacting their availability for consumption (Pretty *et al.*, 2010).

4. Knowledge and Awareness about Utilization:

Limited Knowledge: Lack of awareness about the nutritional value, preparation methods, and potential benefits of NUCs and WEPs can hinder their consumption. This highlights the importance of education and extension programs to promote wider utilization (Gillespie & Harris, 2011).

Preparation Challenges: Some NUCs and WEPs might require specific processing or preparation techniques, which can be a barrier to consumption if knowledge about these methods is limited (Maroyi, 2017).

2.2. Empirical Literature Review

2.2.1. Dietary Diversity in Southern Ethiopia

Several studies have been conducted within the Wolaita and Dawuro zones, or in similar agro-ecological settings within Southern Ethiopia. For instance, a community-based cross-sectional study was conducted to identify dietary patterns and their association with cardiovascular risk factors among adult people in urban and rural areas of Wolaita (Kumma and Loha, 2023).

Kumma and Loha's, 2023 study in Wolaita, southern Ethiopia, identified three major dietary patterns among 2,483 adults and their association with cardiovascular risk factors. The western dietary pattern, associated with urban residence and higher risk of obesity, hypertension, and high cholesterol, included meat, sweets, pasta, butter, bread, and certain Ethiopian dishes. The traditional dietary pattern, linked to rural residence, physical activity, and obesity, but negatively associated with hypertension, consisted of tubers, whole-grain maize products, coffee leaves-and-herbs beverage, legumes, and sweet potatoes. The healthy dietary pattern, negatively associated with obesity and hypertension but positively associated with urban residence, was characterized by intake of green leafy vegetables, green pepper, and whole-grain maize products. The study concluded that promoting healthy and traditional dietary patterns, along with physical activity, could help prevent cardiovascular risk factors, indicating a dietary transition in the region.

A study by Mejaet *al.* (2022) titled "Does Food Insecurity Exist in Rural Households of Wolaita? Evidence in Wolaita Zones, Southern Ethiopia" found that nearly 60% of households in the Wolaita Zone suffer from food insecurity. The study analyzed calorie consumption compared to minimum requirements and identified factors like literacy, land area, and irrigation access as positive influences on food security. Conversely, factors like age, female-headed households, family size, and dependency ratios were negatively associated with food security. The study highlights the need for interventions from institutions, governments, NGOs, and policy changes to address this widespread food insecurity.

2.2.2 Common Staple Foods in the Southern Regions

The staple foods consumed in the Wolaita and Dawuro zones of Southern Ethiopia showcase a rich tapestry of plant-based options. Cereals like maize (corn) reign supreme, with studies by Abebe and Halala (2020) highlighting its importance in production and marketing. However, the Dawuro zone adds another vital player to the mix: Enset, a drought-resistant perennial crop (Dilebo, *et al.* 2023).

Despite this apparent diversity, a closer look reveals a potential pitfall. The Wolaita zone exhibits an overreliance on maize, leading to deficiencies in essential micronutrients like vitamins A and C (Yoseph, 2021). This imbalance underscores the need for dietary diversification, encouraging a wider consumption of fruits, vegetables, and potentially animal source foods.

Fortunately, the zones boast favorable conditions that can support a broader range of crops. This allows for the cultivation of diverse annual and perennial options suitable for both household consumption and market opportunities (Abebe, & Halala, 2020). Dawuro, for example, demonstrates this potential with its production of Enset, Teff, maize, sorghum, wheat, and a variety of vegetables and fruits (Gelu, and Gebre, 2023). This diversity presents a significant opportunity to improve dietary balance and nutritional outcomes in the region.

2.2.3. Challenges Specific to Dietary Diversity in Study Region

While the staple foods of Wolaita and Dawuro zones exhibit some diversity, several factors contribute to limitations in dietary intake. This section explores these challenges and their impact on nutritional well-being.

Socioeconomic Constraints

Poverty and Limited Income: Poverty is a significant barrier to dietary diversity in these regions (Gebremedhin, *et al.*, 2014). Households with limited income struggle to afford a wider variety of fruits, vegetables, and animal-source foods, often relying on cheaper staples like maize. This can lead to monotonous diets lacking essential micronutrients.

Seasonality and Market Access: Seasonal availability of fruits and vegetables can restrict dietary choices throughout the year (Assefa, *et al.*, 2018). Limited access to markets, especially

in remote areas, further compounds the issue. Without well-developed transportation and storage infrastructure, perishable items like vegetables might be scarce or unaffordable during certain seasons (Assefa *et al.*, 2018).

Climate Vulnerability

Dependence on Rain-fed Agriculture: Both Wolaita and Dawuro zones rely heavily on rain-fed agriculture, making them susceptible to climate shocks like droughts (Shimelis, *et al.*, 2016). Droughts can significantly impact crop yields, leading to food insecurity and limiting the availability of diverse food groups (Shimelis *et al.*, 2016). This vulnerability underscores the need for promoting drought-resistant crops and climate-smart agricultural practices.

Cultural and Knowledge Factors

Traditional Food Practices: Deep-rooted cultural preferences can influence dietary patterns (Gebremedhin *et al.*, 2014). For instance, traditional practices might emphasize certain staple cereals like maize, while undervaluing the importance of other nutrient-rich food groups.

Nutritional Awareness Gap: Limited awareness about the nutritional value of different foods can hinder dietary choices. Studies suggest that communities might not fully understand the connection between diverse diets and improved health outcomes (Alemu *et al.*, 2017).

2.2.4 Prevalence of Malnutrition and Micronutrient Deficiencies

1. Malnutrition and Dietary Patterns

The staple food sources in the Wolaita and Dawuro zones of Southern Ethiopia, while seemingly diverse, present a complex picture regarding nutritional outcomes. Studies reveal a concerning prevalence of malnutrition in these regions. However, the specific type of malnutrition (undernutrition or overnutrition) can vary depending on factors like age and dietary patterns.

Undernutrition: Studies by Abebe & Halala (2020) and Ha (2021) highlight the presence of undernutrition, particularly among children and adolescent girls, in the Wolaita and Hadiya zones (Hadiya bordering Wolaita). These studies identify factors like low dietary diversity and inadequate access to animal-source foods as contributing factors (same references).

Overnutrition: While undernutrition remains a concern, the emergence of overnutrition, particularly overweight and obesity, is also being documented. A study by Girmaet *al.*, (2014) in Wolaita Soddo town indicates a rising prevalence of overweight and obesity, particularly among women (Girmaet *al.*, 2014). This suggests a potential shift in dietary patterns towards calorie-dense but nutrient-poor foods.

2. Micronutrient Deficiencies

The reliance on specific staple crops can lead to deficiencies in essential micronutrients. Studies in these zones point towards a significant prevalence of micronutrient deficiencies, particularly iron, vitamin A, and zinc.

Iron Deficiency: Iron deficiency anemia is a significant public health issue in the region. Research by Ha (2021) in Wolaita and Hadiya zones identifies a high prevalence of anemia among adolescent girls, with iron deficiency being a primary contributing factor.

Vitamin A Deficiency: Vitamin A deficiency is another concern. A study by (Woldehanna, *et al.*, 2016) focusing on children under five in the Wolaita zone found a high prevalence of vitamin A deficiency, potentially linked to low consumption of fruits and vegetables.

Zinc Deficiency: Limited data exists on zinc deficiency specifically, but studies suggest its potential presence. The aforementioned study by Abebe&Halala (2020) on undernutrition in Wolaita and Hadiya zones highlights the role of low dietary diversity in micronutrient deficiencies, including zinc (Abebe&Halala, 2020).

2.2.5 Utilization of Neglected and Underutilized Crops (NUCs) and Wild Edible Plants (WEPs) in Ethiopia

There is growing recognition of the potential of Neglected and Underutilized Crops (NUCs) and Wild Edible Plants (WEPs) to address dietary gaps and improve nutritional outcomes in Ethiopia, particularly in regions facing micronutrient deficiencies. Here, researcher explores existing research on the consumption of NUCs and WEPs in Ethiopia, with a specific focus on studies conducted in the Southern Ethiopia. This section delves into documented species, their nutritional composition, and traditional knowledge associated with their use in this region.

Studies conducted within the Southern Ethiopia underscore the significant role of Neglected and Underutilized Crops (NUCs) and Wild Edible Plants (WEPs) in rural diets. Research by Yemataet *al.*, (2017) in the Wolaita zone documents the consumption of a diverse range of indigenous vegetables and fruits. These species play a critical role in bolstering dietary intake, particularly during seasonal food insecurity periods. Similarly, a study by Zemedeeet *al.*, (2018) in the Gamo Gofa zone explores the importance of NUCs such as enset (*Ensete ventricosum*) and indigenous tubers. These plants serve as valuable sources of essential vitamins and minerals, especially during times of food scarcity. These findings highlight the immense potential of NUCs and WEPs to enhance dietary diversity and micronutrient intake, contributing significantly to improved nutritional security for vulnerable populations in Southern Ethiopia.

Research is shedding light on the remarkable variety of underutilized species (NUCS) and wild edible plants (WEPs) consumed in southern Ethiopia. These foods, alongside their nutritional composition, are gaining increasing attention. Studies like those by Gidayet *al.* (2005) and Tadeleet *al.* (2013) provide valuable data on the nutrient profiles of various indigenous vegetables, fruits, and legumes, although their scope might encompass a broader geographical area.

For a more focused perspective, Yemataet *al.* (2018) delve into the Wolaita zone specifically, analyzing the nutritional content of commonly consumed wild vegetables. These studies consistently reveal that many NUCS and WEPs are powerhouses of essential vitamins, minerals, and antioxidants, often surpassing the levels found in staple crops.

Woldemichael&Debela's (2010) research exemplifies this point, highlighting the exceptional vitamin A content of specific indigenous vegetables. This discovery offers a promising solution to vitamin A deficiency, a prevalent issue in certain regions.

Indigenous communities in Southern Ethiopia (SNNPR) possess a vast treasure trove of traditional knowledge (TK) regarding Neglected and Underutilized Crops (NUCs) and Wild Edible Plants (WEPs). This knowledge goes beyond simply identifying edible plants. Studies like Yemataet *al.*, (2017) document specific indigenous vegetables and their traditional uses within the Wolaita zone. This knowledge empowers communities to not only identify edible

species and understand their nutritional value but also utilize them for various purposes beyond food (Yemataet *al.*, 2017).

Furthermore, TK dictates sustainable harvesting practices that ensure the continued availability of NUCs and WEPs. It encompasses methods for processing, preparing, and storing these resources to maximize their nutritional value and extend their shelf life (Zemedet *al.*, 2018). This knowledge even extends to potential medicinal uses of some plants, highlighting the cultural significance these resources hold. Integrating this rich body of TK with scientific research can significantly contribute to promoting the wider utilization of NUCs and WEPs for improved dietary diversity, nutritional security, and potential medicinal applications.

2.2.6. Consumer Preferences and Perceptions of NUCs and WEPs and Gaps in Knowledge Regarding Consumer Preferences and Perceptions in Ethiopia

Consumer preferences and perceptions towards Neglected and Underutilized Crops (NUCs) and Wild Edible Plants (WEPs) are crucial for understanding their consumption patterns. These preferences and perceptions are shaped by a complex interplay of factors. Nutritional value is a key consideration, with people naturally drawn to foods perceived as beneficial for their health (Duguma, 2020). Availability also plays a significant role. If NUCs and WEPs are readily accessible through local markets or personal cultivation, they are more likely to be incorporated into diets. Cultural significance further influences consumption patterns. Traditional knowledge, passed down through generations, can shape preferences for certain NUCs and WEPs, imbuing them with special meaning or integrating them into cultural practices (Wani, *et al.*, 2021). Understanding these factors across different regions is essential for promoting the consumption of NUCs and WEPs, as preferences and perceptions can vary greatly based on local contexts.

Despite the rich traditional knowledge in Southern Ethiopia regarding the use and cultivation of NUCs and WEPs, there are gaps in understanding consumer preferences and perceptions in this region. Existing research on consumer protection law in Ethiopia, while not directly related to NUCs and WEPs, highlights the need for consumer enablement, empowering individuals to make informed choices (Stebek, 2018). This suggests a potential knowledge gap regarding consumer understanding of NUCs and WEPs. Additionally, a study on customer expectations in the Ethiopian hotel industry indicates a broader issue with aligning consumer expectations with

available options, which could be relevant to NUCs and WEP consumption (Gebremichael & Singh, 2019). These gaps in knowledge present opportunities for further research to understand consumer preferences and perceptions towards NUCs and WEPs in Southern Ethiopia.

2.3. Conceptual Framework of the Study

This study is proposed based on the conceptualization that the consumption of NUCs and WEPs may have significant impact on improving HDD, which is an important indicator of nutrition security. Rogers et al. (2019) defined consumption as the continual use of a specific food group, whereas implication on diet diversity is a change in outcome driven by the consumption specific food group. Utilizing a combination of NUCs and WEPs has been largely recommended by recent literature to sustainably improve HDD and other food security indicators and reducing climate change risk. Difference in NUCs and/or WEPs consumption and its dietary diversity impacts is driven by the variation in household's perception, attitude, preference, utility, socio-economic, and biophysical characteristics. The consumption approach allows for full investigation of the relationship between households "consumption" and "no consumption" of NUCs and WEPs in the context of dietary diversity. This approach helps to understand of critical a pathways and impacts driven by the consumption of NUCs and WEPs. Such relationships can be captured by estimating the effect of important explanatory variables on the likelihood of NUCs and WEPs consumption and its dietary diversity impact. Based on this concept the dependent variable of this study is ***consumption of NUCs and WEPs and the outcome variable is improvement in extent of HDD***. The explanatory variables of the study include

Cognitive and psychological factors: This represents household's perception towards consumption of NUCs and WEPs. Households perceiving the good benefits of NUCs and WEPs consumption are likely to use NUCs and WEPs as a supplement for staple crops (Gebru *et al.* 2019). Such perception eases attitudinal constraints and allows them to consume different categories of NUCs and WEPs (FAO 2017). As a result, perception towards the benefits of NUCs and WEPs is expected to affect the consumption NUCs and WEPs and HDD positively or negatively.

Biophysical factors: As one of potential explanatory variables, households with good fertile plots are likely to produce maize and likely to consume the NUCs and WEPs as a relish compared to poor fertile plots (Thornton and Herrero 2015). For this reason, improved soil fertility is expected to have a positive effect on consumption of NUCs and WEPs and HDD. Likewise, gently sloped plots are less prone to soil erosion than steeply sloped plots, and thus have negative relationship with planting of NUCs and WEPs, subsequently consumption, and HDD (Mashamaite *et al.* 2021).

Socio-economic factors: This can include household educational level, access to training, age and family size, land and livestock size. For example, the probability that a household may integrate improved maize with NUCs and WEPs as a nutrient supplement is positively associated with access to training and education level (Feyssa *et al.* 2011). Labor availability and family size may positively and negatively influence the likelihood of farmer to consume NUCs and WEPs, respectively and drives HDD. However, the relationship between age of the household and consumption of NUCs and WEPs is often not straightforward (Aragaw *et al.* 2021). Young household often tend to not consume NUCs and WEPs, olds might be likely to consume NUCs and WEPs. Male households are less likely to consume NUCs and WEPs, but females are more likely to consume NUCs and WEPs due to resource differentials (Thornton *et al.* 2018). Land size is expected to enhance productivity and food availability and influence consumption of NUCs and WEPs negatively (Aragaw *et al.* 2021).

Biophysical factors: A long distance from sites of NUCs and WEPs and local markets is a proxy to poor access and insufficient availability of NUCs and WEPs, and thus expected to negatively influence the consumption of NUCs and WEPs and in turn determine food HDD extent (Shaheen *et al.* 2017).

Institutional factors: This can be defined as social connections owned by individuals, groups and networks. Frequent contact with extension agents is assumed to positively affect the consumption of WEVs and in turn influence food security (Gebru *et al.* 2019). Households who have frequent contacts or connection with local traders are more likely to consume the NUCs and WEPs. Increase in the number of contacts with local organizations is assumed to have positive effect on the consumption of NUCs and WEPs, which enhance HDD (Duguma, 2020).

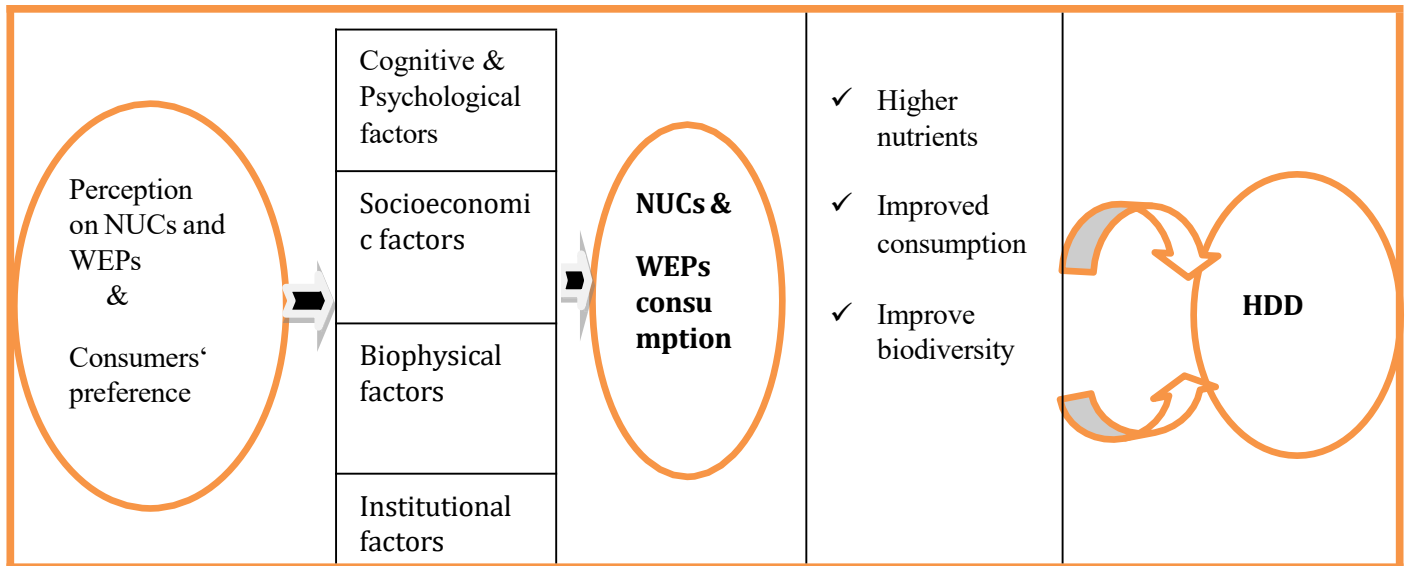


Figure 1: The Relationship between NUCs and WEPs Consumption and HDD > Source: Partially Adapted From FAO Regional Report

3. RESEARCH METHODOLOGY

3.1. Description of the Study Area

Wolaita zone is one of the 12 administrative zones in south Ethiopia region, geographically located between 7° 00' North latitude and 37° 45' East longitude. Wolaita Sodo is the administrative center of the zone, which is located at 312 km southwest of Addis Ababa, the capital city of Ethiopia. The zone has total area of 4512 km² and consist 16 districts (locally termed as woredas). An estimated population of the zone is 5,385,782, of whom 2,698,261 and 2,687,021 are females and males respectively (CSA projection, 2020). The average annual temperature and rainfall of the zone is 21.86°C and 1350 mm/year respectively. Livestock and crop production with some off/non -farm activities are an integral part of the livelihood system and source of income in the area (Getuand Mihretu, 2017).

Dawro zone is one of the six administrative zones in Southwest Ethiopia Peoples' Region. Geographically, it is located in between 6° 35' to 7° 34' North latitudes and 36° 04' to 37° 53' East longitudes. Tarcha is the administrative center of the zone located at about 500km southwest of Addis Ababa, the capital city of Ethiopia. The Gojeb and Omo rivers circumscribe Dawuro from northwest to southwest in a clockwise direction. The zone has total area of with an area of 4,814.52 square kilometers. Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), this zone has a total population of 489,577, of whom 249,263 are men and 240,314 women. Livestock and crop production with some off/non -farm activities are an integral part of the livelihood system and source of income in the area.

For this study, two target districts are selected from each zone (Humbo and Damot Gale from Wolaita zone, and Loma Bossa and Mareka from Dawro zone). The flowing table summarizes the basic features of the target districts.

Table 1: Basic features of the target districts

Features	Damot Gale	Humbo	Loma Bossa	Mareka
Latitude	6°55'00" N & 7°10'00" N	6° 40' N	6°56' N–7°36' N	6° 0' and 7° 21' N
Longitude	37° 42' E	37° 50' E	36°34' E– 37°64' E	37°01' E and 37° 26' E
Agro-ecology	Mid-land	Semi-arid	Highland, Midland and Lowland	Highland, Midland and Lowland
Soil type	Vertisols	Eutricnitisols	Nitsoils and Orthic Acrisols	Nitsoils and Orthic Acrisols
Average temperature	16 °C	22°C	15.1 °C to 27.5°C	15.1-29. 5°C.
Average rainfall	1250 mm	1403 mm	1400 mm-1600 mm	1200mm
Population	151,079	161,792	147,556	145,955
Major crops produced	Maize, teff, haricot beans	Maize, sorghum, teff, sweet potatoes, mango, avocado, and banana.	maize, enset, sweet potatoes and cattle, sheep and goats	enset, maize, teff, cotton, peas, beans spices
Major livestock	Cow, donkey, sheep, goats, poultry	Cow, donkey, sheep, goats, poultry	Cow, donkey, sheep, goats, poultry	Cow, donkey, sheep, goats, poultry

3.2. Research Design and Sampling Technique

The study will apply a convergence research design, which involves collecting and analyzing both qualitative and quantitative data (data of 2024/25) in the same period.

Sample selection will be undertaken using a multi-stage (four stage) sampling technique. First, two zones will be selected purposively with considering their potential in traditional crops and wild edible plants, which have been given less attention in research and development deeds. In second step, the two target districts from each zone, namely, Humbo and Damot Gale from Wolaita zone and Loma Bossa and Mareka from Dawro zone will be selected purposively. This selection is due the fact that the districts are facing frequent and serious food insecurity problems, exposed to droughts and farmers consume diverse NUC&WEP species. These may range from during the season of hardships to large scale drought and extreme food insecurity period. In third stage, a list of all rural kebeles (*Kebele is the list administrative unit in Ethiopia*) in each district will be obtained from local administrators and stratified based on their agro ecologies as highland kebeles, midland kebeles and low land kebeles. Because, heterogeneous climatic conditions can affect the existence, distribution, abundance and consumption of NUC and WEP species (Gebreziher, 2020a). Then, two kebeles from each district and each stratum

will be selected using a simple random sampling method. Through this method, the study will cover 8 kebeles as shown in Table 1 below.

To collect the quantitative data from sample kebeles, an —optimum sample size will be determined using equation (1) as suggested by Kothari (2004).

$$n = \frac{z^2 pq N}{e^2 (N-1) + z^2 pq} = \quad (1)$$

Where n represents the optimum sample size, which is required to predict the population N significantly; z is the standard cumulative distribution that corresponds to the level of confidence at 95% (z =1.96); p denotes the distribution of population attributes (p =0.5); q is 1– p; and e represents the desired level of precision (e = 5%). p value of 50% will be assumed to increase the level of precision for the sample size and reduce variability of population attributes. The more heterogeneous the population, the larger the sample size required to obtain a given level of precision. Then, n is redistributed to each kebele via probability proportion to size.

Finally, systematic random sampling technique will be applied to select sample households as indicated in equation (2) below, which has certain plus points and can be taken as an improvement over a simple random sample as it spread more evenly over the entire population

$$K = \frac{N}{n} \quad (2)$$

Where K is the interval among which the first sample is to be drawn using lottery method; N is total number of households in each sample *Kebele* and n is total sample size allocated for each sample *Kebele*. Thus, the 1st subject will be selected randomly and then every kth subject from the sampling frame will be included till the determined sample size reaches.

The study will use the same sampling procedure to select **key informants and focus group discussants for qualitative data collection.**

Table 2: Sampling Frame and Sampled Households

Target districts	Sample kebeles	Sampling frames	Samples to be taken
Humbo	Ela Kabala	818	51
	Ampo Koysa	779	49
Damot Gale	Woshi Gale	903	56
	Wandara Gale	853	53
Loma Bossa	Tulema Kai	613	38
	Ela Bacho	645	41
Mareka	Arusi Moges	548	35
	Gozo Bamush	610	37
	Total	5,769	360

Source: Computed based on data from kebeles (2024)

3.3. Data Types and Sources

The qualitative and quantitative data will be collected from primary source (respondents) and secondary sources (districts and zonal government's reports, national statistical reports and journal articles).

3.4. Data Collection Methods

Exploratory visit

An exploratory visit will be conducted to obtain general information about the topographic, climate, biophysical features and socio-economic characteristics of the study area. Such a visit is also useful for collecting data on topographic structures, landscape patterns and institutional systems of the study districts. This visit will be started first by contacting districts' administrators to obtain support letters that guarantee access to the research sites. Following this visit, **at least two transect walks will be held within each of the districts**, which are selected purposively after consultation with district food security coordinators, team leaders, and local leaders.

Focus group discussion (FGD)

A total of 8 FGDs (1 in each kebele) each of which consists of 7 households on average will be selected purposively after consultation local administrators and development agents in the respective study district. Accordingly 56 discussants will be participated in 8 FGDs with the

composition kebele leaders, development workers, and elder farmers, youths with considering their gender proportion.

Key Informant Interview (KII)

16 key informants who lived in the community for a long time and have well knowledge about NUCs and WEPs species will be interviewed. Another 16 experts as a key informant, who are knowledgeable about NUCs and WEPs and their effect on diet diversity will be contacted for in-depth interview. The selection of key informants will be achieved using purposive method with the help of development agents and local administrators.

Household survey

The survey question (close and open-ended) which comprises the following **three sections** will be developed to collect different nature of data.

The first section consists questions to collect household level data on demographic, socio-economic, physical attributes and identification of NUCs and WEPs. The second section comprises questions on perception of households towards the consumption of NUCs and WEPs (**Five point likert scale questions**). This scaling method has been preferred because of its easiness to construct, administer and as it is sufficient enough to yield similar results as does the more laboriously construct. Moreover, questions on consumer's preference for identified and prioritized NUCs and WEPs will be included in this section using **pit-sorting method**. The prioritization of NUCs and WEPs will undertake following the five-dimensional criteria suggested by FAO (FAO, 2016) to ensure its nutrition and dietary diversity impact. The criteria includes: (a) nutrient dense, (b) edibility of the NUCs and/or WEPs for extended period of the time (c) climate resilient, (d) economically viable (e) locally available and adaptable. Moreover, the criteria to prioritize NUCs and WEPs will include food environment aspects including healthy diet, taste and time taken for preparation. The third section of the survey will comprise a standard Household Dietary Diversity Score (HDDS) questions based on 12 food groups as described in sub topic 3.5 below.

All the survey process will be conducted with well-trained enumerators (2 from each kebele *8 = 16 enumerators) and those who have previous know how on the theme of this study using local language (Wolaiategna and Dawroigna) under the researcher's direct supervision.

3.5. Data for Household Dietary Diversity (HDD)

The HDD is measured by computing the Household Dietary Diversity Score (HDDS), which is increasingly used as an approximate measure of energy consumption per capita of the household and proxy for nutrient adequacy (Jones et al., 2014). The twelve food groups will be included in the HDD questions are: (1) Cereals (2) Root and tubers (3) Vegetables (4) Fruits (5) Meat, Poultry, (6) Egg, (7) Fish and other sea food (8) Pulses/legumes/nuts (9) milk and milk products (10) Oil/fats (12) Spices, condiments and beverages. Sample respondents will be asked to recall either they had consumed NUC and/or WEP from each of 12 food groups or not within 24 hour reference period preceding the survey time. The interviewer will first determine whether the previous 24 hour is "usual" or "normal" for the household. If it were a special occasion, such as a funeral or feast another day would be chose. The questions will be applied for two groups of households (NUCs and WEPs consumers and non-consumers) to compare their dietary diversity. The assessment of the HDDS should be during the period of food shortage, such as immediately prior to the harvest or immediately after emergencies or natural disasters (Kennedy et al., 2011). Here, the responsible household head for food preparation will be asked the question, or if that person is unavailable, another adult person who consumes food in the recall period will be asked.

3.6. Data Analysis

The data will be analyzed by descriptive statistics along with econometric model to attain the research questions. Based on the specific research objectives, the descriptive statistics (frequency, percentage, mean, and standard deviation) and the inferential statistics (T-test and χ^2 -test) will be applied using statistical software, including STATA V-15 and SPSS V.21.

Descriptive analysis (objective 1, 2,3 and general summary)

The descriptive statistics—frequency, percentage, mean, and standard deviation—will be used to describe and summarize the demographic, socioeconomic and institutional and biophysical attributes of the respondents. The likert scale questions on extent of farmer's perception towards

NUCs and WEPs consumption within context of diet diversity will be analyzed using the aforementioned descriptive statistics. Moreover, the consumers' preference data will be analyzed using descriptive analysis. An inferential statistics, T-test and χ^2 -test will be applied to compare the mean and proportion difference of continuous and discrete explanatory variables (cognitive and psychological, institutional, socio-economic and biophysical factors) in relation to NUCs and WEPs consumption or non-consumption.

Econometric model specification (objective 4)

A Heckman two-steps econometrics approach will be used to evaluate the implication of NUCs & WEPs consumption on improving household's dietary diversity. Though there are another competing models like PSM and Tobit models to analyze this objective, it still assumes that selection is based on observable factors and can lead to biased result when there are non-observable factors that influence both consumption and non-consumption of NUCs and WEPs by rural households. Hence, to circumvent this potential pitfall, the researcher will apply Heckman two-step approach, which corrects the problem of selection bias and simultaneity (Marchenko and Genton, 2012). Thus, the first step has to do with the probability of NUCs and WEPs consumption using the Probit estimation. In this step, the decision to consume NUCs and WEPs is not randomly assigned or it's based on self-selection whether to consume or not. In other words, NUCs and WEPs consumers may be systematically different from non-consumers, and these differences may obscure the true effect of NUCs and WEPs consumption on HDDs. The first step (selection equation) is given as:

$$F_i^* = \beta_0 + \beta_1 X_i + \epsilon_i \quad (3)$$

Where F_i^* is an unobserved latent variable representing Household's consumption decision, X_i is a vector of explanatory variables, β is a vector of parameters to be estimated, and ϵ_i is an error term distributed with mean 0 and variance 1. The observed dummy variable can be expressed as:

$$\left. \begin{aligned} F_i &= 1 \text{ if } F_i^* > 0 \text{ (for NUCs and WEPs consumers)} \\ F_i &= 0 \text{ if } F_i^* \leq 0 \text{ (for NUCs and WEPs non-consumers)} \end{aligned} \right\} \quad (4)$$

The second stage (i.e NUCs and WEPs consumption effect on HDD, measured by household dietary diversity score (HDDS)) will be estimated by using Ordinary Least Square (OLS). For this stage a substantive equation is given as:

$$= 0 + 1 + \quad (5)$$

It should be noted that for the correction for self-selection biases in the substantive equation (5), an Inverse Mills Ratio (IMR) represented by the symbol λ as an extra explanatory variable is added. The IMR computed from first step probit regression provides a corrected selection of OLS estimates (Greene, 2003). Adding IMR translates equation (3) into equation (6) as:

$$= + 0 + \quad + \quad + \quad (6)$$

Where; δ_i is the coefficient of the IMR (λ_i). If λ is statistically significant, sample selection bias is a problem and, therefore, Heckman's two-stage sample selection model is appropriate for the estimation (Marchenko and Genton, 2012). The formulation process of IMR is given as:

$$\lambda_i = \frac{\phi(X_i\alpha)}{(\quad)} \quad (7)$$

Where; ϕ and Φ are normal probability density function and cumulative density function, respectively of the standard normal distribution, and $\phi \equiv (\omega_i\chi)$. μ_i is a two-sided error term with $N(0, \sigma^2)$. In general, the model computes the inverse mills ratio from the Probit regression and uses it as additional explanatory variable to explain the outcome variable, improvement in HDD (Heckman, 1976).

Finally, the qualitative data of the study will be recorded and transcribed and afterwards analyzed using narrative and content approach, which emphasize on identifying, analyzing and interpreting patterns of meaning or themes argued by FGDs and KIIs.

4. WORK PLAN AND BUDGET

4.1 Work Plan

Table 3: Work Plan Lasts for 1 Year

No	Types of activities	Duration of the study (January 2024- November 2024 EC)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Proposal development	✓	✓	✓	✓								
1	Discussion with zone, Woreda and kebele administrators					✓							
3	Enumerators training and pilot study					✓	✓						
	Actual data collection						✓	✓					
4	Data Processing								✓	✓	✓		
5	Data Analysis									✓	✓	✓	
6	Result writing										✓	✓	
7	Progress report											✓	
8	Submission of final paper												✓
9	Final defense												✓
10	Incorporation feedback and prepare last article for publication												✓

4.2 Budget Breakdown

Table 4: Stationary Costs

S.No	Description	Unit	Qty	Unit cost(ETB)	Total cost(ETB)
1	Printing and binding				6500
2	Sound Recorder (Sony ICD-PX470) For FGD and KII	No	1	7300	7300
	Total cost	-	-		13,800

Table 5: Personal Costs

List of Activities	Budget type	Quantity	Unit cost/Price	No. of Days	Total cost
Discussion with Zone, woreda and kebele level government officials and DA	Per-diem	2	339	15	10170
Preliminary survey	Per-diem	1	339	20	6780
Training	Trainers Per-diem	2	339	6	4068
Training	Trainees Per-diem	16	200	3	9600
Data collection	Enumerators fee	16	200	45	144,000
Enumerators supervision periderm	Per diem for Researcher	2	339	45	30510
Qualitative data collection KII	Per diem for Researcher	2	339	16	10,848
Qualitative data collection kebele level KII	KII Per-diem	32	200	3	19,200
Qualitative FGD data collection	Per diem for Researcher	2	339	16	5424
FGD Participants refreshment	Data collection	56	100	1	5600
Transcription of KII and FGD data	Per diem for Researcher	1	339	10	3390
Data organization	Data cleaning	1	339	15	5085
Data entry	Data Entry	1	339	30	16,950
Data analysis	Analysis	2	339	45	30510
Draft Report write-up	Write-up	2	339	45	30510
Transportation					20,000
Sub Total					352,645
Grand Total (Stationary + Personal Cost)					366,445

References

- Abebe Yimer , Sirawdink Fikereyesus Forsido , Getachew Addis , Abebe Ayelign . (2023). Phytochemical profile and antioxidant capacity of some wild edible plants consumed in Southwest Ethiopia . *Heliyon* 9 (2023) e15331, journal homepage: www.cell.com/heliyon.
- Abebe, A., & Halala, H. . (2020). Factors Affect Maize Production and Marketing in Wolaita and Dawuro Zones, SNNPR State, Ethiopia . *International Journal of Science and Research (IJSR)*, 9(2), 771-783.
- Aisha, A. H., Abdalla, O. E., & Aladwani, D. A. (2022). Neglected and Underutilized Crops (NUCs) for enhancing food and nutrition security in the Near East and North Africa region. *Agriculture and Food Security*, 11(1), 1-14.
- Alem, G., & Asfaw, Z. (2017). The potential of indigenous vegetables for improving household dietary diversity and vitamin A intake in southwestern Ethiopia. *Ecological Processes*, 6(1), 1-12.
- Alemerew, B., & Ayenew, G. (2020). Distribution and constraints of using neglected and underutilized crop species for food and nutrition security in Ethiopia. *Agricultural and Food Science*, 29(1), 1-12.
- Alemu, G. H., Amare, M., & Bergmans, H. (2017). Food consumption patterns and associated factors among lactating mothers in rural Ethiopia. Maternal health, nutrition, and dynamics in Ethiopia. 28, 125-134.
- Alemu, H. A. (2016). Determinants of household dietary diversity in rural and urban Ethiopia. *Agricultural and Food Economics*, 4(1). <https://www.sciencedirect.com/science/article/pii/S2666154323000571>.
- Aragaw et al. . (2021). Nutrient Composition of Underutilized Plant Species in Ethiopia.
- Aregheore, T. M., & Oniang'i, R. A. (2016). Factors influencing the consumption of underutilized indigenous vegetables in African households. *Food Policy*, 60, 10-20. <https://doi.org/10.1016/j.foodpol.2015.11.002>.

- Assefa, D. Z., Tadelle, G., & Rahmeto, R. . (2018). Seasonal variations in dietary diversity scores and its determinants in rural Ethiopia. *PloS one*, 13(1), e0191525.
- Aune, D., Keum, N., Giovannucci, E., Flicker, L., Norris, J. W., Jacobs, D. R., ... & Crowe, S. E. (2017). Whole grain consumption and risk of type 2 diabetes: a systematic review and meta-analysis of observational studies. *Nutrition reviews*, 75(1), 72-85.
- Awais, T., Asfaw, Z., & Adugna, T. (2020). Wild edible plants used by local communities in the central highlands of Ethiopia and their potential for dietary diversification. *African Journal of Ecology*, 58(3), 822-830. https://www.researchgate.net/publication/51985506_Wild_edible_plants_in_Ethiopia_A_review_on_their_potential_to_combat_food_insecurity.
- Awasthi, A., et al. . (2016). Enhancing climate resilience of food systems for smallholder farmers in Sub-Saharan Africa through the use of neglected and underutilized crop species. *Current Agriculture Research Journal*, 4(2), 110-120.
- Ballard, C., Piggott, M., Wright, S., & Singer, J. . (2011). Cognitive decline and vitamin B12, folate, and homocysteine status in community-dwelling elderly persons. *The American journal of clinical nutrition*, 93(4), 1062-1068.
- Berhanu, F., & Bekele, T. . (2019). Diversity of indigenous vegetables in southern Ethiopia. *Acta Scientiarum Polonorum, Hortorum Cultura*, 18(3), 45-53.
- Beza, E., Berhane, M., & Gebrehiwot, T. . (2021). Climate change and food security in Ethiopia: Challenges and opportunities. *Sustainability*, 13(21), 12227. <https://www.mdpi.com/2071-1050/13/19/11047>.
- Bharucha, Z. P., & Pretty, J. N. (2010). The role of wild food systems in poverty reduction and biodiversity conservation in developing countries. *Journal of Development Studies*, 46(13), 2008-2030. <https://journals.sagepub.com/doi/pdf/10.1191/1464993406>.
- Boeing, H., Bechthold, A., Ogata, N., Schwedt, P., Steffen, A., & Kroger, J. (2014). Critical review: vegetables and fruits in the prevention of chronic diseases. *European Journal of Nutrition*, 53(Suppl 2), S1-S12.

- Cryan, J. F., Dinan, T. G., & O'Riordan, K. J. (2019). Mind-altering microbiota: the impact of the gut microbiome on brain and behaviour. *Nature Reviews Neuroscience*, 20(3), 155-169.
- Dilebo, T., Feyissa, T., Asfaw, Z. et al. . (2023). On-farm diversity, use pattern, and conservation of enset (*Ensete ventricosum*) genetic resources in southern Ethiopia. *J Ethnobiology Ethnomedicine*, 19, 2 <https://doi.org/10.1186/s13002-022-00569-x>.
- Duguma, H. T. (2020). Wild edible plant nutritional contribution and consumer perception in Ethiopia. *International Journal of Food Science*.
- Ettiene, T. N., & Ekpo, A. S. (2014). Availability and utilization of wild edible plants among the Ibibio people of southern Nigeria. *Advances in Applied Science and Technology*, 7(6), 100-107.
- Eyayu, M., Hailu, G., & Addis, G. (2016). The role of underutilized traditional vegetables in combating malnutrition in Wolaita Zone, Southern Ethiopia. *Journal of Biodiversity and Environmental Sciences (JBES)*, 8(6), 122-131. <https://www.mdpi.com/2071-1050/6/1/319>.
- Fan, M. S., Hawkes, C., & Dangal, G. S. (2020). The role of food systems in economic transformation and food security in Africa. *Global Food Security*, 27, 100720. <https://www.tandfonline.com/doi/full/10.1080/23322039.2023.2273590>.
- Fanzo, J., Hunter, D., Borelli, T., & Mattei, D. (2013). Food security, nutrition security, and the right to food: What's the difference? *The Fletcher Journal of Health Law and Policy*, 14(2), 323-346.
- FAO. (2019). Neglected and Underutilized Crops (NUCs): An Overview.
- FAO. (2023). Food Security and Nutrition. <https://www.fao.org/hunger/en/>.
- FAO, Food and Agriculture Organization of the United Nations. . (2019). The State of the World's Biodiversity for Food and Agriculture. <https://www.fao.org/3/CA3129EN/CA3129EN.pdf>.

- FAO, IFAD, UNICEF, WFP, & WHO. . (2021). The State of Food Security and Nutrition in the World 2021: Transforming food systems for food security, improved nutrition and a better environment. *FAO*. <https://www.fao.org/documents/card/en?details=cb4474en>.
- Gebremedhin, H. G., Bekele, T., & Johnson, C. D. . (2014). Food insecurity and its determinants in production and consumption areas in southern Ethiopia. *Agriculture and Food Security*, 3(1), 1-11.
- Gebremichael, G. B., & Singh, A. I. (2019). Customers' expectations and perceptions of service quality dimensions: A study of the hotel industry in selected cities of Tigray Region, Ethiopia. *African Journal of Hospitality, Tourism and Leisure*, 8(5), 1-15.
- Geleta, B., Bryle, M., & Pilling, D. (2019). Dietary diversity score and its association with socio-demographic and economic factors in rural Northwest Ethiopia. *International Food Research Journal*, 26(4), 1183-1193. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9254638/>.
- Gelu, D.G., Gebre, G.G . (2023). Impact of adopting wheat row planting on yield among smallholder farmers in Dawuro Zone, Southwestern Ethiopia. *Environ Dev Sustain* 25, , 13149–13169. <https://doi.org/10.1007/s10668-022-02608-9>.
- Gemedo, D. S., Woldu, Z., Feyissa, D. S., & Struik, P. C. (2023). Dietary diversity and micronutrient deficiencies among women of reproductive age in rural Ethiopia: A cross-sectional study. *Food Science & Nutrition*, <https://www.ncbi.nlm.nih.gov/pmc/art>.
- Giday, M., Asfaw, Z., & Wolde-Gabriel, G. (2005). The chemical composition of the principal Ethiopian pulses. *Journal of Food Composition and Analysis*, 18(5), 557-564. DOI: 10.1016/j.jfca.2004.08.003: [invalid URL removed].
- Gillespie, S., & Harris, J. (2011). The role of nutrition in early childhood development. *Maternal & Child Nutrition*, 7(3), 309-327.
- Girma, M., Hailemariam, D., Gebreselassie, S., & Amare, B. . (2014). Prevalence and associated factors of overweight and obesity among adults in Wolaita Soddo town, southern Ethiopia: a community based cross-sectional study. *Nutrition Journal*, 13(1), 1-8.

- H. Zheng and W. Ma. (2023). Impact of agricultural commercialization on dietary diversity and vulnerability to poverty: Insights from Chinese rural households. *Economic Analysis and Policy*, doi: <https://doi.org/10.1016/j.eap.2023.09.007>.
- Headey, D., & Fan, S. (2010). Vulnerability, coping strategies and policy choices for food security in the wake of food price volatility. *The World Bank Research Observer*, 25(1), 87-108.
- Headey, D., Hoddinott, J., & Rutledge, D. (2020). Food and nutrition security in sub-Saharan Africa: Progress and challenges. *International Food Policy Research Institute (IFPRI)*. <https://www.ifpri.org/country/africa>.
- Hunde, A., Asfaw, Z., & Kelbessa, E. (2014). Use and management of medicinal plants by local communities in Enjera Cochle (Ethiopia). *Journal of Medicinal Plants Research*, 8(24), 1773-1783. DOI: 10.5897/JMPR2013.5939.
- Hunter, D., Heywood, V., & Garibaldi, L. (2017). The implications of conservation for nutrition in the developing world. *Proceedings of the National Academy of Sciences*, 114(31), 8383-8390. <https://www.nature.com/articles/s41893-018-0192-z>.
- Johns, T., Kokwaro, J. O., & Kimanani, E. (1999). Herbal remedies of the Luo of Kenya. *Journal of Ethnopharmacology*, 69(1), 171-181.
- Johns, T., Mithen, S., & Walls, M. (2009). *Ethnobotany: Plants and their human uses* (2nd ed.). Oxford University Press.
- Kumma WP and Loha E. (2023). Dietary patterns and their association with cardiovascular risk factors in Ethiopia: A community-based cross sectional study. *Front. Nutr*, 10:1074296. doi: 10.3389/fnut.2023.1074296.
- Li & Siddique . (2019). Future Smart Food: Leveraging the Legume Advantage for Resilient Food Systems.
- Maroyi, A. (2017). Contribution of indigenous vegetables to dietary diversity and vitamin A intake in southern Africa. *Agriculture and Food Security*, 6(1), 1-9.

- MDPI. (2020). Neglected and Underutilized Plant Species (NUCS) from the Apulia Region Worthy of Being Rescued and Re-Included in Daily Diet. *MDPI* [available online at [mdpi.com](https://www.mdpi.com/)].
- Meja, M., Mathewos, A., Kebede, A. K., & Goa, W. . (2022). Does Food Insecurity Exist in Rural Households of Wolayta? Evidence in Wolayta Zones, Southern Ethiopia.
- Ngigi PB, Termote C, Pallet D and Amiot MJ. (2023). Mainstreaming traditional fruits, vegetables and pulses for nutrition, income, and sustainability in sub-Saharan Africa: the case for Kenya and Ethiopia. *Front. Nutr*, 10:1197703. doi: 10.3389/fnut.2023.119.
- NUCS. (2018). Neglected and underutilized species for food and income security in marginal environments. *International Center for Biosaline Agriculture* [available online at [biosaline.org](https://www.biosaline.org/)].
- Padulosi, S., & Hoeschle-Zeledon, I. (1993). *Tropical trees: Potential sources of food, medicine, and timber*. Earthscan Publications Ltd.
- Padulosi, S., Thompson, J., Rudebjer, P. (2013). Fighting poverty, hunger and malnutrition with Neglected and Underutilized Crops (NUCs): needs, challenges and the way forward. *Bioversity International, Rome*.
- Rapsoman, T., Afolayan, A. J., & Odebode, T. O. . (2014). Deficiencies in micronutrients among women in developing countries: Prevalence, causes, consequences and interventions. *International Journal of Vitamin and Nutrition Research*, 84(2), 70-77.
- Scarano, A.; Semeraro, T.; Chieppa, M.; Santino, A. . (2021). Neglected and Underutilized Plant Species (NUCS) from the Apulia Region Worthy of Being Rescued and Re-Included in Daily Diet . *Horticulturae*, 7, 177. [https:// doi.org/10.3390/horticulturae7070177](https://doi.org/10.3390/horticulturae7070177).
- Shackleton, C. M., Shackleton, S. E., & Cordeiro, M. N. (2007). Stakeholder perceptions of forestry governance and timber harvesting in South Africa. *Ecology and Society*.
- Shimelis, H., Mohammed, A., & Jaleta, M. (2016). Climate change impact on wheat and barley production in the highlands of Ethiopia. *Journal of Agricultural Science*, 8(6), 747-759.

- Stebek, E.N.. . (2018). Consumer Protection Law in Ethiopia: The Normative Regime and the Way Forward. *J Consum Policy*, 41, 309–332: <https://doi.org/10.1007/s10603-018-9389-9>.
- Tadele, T., Hunde, A., & Asfaw, Z. (2013). Proximate composition and mineral contents of some Ethiopian medicinal plants. *International Journal of Biodiversity and Conservation*, 5(7), 380-389. DOI: 10.5376/ijbc.2013.05.07.02: [invalid URL removed].
- United Nations. (2015). Transforming Our World: The 2030 Agenda for Sustainable Development. <https://sdgs.un.org/2030agenda>.
- Wani, A.B., Biaza, Irtiza. (2021). Neglected and Underutilized Crops: Present Status and Future Prospectus. In: Zargar, S.M., Masi, A., Salgotra, R.K. (eds) Neglected and Underutilized Crops - Towards Nutritional Security and Sustainability. *Springer, Singapore*. https://doi.org/10.1007/978-981-16-3876-3_2.
- Woldehanna, S., Tadesse, Z., & Yismaw, G. (2016). Vitamin A deficiency and its associated factors among under-five children in Wolaita zone, southern Ethiopia: A community-based cross-sectional study. *BMC Public Health*, 16(1), 1222.
- Woldemichael, K., & Debela, A. . (2010). Determination of antioxidant activity and vitamin A content of three Ethiopian indigenous vegetables. *Pakistan Journal of Nutrition*, 9(8), 759-764. DOI: 10.3923/pjn.2010.759.764.
- Yemata, G. T., Addisalem, S., & Assefa, D. (2017). Adolescent Girls' Nutrition in Wolaita and Hadiya Zones, Southern Ethiopia. [Doctoral dissertation, Addis Ababa University].
- Yemata, G. T., Addisalem, S., & Assefa, D. (2018). Nutritional composition of wild vegetables consumed in Wolaita Zone, southern Ethiopia. *Journal of Food and Nutrition Sciences*, 6(6), 473-478.
- Yoseph . (2021). Adolescent Girls' Nutrition in Wolaita and Hadiya Zones, Southern Ethiopia. Addis Ababa University. Retrieved from [URL of the source if available].
- Zemedede, A., Asfaw, Z., & Hunde, A. (2018). Ethnobotanical study of medicinal plants used by the indigenous people of Gamo Gofa zone, southwestern Ethiopia. *Journal of*

Ethnopharmacology, 220, 200-210. DOI: 10.1016/j.jep.2018.03.014: [invalid URL removed].

Zheng and Ma.,. (2023). Dietary Diversity Scores: An Indicator of Micronutrient Inadequacy Instead of Overweight Status in Chinese Children. *British Journal of Nutrition*.