COLLEGE OF DEVELOPMENT STUDIES

CENTER FOR FOOD SECURITY STUDIES

BEEKEEPING PRACTICES AND ITS CONTRIBUTION TO HOUSEHOLD FOOD SECURITY IN ADDIS ABABA: THE CASE OF YEKA SUB-CITY

BY

GEMECHIS JALETA

June 2024

Addis Ababa, Ethiopia

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A thesis submitted to the Centre for Food Security Studies of College of Development Studies, Addis Ababa University as a Partial Fulfilment of the Requirements for the Master of Science Degree in Food Security and Development Studies.

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Addis Ababa

DECLARATION

This thesis entitled **"Beekeeping Practices and its Contribution to Household Food Security in Addis Ababa: The Case of Yeka Sub-city"** is my original piece of work and has not been submitted to any other university for any academic degree. I have dully acknowledged any materials and information used in the thesis that are not my own.

Name: Gemechis Jaleta

Signature: _____

Date: _____

Addis Ababa University College of Development Studies; Center for Food Security Studies

I hereby confirm, as the candidate's advisor, that to the best of my knowledge, the declaration made by the candidate is correct.

Meskerem Abi, Ph.D

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Date: _____

THESIS APPROVAL SHEET

As a member of the Board of Examiners responsible for the open defense examination of the Master of Sciences thesis, we have thoroughly reviewed and evaluated the thesis titled "Beekeeping Practices and its Contribution to Household Food Security in Addis Ababa: the Case of Yeka Sub-city" prepared by Gemechis Jaleta. We hereby confirm that the thesis meets the criteria and is accepted as a fulfillment of the requirements for the award of the degree of Master of Sciences in Food Security and Development Studies.

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Gemechis Jaleta

June 2024

DEDICATION

This thesis is dedicated to my dear brother Dereje Jaleta, who is now in heaven.

ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
ATA	Agricultural Transformation Agency
CSA	Central Statistical Agency
Covid 19	Corona Virus Disease 2019
EBA	Ethiopian Beekeepers Association
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FCS	Food Consumption Score
GHI	Global Hunger Index
HDDS	Household Dietary Diversity Score
HFAIS	Household Food Insecurity Access Scale
KII	Key Informants Interview
MoARD	Ministry of Agriculture and Rural Development
NGO	Non-Governmental Organisation
SNV	Netherlands Development Organisation
STATA	Statistical Software for Data Science
UA	Urban Agriculture
USAID	United States Agency for International Development
WFP	World Food Program

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ABSTRACT

Beekeeping in Ethiopia has a rich and longstanding tradition, deeply rooted in the country's history and cultural heritage. Ethiopia, known as the 'Land of Origins', possesses a diverse ecosystem that supports a wide variety of bee species, making it an ideal location for apiculture. Beekeeping plays a key role in enhancing household incomes, preserving biodiversity, and ensuring food and nutrition security. Despite its importance, beekeeping in urban areas is an understudied sector and encounters various challenges and limitations, including societal concerns regarding honeybees' stings and the need for suitable apiary sites. Therefore, the study aims to investigate beekeeping practices and its contribution to food security. The research design applied was cross-sectional. A two-stage sampling technique was applied to select 176 household heads. Both primary and secondary sources of data were used in the study. The demographic, socioeconomic, and food security status of beekeepers were analyzed using descriptive and inferential statistical techniques. The multiple linear regression model and ordered Probit model were conducted to identify determinants of beekeeping practice and to analyze the role of beekeeping in food security respectively. The result showed that family size, market information, and access to forage have a significant relationship with beekeepers' quantity of honey produced. The ordered probit model result showed that producing a high amount of honey enables beekeepers to achieve food security and the amount of honey production has a positive contribution to food security. Addressing the factors that restrict beekeeping practices can have a positive effect on beekeepers' incomes and greatly contribute to food and nutrition security. Public and private actors must focus on preserving habitats, promoting policies benefiting pollinators, and facilitating market connections. The Addis Ababa city administration needs to develop market infrastructure, promote agroforestry practices, foster collaboration, and engagement among multiple stakeholders, and adopt sustainable beekeeping in urban areas. These efforts will not only enhance the economic prospects of beekeepers but also have significant benefits for the overall well-being of the community in terms of food security and nutrition.

Keywords: Beekeeping, Food security, Honeybee, Honey, Hives, Urban agriculture

CHAPTER 1: INTRODUCTION

1.1. Background

Beekeeping is a common activity in many rural areas around the world, with thousands of small-scale beekeepers relying on bees for a living. Beekeeping is the practical management of bees to produce food and agriculture (FAO, 2021). It is the management of honeybee colonies for crop pollination, honey production, and other purposes (Bradbear as cited by Kenesa, (2018a). This environmentally friendly business activity is carried out by farmers and landless people. Beekeeping requires no cultivated land, little investment, and provides quick economic benefits. It is also a low-pollution intensive agricultural practice.

According to Nega (2018), global honey production is estimated to be 1.3 million tonnes per year on average. Most of the honey is produced in developing countries, while developed countries are the largest consumers. Developing countries produce approximately 47% of the world's total honey production. China, Turkey, and Argentina are the top honey producers. Brazil, India, Ethiopia, Mexico, Kenya, Tanzania, and Angola are also relatively large honey producers in the developing world (AusAID, 2005). According to research and oral evidence from many African communities, beekeeping has been practiced for many centuries in Africa, primarily for food and medicinal purposes. Honey was used for cultural purposes in some communities in East and North Africa, such as paying dowry and making traditional brews (FAO et.al. 2021; Gemechis, 2015). With an increase in regional and global demand for honey, as well as access to information about the nutritional benefits of organic honey, there has been a surge in communities taking up beekeeping as an income-generating enterprise.

Beekeeping has a long history in Ethiopia; it appears to be as old as the country's history (Belie, 2009). Furthermore, beekeeping plays a big part in household income in farming communities and the national economy (Gemechis, 2015). Beekeeping is an eco-friendly activity that can help reduce poverty and protect biodiversity. By producing valuable products like honey, beeswax, queens, and bee colonies, as well as other items like pollen, royal jelly, bee venom, and propolis, it plays a significant role

both directly and indirectly. In addition, it helps with financial security and offers employment opportunities (Abebe & Puskur, 2011). With a few exceptions, beekeeping is a common practice in every place where man has settled. Beekeeping is not a new phenomenon in Addis Ababa; it has been an important part of the city's development as Ethiopia's capital since its inception. Many of the city's early inhabitants grew crops, raised chickens, and kept bees (Gebreyesus, 2015). The city expansion occurred through the incorporation of rural communities that relied on livestock, crop cultivation, and beekeeping as their primary means of livelihood. Today, beekeeping is spreading throughout the city to provide employment opportunities for youth and landless people. Every year, approximately 62 tonnes of honey are produced in Addis Ababa (Delelegn & Mulugeta, 2018a).

Beekeeping practices play a fundamental role in enhancing household food security. Bees, as pollinators, are responsible for the reproduction of several plants, including many food crops. Animal pollination is crucial for over three-quarters of the major types of food crops grown worldwide. This process of pollination increases crop yield, improves crop quality, and enhances agricultural productivity. Pollinator-dependent crops contribute to 35% of global crop production volume. These constitute leading export products such as coffee, cocoa, and almonds, that are providing employment and income for millions of people (IPBES, 2016).

Beekeeping contributes to the creation of jobs, reduces poverty, increases income, and provides food security (Mutua, 2018). Beekeeping provides both direct and indirect benefits to residents in both rural and urban areas. Beekeeping provides food, safe medicines, raw materials for industry, and hive products that directly support household income. Beekeeping contributes indirectly to watershed management, forest conservation, and crop pollination. In their studies, Chaplin-Kramer et al. (2014) discovered that bees play a crucial role in one-third of food crops planted and produced by humans. Bees make significant contributions to the upkeep of ecosystems through pollination. They contribute significantly to the preservation of biodiversity, food security, nutrition, the survival of numerous plant species, the improvement of forest regeneration, the sustainability and climate change adaptation of agricultural production systems, and the improvement of the quantity and quality of agricultural

yield. Bees offer humans a diverse range of valuable hive products and services while supporting significant economic, cultural, and social functions. These include services like apitherapy (using bee products for medicinal purposes), api-tourism (visiting bee farms or observing bee habitats), and environmental monitoring (using bees as indicators of ecological health (FAO, 2021).

Maurice (2006) claims that beekeeping can help to conserve the environment in three ways: Boosting the honeybee population in an area should improve the pollination success of many flowering plant species and thus yield; the income generated by beekeeping can help to alleviate pressure on the local resource base; and there is the potential to change people's perceptions of their local environment. With all the benefits listed above, beekeeping is thought to improve the living conditions of the urban poor. In light of this understanding, an attempt is made to investigate beekeeping practices in Addis Ababa and their vital role in food security.

1.2. Statement of the Problem

In Ethiopia, beekeeping is an aged agricultural practice. It is a main part of the nation's agricultural economy. Its role is of utmost importance in food production and provides employment opportunities and economic stability for beekeepers. Unfortunately, beekeeping in Ethiopia has not received the recognition it deserves in terms of its potential and its role in socio-economic development, despite its numerous possibilities. Ethiopia has the potential to produce approximately 500,000 tonnes of honey and 50,000 tonnes of beeswax annually. However, only about 10% of this potential has been realized, and the commercialization of other valuable bee products such as pollen, propolis, and bee venom is yet to be recognized or practiced at a marketable scale (Teferi, 2018).

While beekeeping provides significant contributions to household incomes, enhances the resilience of natural ecosystems, and significantly contributes to nutrition and food security, beekeeping research and interventions are overlooked, unlike other livestock. Urban beekeeping is specifically faced with several production challenges and limitations such as social fear of honeybees' sting and apiary site requirements. It has been underestimated and unrecognized, unassisted, or discriminated against. It is also

treated as a temporary phenomenon and research on this area has been scanty. It has been disregarded by researchers and little understood by urban planners and decision-makers. Studies conducted on urban beekeeping are limited and the existing studies focus on limited aspects. Despite various studies conducted in urban agriculture (Teferi, 2009; Endale, 2011; Gebretsadkan, 2015), limited research has been conducted on beekeeping. Most of them have focused on the contributions of urban agriculture such as dairy, vegetables, poultry, and mushroom cultivation in household food security. However, in contrast, the Addis Ababa City Administration has created an Urban Agriculture Bureau to manage urban agriculture and encourage activity. Considering this, the study tries to examine the conditions that impede the productive functioning of urban beekeeping, investigate the problems faced by beekeepers, and assess the contribution of beekeeping to household food security as the issues demand consideration and systematic investigations.

1.3. Objective of the Study

1.3.1. General objectives

The general objective of this study was to examine beekeeping practices and its contribution to household food security in the Yeka sub-city, Addis Ababa, Ethiopia in the year 2022/23 (2015EC).

1.3.2. Specific objectives

The specific objectives of the study were:

- To identify the factors determining beekeeping practices in the study area
- To analyze the effect of beekeeping in ensuring household food security in the study area
- To assess the challenges and opportunities of beekeeping practices in the study area

1.4. Research Question

The following are working research questions.

- What factors influence beekeeping practices in the Yeka sub-city, Addis Ababa?
- How does beekeeping contribute to household food security in the study area?
- What are the existing challenges and opportunities associated with beekeeping practices in the study area?

1.5. Significance of the Study

This study is important in many ways because it closes the knowledge gap about beekeeping practices and how it affects household food security in Addis Ababa. Additionally, this research may address the policy implications for promoting economic development, improving urban food security, and increasing the production and commercialization of honey in Addis Ababa, Ethiopia. Thus, this study could offer valuable insights that would benefit both the nation as a whole and the Addis Ababa City Urban Agriculture Bureau specifically planners, beekeepers, extension agents, and agricultural specialists. For the most part, the study could produce insights into how county and city governments might promote and strengthen urban beekeeping. Urban food insecurity is a major problem in the nation, and increasing production of honey in urban areas can help. The findings might also encourage young people and the private sector to engage in beekeeping businesses.

1.6. Scope and Limitation of the Study

The study was focused on beekeeping practices and its contribution to household food security. It aimed to identify the factors that determine beekeeping practices, analyze how beekeeping contributes to household food security, and evaluate both the challenges and opportunities associated with beekeeping practices. The study was conducted applying three methods of measurement of food security, which are the household food insecurity access scale, household dietary diversity score, and food security score. Given the multifaceted nature of food security, it would have been advantageous to utilize a broader range of measurements. Data collection for the study encompassed both individual and household levels, which provided valuable insights.

However, expanding the scope to include data collection at the country and community levels would have enhanced the study's comprehensiveness. The study utilized cross-sectional data, capturing various variables of interest concurrently within a specific timeframe, specifically the Ethiopian Calendar year 2015 (2022/2023). Incorporating panel and time-series data could have produced more robust results. To analyze the relationship between beekeeping practices and food security, the study employed an ordered probit model. However, to ensure the robustness of the findings, the inclusion of impact models could have been beneficial. The study was conducted in Woreda 2 of Yeka sub-city. While this provided valuable insights, conducting the study at the city administration level may have probably provided more comprehensive data and a broader perspective. Overall, the study provides valuable insights into beekeeping practices and their impact on household food security. Incorporating additional measurements, expanding data collection to higher levels, utilizing panel and time-series data, and exploring alternative modeling techniques could further enhance the study's findings.

1.7. Organization of the Thesis

There are five chapters in this study. The first chapter, an introductory part includes the background of the study, problem statement, research objectives, research questions, significance and scope of the study, and limitations of the study. Reviews of the literature, both theoretical and empirical, are covered in the second chapter. The research methodology is presented in the third chapter. The fourth chapter includes results and discussions. A summary, conclusion, and policy recommendations are provided in the final chapter.

CHAPTER 2: LITERATURE REVIEWS

2.1. Conceptual and Theoretical Literature Reviews

2.1.1. Concepts and definitions

Urban Agriculture: Urban agriculture encompasses a range of activities related to the production, processing, distribution, and sale of food within urban, suburban, and peri-urban areas. These activities serve various purposes, including non-profit initiatives, commercial ventures, non-commercial projects, recreational endeavors, and educational programs. Urban agriculture includes food-producing gardens found at homes, community spaces, or schools, as well as beekeeping, poultry farming, aquaculture, and animal husbandry. Edible landscaping, and urban farms (including indoor and rooftop farms, vertical farming, hydroponics, and aquaponics) are other forms of urban agriculture (Campbell and Rampold, 2021). The concept of urban agriculture also encompasses the production of both food and non-food items in urban and peri-urban settings involving various practices such as cultivating plants, tree crops, engaging in aquaculture, beekeeping, and animal husbandry (Jonkman, 2019). According to FAO (2007), urban agriculture is described as "the cultivation of plants and the rearing of animals for food and various other purposes within and in the vicinity of cities and towns." This definition encompasses not only the production and delivery of inputs, processing, and marketing of products but also emphasizes the integration of urban agriculture into the local economic and ecological systems of cities. Additionally, urban agriculture can extend to nearby towns and suburbs, which provide food and resources to urban areas. Mougeot (2005) further emphasizes the interconnectedness of urban agriculture with urban and peri-urban environments, highlighting its role in the broader local food system. This study follows the definition by FAO.

Honey: Based on Codex Alimentarius and the European Union, as referenced by Thrasyvoulou (2018), honey is a naturally sweet substance created by bees through the collection, transformation, and deposition of nectar from plants, secretions from living parts of plants, or excretions from plant-sucking insects found on the living parts of plants. The bees store the gathered nectar in honeycombs, allowing it to ripen and mature. The exact physical properties of honey depend on the flora used to make it.

Rich in natural sugars like glucose and fructose, honey also contains a range of enzymes, antioxidants, and other bioactive compounds that contribute to its diverse health benefits. The unique components of honey, varying based on floral sources, impart distinct flavors, colors, and nutritional profiles to different types of honey (Bogdanov et al., 2008). Research studies have highlighted honey's potential as a natural remedy for various ailments due to its antimicrobial, anti-inflammatory, and wound-healing properties (Scepankova et al., 2021). Beyond its medicinal uses, honey finds applications in the food industry as a natural sweetener and flavor enhancer, as well as in cosmetics for its moisturizing and antioxidant effects (Bogdanov, 2012).

Beeswax: Worker bees produce honeybee wax, which is a complex organic compound primarily composed of lipids. They produce through specialized wax glands located on the inner side of their 4th to 7th abdominal sternites. They secrete wax in the form of wax scales, which are transferred to their mandibles using their forelegs. The bees then chew the wax scales, mix them with salivary secretions, and incorporate them into the comb they are constructing. Beeswax serves as a construction material for building the comb, also referred to as honeycomb or comb wax. The comb serves multiple functions, including storing food such as honey and pollen, as well as providing a space for rearing brood (Svečnjak et al., 2019). In addition to its role in beekeeping for creating comb foundations, beeswax finds various applications in cosmetics, pharmacy, candle making, art, and numerous other purposes.

Household: A household is a social entity comprising one or more people who live together in a dwelling and share resources such as food, income, and facilities. A household may or may not be related by blood, marriage, or adoption. A household may also include domestic workers**,** boarders, or guests who reside in the dwelling.

Food security: is defined in different ways, as evidenced by the research conducted by Maxwell and Frankenberger (1992), who identified nearly 200 distinct definitions. According to FAO (1996), food security is attained when all individuals have continuous physical and economic means to obtain sufficient, safe, and nutritious food that fulfills their dietary needs and preferences, enabling them to lead an active and healthy life. Mah et al. (2014) expanded on this definition by including the equitable distribution of resources for food production and the purchasing power required to

acquire food from the places where it is produced. Conversely, FAO (2008) defines food security as the ample availability and accessibility of food for households to meet the minimum energy requirements necessary for an active and healthy lifestyle. In this study, the definition of food security adopted aligns with FAO (2008), focusing on the availability and access to food.

Components of food security

Understanding the four dimensions of food security - stability, availability, access, and utilization is crucial for comprehensive assessments of food security and designing effective interventions to address its challenges. A person must be food secure if they meet the requirements of those elements. These four dimensions are together, equally useful as a method for analyzing food security. The Sustainable Development Goal 2, part of the United Nations' set of 17 goals, known as 'Zero Hunger,' aligns with this food security definition. Its objective is to eradicate hunger and ensure universal access to safe, nutritious, and sufficient food throughout the year, with a target to achieve this by 2030. This commonly acknowledged definition highlights the various dimensions of food security, including food availability, access, utilization, and stability (FAO, 2006).

Food availability: Ensuring an ample supply of food, both in terms of quantity and quality, through domestic production or imports (including food aid).

Food access: The ability of individuals to obtain sufficient resources (entitlements) to acquire nutritious food that aligns with their dietary needs. Entitlements encompass the range of commodity options that individuals can command based on the legal, political, economic, and social structures of their community, including customary rights such as access to communal resources.

Utilization: Utilizing food to attain a state of nutritional well-being, where all physiological requirements are met through a balanced diet, access to clean water, sanitation, and medical care. This emphasizes how crucial non-food inputs are to ensuring food security.

Stability: A population, household, or individual must always have access to enough food to be considered food secure. The risk of losing access to food due to unforeseen shocks (such as economic or climatic crises) or cyclical events (like seasonal food insecurity) should be minimized. Therefore, the notion of stability encompasses both the availability and access aspects of food security.

2.1.2. Theories of food security

Several theories and frameworks have been developed to understand food security. Some of the prominent ones are:

Entitlement theory: Proposed by Amartya Sen, this theory emphasizes the role of individuals' entitlements and capabilities in accessing food. According to Sen (1982), food security is not solely determined by the availability of food but is influenced by individuals' entitlements and capabilities to access food. Entitlements refer to the various means through which individuals can acquire food, such as income, assets, and social support networks. Capabilities, on the other hand, involve the ability to convert entitlements into actual access to food. Sen argues that food security challenges are often rooted in issues of inequality and distribution rather than absolute scarcity. He emphasizes the importance of examining the broader socio-economic and political context in which food security is situated. For example, poverty, unequal distribution of resources, and social and economic structures can create barriers to food access and lead to food insecurity.

The entitlement theory highlights the significance of understanding the diverse factors that shape individuals' access to food. It recognizes that ensuring food security goes beyond increasing food production but also requires addressing issues of inequality, poverty, and social exclusion (Leach et al., 2020). By focusing on entitlements and capabilities, the theory provides a comprehensive perspective on food security, enabling policymakers and practitioners to identify and address the underlying causes of food insecurity and develop effective interventions.

Entitlement theory can be applied to analyze the food security situation of beekeepers. According to this theory, an individual's ability to access food and achieve food security

is determined by their entitlements, which are the set of resources and capabilities they have at their disposal. Regarding beekeepers, their entitlements can include factors such as access to land for beekeeping, availability of bee forages (nectar and pollen sources), access to water, access to markets for selling honey, and knowledge and skills related to beekeeping practices. The food security status of beekeepers is influenced by their entitlements, as they rely on these resources and capabilities to maintain healthy bee colonies and produce honey. Factors that negatively impact their entitlements, such as loss of land or decline in bee forages due to environmental changes, can lead to reduced food security for beekeepers and their households. Therefore, understanding and addressing the entitlements of beekeepers is crucial for promoting their food security and sustaining their livelihoods.

Sustainable livelihoods approach (SLA): The sustainable livelihoods approach considers food security as part of broader livelihood strategies. It examines the interactions between various capitals (natural, social, human, physical, and financial) and their influence on food security (Scoones, 1998). The SLA recognizes that food security is influenced by a range of factors beyond food production, including access to resources, income, social networks, and institutions. It emphasizes the interconnectedness of different livelihood assets - natural, social, human, physical, and financial - and their role in shaping food security outcomes. The approach recognizes the complex and multidimensional nature of food security and the need for integrated interventions.

The sustainable livelihoods approach theory can be applied to assess the food security status of beekeepers by considering various dimensions that contribute to their overall well-being. This approach highlights the significance of diversifying livelihood strategies, enhancing assets, promoting access to resources, fostering social networks, and improving institutions. To apply this theory to beekeepers, it is essential to support them in diversifying their income sources beyond honey production, for instance, by providing training and resources for value-added activities like beeswax processing or pollen collection. Enhancing their assets can involve facilitating access to modern beekeeping equipment, technologies, and financial services. Promoting access to resources entails ensuring the availability of land with abundant floral resources and

promoting sustainable land use practices. Fostering social networks can be attained through facilitating platforms for knowledge sharing among beekeepers and connecting them to markets and beekeeping associations. Lastly, improving institutions requires establishing policies that safeguard beekeepers' rights, regulate pesticide use, and promote sustainable beekeeping practices. By adopting a sustainable livelihood approach, beekeepers can enhance their food security and build resilient livelihoods to overcome challenges.

Ecological resilience theory: This theory explores the relationship between ecological systems and food security. It recognizes the importance of maintaining ecological resilience, biodiversity, and sustainable resource management to ensure long-term food security (Walker et al., 2004). The theory emphasizes the need to understand and manage the interactions between ecological components, such as soil health, water availability, and biodiversity, and their effect on food production. By promoting sustainable agricultural practices, ecosystem conservation, and adaptive management approaches, Ecological Resilience Theory offers insights into building resilient food systems capable of withstanding environmental shocks and disruptions.

Ecological resilience theory can be applied to examine the food security status of beekeepers by examining the capacity of beekeeping systems to endure and recover from disturbances. Applying this theory to beekeepers involves promoting biodiversity in the surrounding landscape to ensure a diverse and abundant supply of nectar and pollen sources for bees. It also entails encouraging the maintenance of diverse bee genetic stocks to enhance resilience against diseases and pests. Additionally, enhancing adaptive capacity involves providing beekeepers with knowledge, skills, and resources to respond to changing environmental conditions and emerging challenges such as climate change. By applying ecological resilience theory, beekeepers can improve their food security by building systems that are more robust and better able to withstand disturbances, ultimately ensuring the long-term sustainability of beekeeping as a livelihood.

2.2. Empirical Literature Reviews

2.2.1. Urban agriculture in Ethiopia

Urban agriculture and food production in cities have recently experienced huge growth in interest. In response to concerns about the safety and sustainability of our existing food systems, many people in cities are looking for ways to produce more of the food they eat within the city itself (Berquist et al., 2012). A significant aspect of this trend involves the increasing popularity of urban beekeeping. Supporters of urban beekeeping contend that it can be a secure and beneficial endeavor, offering various environmental, economic, and social advantages for both practitioners and cities. Urban agriculture holds the potential to make a meaningful contribution to food security across all four dimensions.

The existing agricultural land has experienced significant degradation, characterized by erosion, declining fertility, loss of biodiversity, and an increased presence of resilient soil-borne pathogens, pests, and weeds (Bridges & Oldeman, 1999; Bai et al., 2008; FAO and ITPS, 2015). A significant portion of this phenomenon can be attributed to the extensive adoption of unsustainable, intensive farming methods. These practices include cultivating high-yielding crops in monocultures with limited genetic diversity and relying heavily on synthetic fertilizers and pesticides (Sánchez-Bayo & Wyckhuys, 2019). Despite the adverse environmental impacts associated with these practices, the prevailing narrative surrounding global food security continues to promote an approach that prioritizes intensifying agricultural production as the primary solution. Nevertheless, it is crucial to highlight that the main challenges of hunger and malnutrition are typically not rooted in insufficient food supply, but rather in issues of affordability and access (Holt-Giménez & Altieri, 2013). Therefore, it is crucial to prioritize the empowerment and support of regenerative, biodiverse smallholder farms and local food systems in any discussion concerning sustainable agriculture and food security (FAO, 2017).

Considering this, urban agriculture has emerged as a viable strategy to enhance local food security by augmenting the availability and accessibility of fresh and nutritious produce in food-insecure urban areas (Zezza & Tasciotti, 2010). By shifting some food

production to high-demand areas, urban agriculture can also mitigate greenhouse gas emissions linked to lengthy food supply chains, offer fresher and healthier produce compared to imported goods due to reduced transportation time, and alleviate strain on existing agricultural land (Kulak et al., 2013; Wilhelm & Smith, 2018).

The majority of urban agriculture practitioners in Addis Ababa and the nearby small towns are individuals with low incomes who engage in urban agriculture primarily for their survival, benefiting from a blend of nutritional and socioeconomic advantages. Their practices involve livestock rearing, particularly dairy cows, sheep, and chickens, beekeeping, and the cultivation of rain-fed and irrigated crops, primarily vegetables, in various locations such as homesteads, riverbanks, school compounds, and open fields. The urban agriculture sector in Addis Ababa and the surrounding towns comprises different entities, including individuals, farmers organized in micro-enterprises and cooperatives, as well as a few commercial enterprises. The role of urban agriculture in this region can generally be categorized into two groups: the first category involves farming in backyard areas and open spaces around houses and riverbanks, while the second category is found in peri-urban areas located within a reasonable distance from residential areas, including farmlands and protected forests. Dairy farming and vegetable production are the predominant activities within the realm of urban agriculture (Delelegn and Mulugeta, 2018)

The document reviewed for this study shows the significant roles played by urban agriculture in the socio-economic development, food security, and livelihoods of residents in Addis Ababa and the neighboring towns. Urban farming makes a substantial contribution to the local food supply. For instance, according to a report from CSA (2007) cited by Delelegn & Mulugeta (2018), urban agriculture accounts for 30% of vegetable production, 60 to 70% of milk production, and 40 to 60% of egg production consumed in Addis Ababa. Despite these notable contributions in various aspects, urban agriculture's role in employment is relatively minimal, estimated to be only 3% in Addis Ababa. Gebremichael et al. (2014) cited by Delelegn & Mulugeta (2018) highlighted that over 50% of household heads in Addis Ababa are involved in service sectors, while nearly 40% work in manufacturing, repairing, and construction sectors, leaving only a small portion involved in urban agriculture.

2.2.2. Beekeeping roles and practices in Ethiopia

Beekeeping, known as apiculture, encompasses all practical management activities related to social bee species (FAO, 2021). Beekeeping offers humans a range of valuable hive products, including honey, wax, propolis, pollen, and royal jelly. Additionally, it provides essential services such as pollination, apitherapy, Apitourism, and environmental monitoring. Beyond these practical benefits, beekeeping also plays significant economic, cultural, and social roles (SNV, 2012, FAO, 2021).

Ethiopia has a wide-ranging agroecological and climatic zone supporting a diverse and unique natural and cultivated flora well suited to beekeeping. Beekeeping is a traditional activity for an estimated 1.4 million rural households in Ethiopia. The country is the world's 10th largest honey producer and the 4th largest beeswax producer. There are five distinct wild bee species and an estimated 5-10 million bee colonies in Ethiopia. In the Ethiopian tradition, 80-90% of honey is used to produce local honey wine called ‘Tej’ (SNV, 2012).

Despite its long history beekeeping in Ethiopia is still underdeveloped (Edessa, 2005). The knowledge and skills of Ethiopian farmers in honey production and beeswax extraction have remained very traditional and highly inefficient, yielding an average production of 5-7kg per colony per year. Regarding volume of production, the country produces about 129,000 tons of honey annually (CSA, 2021). An assessment done with selected households revealed that cash income from the sale of honey and beeswax accounts for one-third of the total household income for rural households involved in beekeeping activities. The contribution of honey towards income generation and poverty alleviation could be even higher as the country has the potential to produce up to 500,000 tons of honey and 50 thousand tons of beeswax per year (SNV, 2012).

When the socioecological impact of beekeeping becomes a deliberate objective, it can be considered as beekeeping for the city-dwellers. In this context, urban beekeepers perceive their beekeeping activities as a means of environmental and social activism, actively participating in the urban fabric. It represents ecological citizenship (Light, 2003). Beekeeping of a city involves reimagining the role of nature in urban lifestyles through fostering interspecies relationships. This form of urban beekeeping captures

public attention due to its intentional public engagement, often accompanied by vocal advocacy and invitations for community participation.

Urban beekeeping plays a significant role in the economy. Urban beekeepers variously sell their products. These include the direct sale of hive products and their derivatives, such as honey, wax, pollen, and propolis. Additionally, urban beekeepers offer services such as managing hives on behalf of individuals or businesses through contractual arrangements. In the case of many urban beekeepers, the economic benefits derived from beekeeping serve as supplementary sources of income. However, there are instances where beekeeping becomes a primary livelihood for urban beekeepers, and in some cases, it even creates employment opportunities for others. An important yet interconnected aspect of urban socio-ecological value revolves around the importance of hive products as a distinctive representation of the local neighborhoods they originate in. The promotion of localized food consumption and adoption of alternative food practices, like shopping at farmer's markets, are frequently praised for their ability to facilitate community cohesion through shared and relational experiences (Eigenbrod, & Gruda, 2015).

Most flowering plants rely on animal pollinators, either fully or partially, to produce fruits and seeds (Ollerton et al., 2011). Among pollinators, bees hold the utmost significance (Willmer et al., 2017). While wild bees and other insect pollinators contribute significantly to pollination, often attributed to managed honeybees (Garibaldi et al., 2013), the honeybee possesses special value as a pollinator due to its widespread distribution and amenability to human management. Nevertheless, the role of honeybees as pollinators in urban environments remains largely unexplored, and their importance is likely to vary considerably across specific urban contexts. Before assuming that the presence of honeybees will enhance pollination services for crops or wild plants, it is important to establish two factors: (1) the existence of a deficiency in pollination services and (2) the role of honeybees as pollinators in the relevant plants (Melathopoulos et al., 2015). Even in cases where these conditions are met, the traditional monetary assessment of honeybee pollination services may not be directly applicable in urban systems, where the link between pollination and the sale of agricultural products is not consistently observed. However, it is reasonable to

acknowledge that most plants in urban areas likely benefit from honeybee pollination, even though this service is not extensively studied and is challenging to quantify. Nonetheless, the value of honeybee pollination is appropriately acknowledged as an asset of urban beekeeping. When strategically incorporated into the cultivation of pollinator-dependent crops within urban agricultural systems, beekeeping can become an integral part of a broader interconnected framework encompassing social, ecological, and technological aspects. It serves as a stewardship mechanism that bridges the gap between the social and natural realms (Markolf et al., 2018).

2.2.3. Food security status in Ethiopia

Ethiopia, with a population of approximately 123 million people as of 2022, ranks as the second most populous nation in Africa, following Nigeria. The country's economy is one of the fastest growing in the region, with an estimated growth rate of 6.4% in FY2021/22 (World Bank, 2023). Despite this economic growth, Ethiopia faces significant challenges regarding food security, making it one of the most food-insecure and famine-affected countries. A considerable portion of the population experiences chronic and transitory food insecurity. The food security situation in Ethiopia is closely intertwined with recurring food shortages and famines, often attributed to factors such as drought, crop failure, land degradation, livestock diseases, internal conflicts, political instability, and the impact of COVID-19. According to the FAO (2018), about 29.1% of the Ethiopian population lives below the national poverty line. The Global Hunger Index further highlights the extent of food insecurity in Ethiopia, with an alarming figure of 32.1 million people facing hunger, ranking it as one of the most hunger-stricken countries worldwide. According to estimates 35.1% of the population is undernourished or experiencing hunger (WFP and CSA, 2020; CSA, 2021).

2.2.4. Determinants of beekeeping practice

Previous research conducted by Tigist (2023), Mekonnen (2021), Andaregie and Tessema (2021), and Ababulgu et al. (2021) has shown evidence that a variety of factors, including changes in the population and demographics, technology, infrastructure, market forces, and macroeconomic policies, have an impact on beekeeping. It is suggested in the literature that at a household level, beekeeping

practice is influenced by agro-climatic conditions and risk; access to infrastructure and market; resource endowment of community and household; factor and input markets; institution and law; social and cultural factors affecting consumer preferences, production, and market opportunities and constraints.

Tigist (2023) conducted a study on the contribution of socio-economic factors on income generation among urban apiculture households' in Gullele sub-city of Addis Ababa. The study indicated that factors such as the number of years of experience in beekeeping, the availability of professional beekeeping assistance, experience in swarm catching, production potential, and the availability of honey forage all have a significant and positive correlation with beekeepers' income. The research concludes that socioeconomic factors play a crucial role in generating income through beekeeping, and beekeeping itself has a substantial positive impact on household income.

Mekonnen (2021) conducted a study on the analysis of urban apiculture and its contributions to household food security in Kolfe Keranio sub-city of Addis Ababa. The author employed a multiple regression to determine factors affecting urban apiculture production. The findings indicated several significant factors. Firstly, the size of the apiary land area, the use of wax foundation, the number of transitional and improved (modern) hives, the frequency of extension contacts, the price of honey, access to swarms, and the level of experience in urban beekeeping were all found to have a positive influence on urban apiculture production. However, it was observed that the age of the household head harmed the production of urban apiculture.

Andaregie and Tessema (2021) conducted a study on determinants of beekeeping adoption by smallholder rural households in Northwest Ethiopia. The authors employed a nonlinear econometric (binary logistic regression) model. The results of maximum likelihood estimation indicated that several variables had a statistically significant influence on beekeeping adoption in the study area. These variables include sex, marital status, household size, educational status of the household head, number of extension visits, membership in a farmers' association, and access to credit.

Ababulgu et al. (2021) conducted a study on the analysis of the economy of beekeeping and honey supply in Horo Guduru Wollega Zone of Oromia region. The findings

derived from the econometric analysis demonstrate that colony size, the type of beehives utilized, beekeeping equipment, market information, current honey price, frequency of extension contact per year, and training all exerted a positive and significant influence on honey supply.

Based on the above empirical evidence, it can be possible to conclude that most of the factors influencing beekeeping practices differ from one area to another. Hence, the difference in the production system of the location of the study area leads to variations in the factors affecting beekeeping practices.

2.2.5. Contributions of beekeeping for household food security

Mekonnen (2021) conducted a study on the analysis of urban apiculture and its contributions to household food security: the case of Kolfe Keranio sub-city in Addis Ababa. The author utilized ordered logit models to examine the factors influencing urban beekeeper household food security. The results confirmed that the educational status of the household head, utilization of wax foundation, access to credit, experience in urban beekeeping, and availability of apiary land all have a significant and positive impact on urban beekeeper household food security. Conversely, family size was found to have a negative effect on household food security among urban beekeepers. This research concludes that urban beekeeping plays a significant role in enhancing household food security.

Beekeeping contributes to food security, poverty reduction, employment creation, and income generation in the majority of sub-Saharan Africa (Mutua Caroline Nzula, 2018). Beekeeping offers direct and indirect benefits to rural and urban people. Directly, beekeeping subsidizes household income from hive product sales and provides food, safe medicines, and raw materials for industries. Indirectly, beekeeping contributes to watershed management, forest conservation, and crop pollination. In their studies, (Chaplin-Kramer et al., 2014), found that bees are responsible for one-third of food crops planted and produced by humans.

A review report conducted by Fikru (2015), highlights the significant role of beekeeping in Ethiopia in generating income and diversifying the livelihoods of

smallholder farmers and landless youth. The report indicates that beekeeping has a promising opportunity to create employment for smallholders in both rural and urban areas of the country.

Maurice (2006) argues that beekeeping can help to conserve the environment mainly in three interconnected ways: increasing the number of honeybees in an area should improve the pollination success of numerous flowering plant species; the income generated from beekeeping can help to alleviate pressure on the local resource base, and there is a potential to alter the way the people view their local environment. Honeybee pollination improves the quality, quantity, and market value of food crops. With all the above benefits, it is believed that beekeeping can improve the living standards of the urban poor and food security status.

2.2.6. Determinants of household's food security

Combinations of natural and manmade factors have directly affected and enhanced the food insecurity problems in many parts of Ethiopia. The immediate causes of food insecurity include frequent drought and shortage of rainfall distribution patterns, resource degradation, and rapid population growth. Furthermore, limited adoption of technologies, inadequate rural infrastructure, and the persistence of historical policy constraints are recognized as fundamental factors contributing to food insecurity and widespread poverty in the country. Other factors that contribute to the prevailing state of food insecurity and poverty among Ethiopians include fluctuations in crop production, limited off-farm employment opportunities, insufficient income levels, and market fragmentation (Leonard, 2019).

Beekeeping plays a vital role in enhancing food security, reducing poverty, creating employment opportunities, and generating income. Most flowering plants rely on animal pollinators, with bees being the most significant group of pollinators (Ollerton et al., 2011). However, it cannot be assumed that the introduction of honeybees to an environment will automatically enhance pollination services for crops or wild plants without first confirming the existence of a pollination deficit and establishing honeybees as effective pollinators for the specific plants in question (Melathopoulos et al., 2015). By strategically integrating beekeeping into the cultivation of pollinator-

dependent crops within urban agricultural systems, it has the potential to become an integral part of the urban landscape, functioning within an interconnected social, ecological, and technological framework that nurtures the interdependence of the social and natural realms (Markolf et al., 2018). The food security of beekeepers in urban areas is mostly affected by drought, shortage of rainfall patterns, deforestation, household income, and market price, which together determine the purchasing power of the residents.

Koirala and Thapa (1997) assert that income security is a prerequisite for achieving food security. Beekeeping is widely acknowledged as a beneficial practice that can enhance the livelihoods of impoverished communities with minimal investment costs (Baptist and Punchihewa, 1983). Beekeeping is an important source of income. Theoretically, support to urban beekeepers in increasing the productivity and yield from beekeeping, addressing the challenge and constraint above could contribute to improvement in the status of household food security. Therefore, this study seeks to examine the contribution of beekeeping to household food security in Addis Ababa.

2.2.7. Challenges and opportunities of beekeeping

Dibaba (2023) conducted a study on opportunities and challenges of apiculture development in Dambi Dollo Town, Western Ethiopia. The study showed that the major opportunities found in the study area for urban beekeeping were suitable climate, bee forage plant availability, sufficient rainfall, water, and honeybee density. On the flip side of these opportunities, the high cost of modern hive equipment inputs, improper agrochemical use, and beeswax were the challenges of urban beekeeping. Andaregie and Tessema (2021) conducted a study on determinants of beekeeping adoption by smallholder rural households in Northwest Ethiopia. The author grouped the constraints to beekeeping adoption into three significant groups: marketing constraints, natural constraints, and financial constraints.

Reda et al. (2018) conducted a study on beekeeping practice and honey production potential in Afar Regional State, Ethiopia. The findings of this study demonstrate that the primary obstacles to honey production in the area include recurring drought, inadequate extension services, limited access to improved technology, and

deforestation, among others. As a result, interventions are necessary to address these challenges by providing training and introducing improved production systems that can bring about a transformation in traditional beekeeping practices.

Ababulgu et al. (2021) conducted a study on determinants of Honey Supply by Smallholder Farmers in Horro Guduru Wollega. The result showed that the major constraints of honey production and supply were the scarcity of bee forage, indiscriminate agrochemical application, pests, and predators, rain at harvesting time, drought, absconding and migration, lack of knowledge and extension support, poor infrastructure, market problem, lack of beekeeping equipment and honey collection centers.

In a study conducted by Taye and Marco (2014) in the Wonchi district of the Southwest Shewa Zone in Oromia, the researchers assessed the constraints and opportunities of honey production. The major constraints identified in the study area were as follows: the high cost of modern hives with accessories (ranked 1st), a shortage of bee forage (ranked 2nd), pests and predators (ranked 3rd), poisoning of bee colonies (ranked 4th), low quality of honey products (ranked 5th), and inadequate infrastructure development (ranked 6th). Despite these challenges, the study also highlighted future opportunities for beekeeping development in the district. These opportunities included a significant number of existing bee colonies, the presence of tourists in the area, a steady increase in the demand for local honey, the presence of beekeeper associations, and favorable government policies.

Beekeeping makes a direct contribution through the production of various outputs, including honey, beeswax, queen and bee colonies, as well as other products like pollen, royal jelly, bee venom, and propolis, which find applications in cosmetics and medicine (SNV, 2012). Ethiopia benefits from abundant forage availability and favorable agro-climatic conditions, which support the growth of over 7,000 species of flowering plants and the thriving of numerous local bee colonies. It is estimated that there are over two million bee colonies in the country. Beekeeping is deeply ingrained in the lifestyle of farming communities in Ethiopia, and it is a common practice in almost every settled area, except for a few extreme regions. Moreover, Ethiopia boasts one of the longest

traditions in beeswax and honey marketing among African countries (Kennard & Bamford, 2020).

Ethiopia has enormous untapped potential for promoting beekeeping; both for local use and export purposes. However, similar to other livestock sectors, the beekeeping sub-sector faces complex constraints. The specific production constraints within the beekeeping sub-sector vary depending on the agroecology of the respective areas where the activities are carried out. According to the Holeta Bee Research Centre and Ethiopian Beekeepers Association EBA (2016), the major constraints in the beekeeping sub-sector are lack of beekeeping knowledge, shortage of skilled manpower, shortage of bee equipment, pests, and predators, the threat of pesticides, inadequate infrastructure development, a scarcity of bee forage, insufficient research extension services, and low productivity and quality of bee products. These constraints pose significant economic challenges for beekeepers. Even though constraints in urban beekeeping have not been studied in Ethiopia, Urban beekeeping specifically faced different constraints such as:

Social fear of honeybees' sting: Honeybees typically sting in the vicinity of their hive, usually as a response to a disturbance. Even though the beekeepers know this fact, most of the population of the urban-dwelling communities has developed a fear of the stings of the honeybees. Therefore, it is crucial to consider the potential risk of bystanders getting stung when assessing the suitability of beekeeping in urban settings. Hence, prioritizing the minimization of sting-related risks becomes essential when keeping bees in densely populated areas. This can be accomplished through measures such as implementing signage, installing fencing, strategically placing beehives, and practicing meticulous colony management (Moraitopoulos et al., 2015).

Hive and Site Requirements: An important consideration in urban beekeeping is colony density, which plays a significant role in determining the potential negative impacts such as resource competition and the transmission of pests and pathogens. Evaluating the number of colonies that can be accommodated on a given land parcel and determining the appropriate apiary spacing are crucial aspects to be carefully assessed in urban beekeeping programs. The recommended apiary spacing in rural areas, which allows for sufficient competition gaps between neighboring apiaries

(around 1 km), poses challenges in urban settings as it would either exclude many beekeepers or necessitate impractically large apiaries due to limited space availability (Henry & Rodet, 2018). Furthermore, for most urban beekeepers, the choice of apiary location becomes a subject of debate as their backyards often serve as the only available space for keeping bees.

2.3. Conceptual Framework

The conceptual framework presented in Figure 2.1 below is constructed based on the literature reviewed, previous knowledge of the sector, and a framework described by Ifa (2020), but specifically uses beekeeping to address the aspect of contributing to food security. The framework shows the linkage between study variables affecting the food security status of beekeepers in the study area. Studies indicate that many factors influence beekeeping practices. Factors that affect a household's participation in beekeeping activities are categorized into demographic, natural, socio-economic, and institutional factors. It was hypothesized that these factors affect beekeeping practices and household food security either negatively or positively.

Beekeeping improves the food security status such as food availability, access, utilization, and stability in the household (Fikadu, 2019). It enhances food availability and stability by increasing crop yield through pollination and maintaining biodiversity (Khan, 2018). Additionally, it contributes to an urban green environment including fruits and flowers. Beekeeping improves food access by generating employment opportunities and income sources for some members of the family (Fikadu, 2019). It helps to generate income from sales of honey and other hive products that can contribute to food security by purchasing food from elsewhere. Furthermore, the family can consume balanced and nutritious food from their hive products (Richardson, 2023).

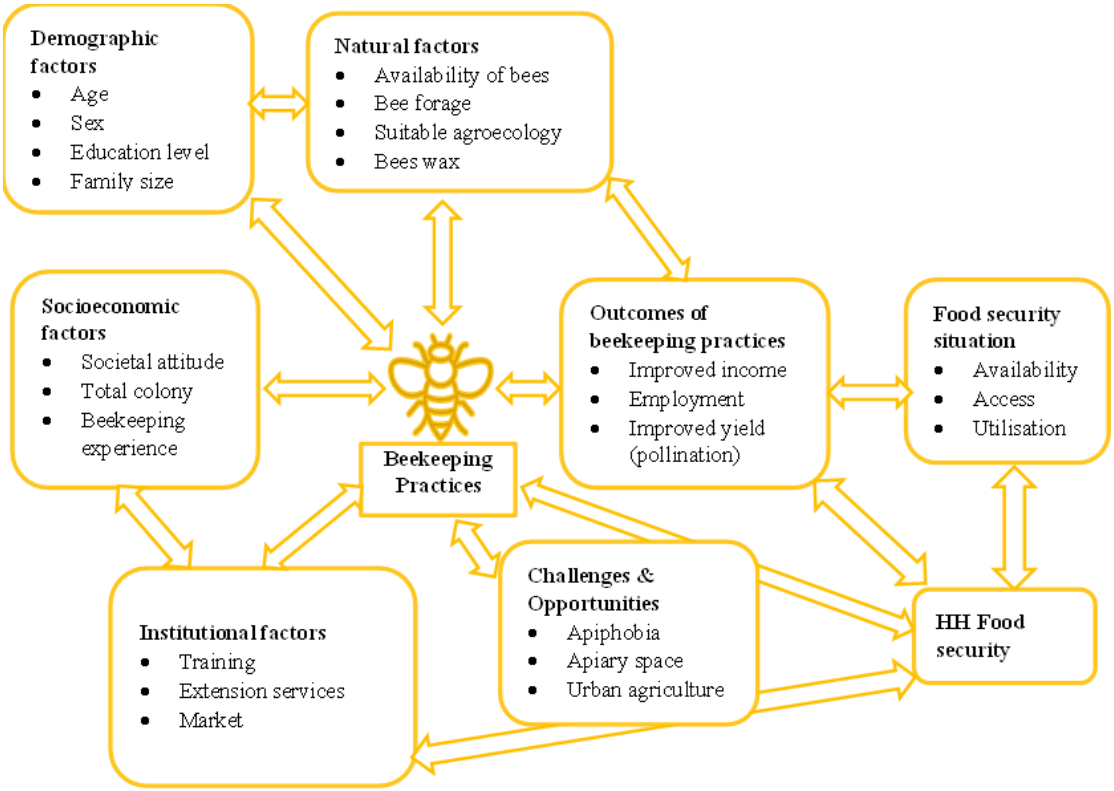


Figure 2.1: Conceptual framework

Source: Modified by a researcher from Ifa (2020)

Beekeeping is vital for food security as it positively impacts agricultural productivity and biodiversity. Bees are crucial pollinators, ensuring efficient pollination and increased crop yields. By providing suitable habitats for bees, farmers can enhance food production. Beekeeping also promotes biodiversity by supporting diverse plant species that benefit bees and the ecosystem. Bee products like honey and beeswax contribute to nutrition and income diversification for beekeepers, strengthening food security at the household level. Recognizing the importance of bees and promoting sustainable beekeeping practices can enhance food security, maintain ecological balance, and support communities worldwide.

Socioeconomic and demographic factors play a significant role in beekeeping. Socioeconomic aspects, including income, beekeeping experience/education, and resource accessibility, influence the success of beekeeping. Limited financial resources can hinder initial investments, while knowledge and training are crucial for effective

beekeeping. Demographic factors like population density and urbanization also impact beekeeping, as urban areas often lack sufficient space for beekeeping activities. Additionally, societal attitudes, traditions, and perceptions of bees and beekeeping influence interest, support, and participation in this practice.

The availability of bee traces, bee forage, and sustainable agroecology are interconnected natural factors that have a significant impact on beekeeping. Bee traces are essential nesting sites and habitats that enable healthy bee colonies to thrive. Inadequate traces hinder beekeeping expansion, negatively impacting pollination services and food security. Bee forage, comprising nectar and pollen-rich flowers, is vital for bee nutrition and colony health. Abundant forage allows bees to gather ample resources, resulting in strong and productive colonies. Insufficient forage leads to malnutrition, weakened colonies, and reduced pollination, affecting crop yields and food security. Implementing sustainable agroecology practices plays a crucial role in creating favorable conditions for bees. It fosters a resilient and vibrant ecosystem that supports bee populations, enhances pollination services, and contributes to food security by increasing crop yields and promoting long-term agricultural sustainability.

It is crucial to promote and address the demographic, natural, socio-economic, and institutional factors for successful beekeeping and improved food security. By creating suitable habitats, preserving natural areas, planting diverse flowering plants, and adopting sustainable agricultural practices, we can support healthy bee populations, enhance pollination services, and ensure the sustainable production of food crops.

CHAPTER 3: DESCRIPTION OF THE STUDY AREA AND METHODOLOGY

In this chapter, an in-depth examination of the research methodology is presented. This encompasses various components such as the description of the study area, the research design and approach, research methods employed, sources of data, sampling design and techniques utilized, as well as the methods employed for data analysis.

3.1. Description of the Study Area

The study was conducted in Yeka sub-city, located in the northeastern part of Addis Ababa, Ethiopia. Yeka is one of the eleven sub-cities within Addis Ababa and consists of 12 woredas. It is situated at a geographical coordinate from 9°2'30" N to 38°48'0" E, with an average altitude of 2,400 meters above sea level. The sub-city covers a total land area of 85.98 sq. km, surrounded by mountainous terrain. The presence of the Kebenna River within Yeka sub-city contributes to the availability of bee forages.

Yeka sub-city has a diverse population of approximately 497,624 people, comprising different ethnic groups (Yeka sub-city, 2023). The sub-city exhibits a mix of urban and suburban areas. Various economic activities, including commerce, services, and industries, are prominent in Yeka. According to the sub-city's urban agriculture bureau (2022), common agricultural practices include beekeeping, poultry, dairy, and vegetable production. Yeka sub-city is home to around 370 individual beekeepers and 31 beekeeping cooperatives. Among the 12 woredas in the Yeka sub-city, Woreda 2 was specifically selected as the study area due to its higher concentration of beekeepers compared to other woredas. Woreda 2 is located approximately 10 km from the city center and encompasses areas such as Ferensay (Biret dildiy) and Gurara Abbo.

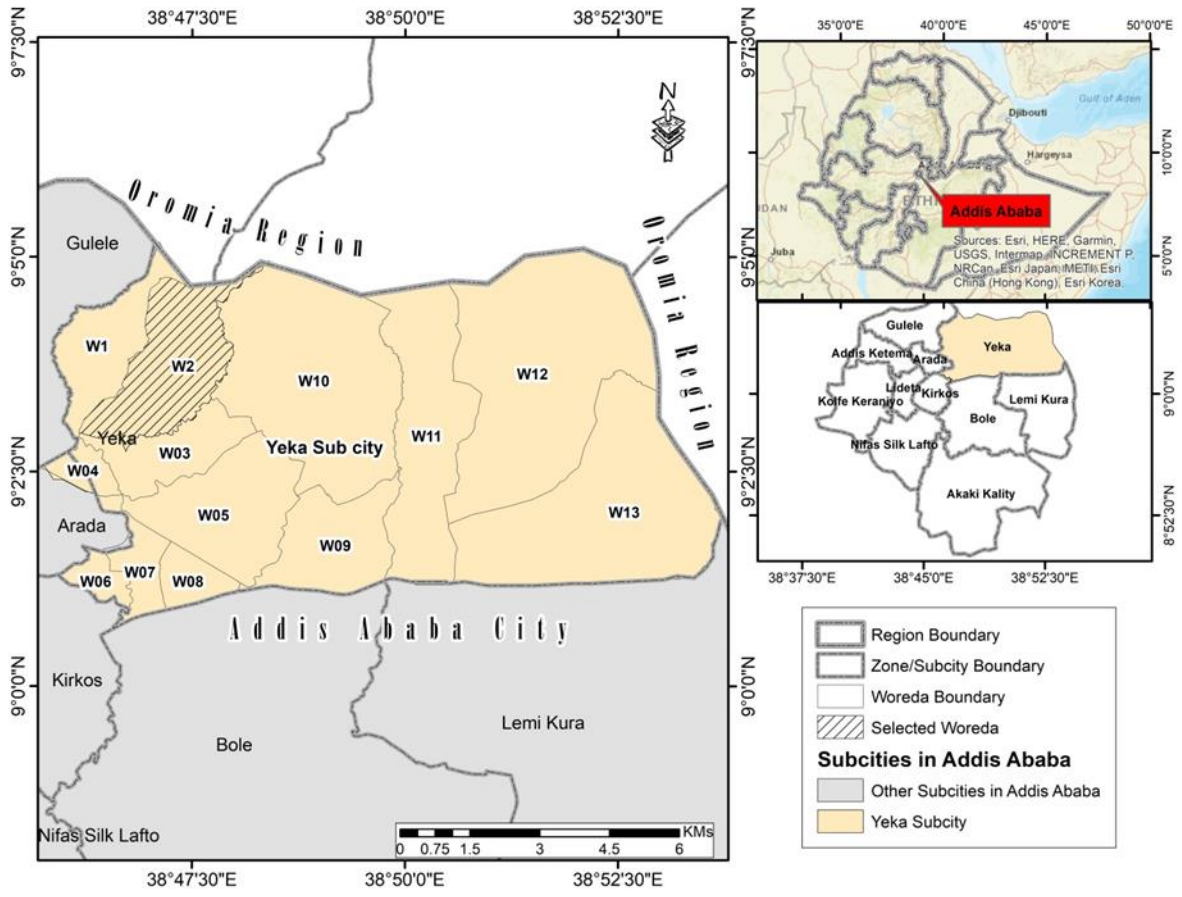


Figure 3.1: Map of the study area, Woreda 02 of Yeka sub-city – Addis Ababa

Source: Own computation based on GIS (2023)

3.2. Research Design and Approach

The research employed a mixed research approach, a combination of quantitative and qualitative data. The mixed-method approach provides a better understanding of a research problem than either quantitative or qualitative data by itself (Creswell, 2012). Because mixed methods are very important for the validation of findings in terms of accuracy and checking personal bias in the research. The sequential explanatory design of the mixed research approch used. This design involves collecting and analyzing quantitative data first, followed by qualitative data to provide further insights or explanations. The qualitative data helps to clarify or expand upon the quantitative findings. Additionally, the research has used a cross-sectional research design. Cross-sectional studies are characterized by the collection of relevant information (data) at a

given point in time. Moreover, cross-sectional studies are exploratory and descriptive in purpose (Kesmodel, 2018).

3.3. Sample Size Determination and Sampling

A double-stage sampling procedure was used to address the objectives of the study. In the first stage, Yeka sub-city and Woreda 2 were selected purposively based on their beekeeping production, production potential and convenience. As shown in the table 3. 1 below, Yeka is the second sub-city with the highest number of beekeepers, following Nefasilk Lafto. Yeka was purposefully selected by the researcher because of its fbeekeeping potential and convenient factors.

Table 3.1: Number of beekeepeers in Addis Ababa

Sub city	**Male**	**Female**	**Total**
Addis Ketema	27	26	53
Akaki Kaliti	117	57	174
Arada	37	29	66
Bole	79	16	95
Gulele	16	50	66
Kirkos	11	3	14
Kolfe Keraniyo	92	43	135
Nefasilk Lafto	130	64	194
Yeka	**132**	**44**	**176**
Lideta	32	22	54
Total	**673**	**354**	**1027**

Source: Addis Ababa city urban agriculture and farmers bureau (2015 EC)

Three hundred fifteen households in Woreda 2 were listed as actively engaged in urban beekeeping, according to the Urban Agriculture and Farmers Bureau (2022). In the second stage, simple random sampling was applied using a random generator (lottery method) to select the study household. The sample size was determined by using the Yamane formula. Yamane formula was applied when the study has a finite, known population, and homogenous population (Yamane, 1967).

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

n= sample size

N=Target population of the study

e= margin of error (precision level)

Therefore, the sample size was calculated as follows:

$n = \frac{315}{1+315(0.05^2)} = \frac{315}{1.7875}$= 176

3.4. Data Type and Methods of Data Collection

The research utilized both primary and secondary sources of data to gather quantitative and qualitative information. A structured questionnaire was developed and administered to beekeepers and relevant respondents in Addis Ababa to collect primary data. Qualitative research methods such as focus group discussions and key informant interviews were also conducted. The qualitative data obtained from these methods were transcribed verbatim, translated, and analyzed. Secondary data was obtained from various sources including published documents, grey literature, prior research, journals, articles, books, websites, and manuals. The researcher reviewed the secondary data to complement the information gathered from the primary data source.

The study employed multiple techniques to collect primary data, including household surveys, focus group discussions, key informant interviews, and field observations. The questionnaire was complemented by the qualitative data collected through focus group discussions and key informant interviews. The participants in these discussions and interviews represented diverse characteristics such as age, education level, job experience, and gender. For this study, three focus group discussions were conducted, and four key informant interviews were held with cooperative beekeepers and local government officials. Before the actual survey, a pilot survey was conducted with 10 randomly selected households to test the data collection instruments, assess question clarity, estimate interview duration, and make necessary revisions to the questionnaire.

Well-trained enumerators with experience in household surveys were hired to collect the data required for the study in the year 2015 EC (2022 GC).

3.5. Method of Data Analysis

Both quantitative and qualitative data analysis techniques were used to address the objectives of the study. Quantitative data generated through questionnaires were systematically analyzed by applying statistical software (STATA Version 17). Qualitative data generated through focused group discussion, key informant interviews, observations, and questionnaires were also analyzed by using narratives.

In this study, both descriptive statistics and econometric analyses were used, and these are explained as follows:

3.5.1. Descriptive analysis

Descriptive statistical techniques, including measures such as mean, standard deviation, and percentages, were employed to analyze the socioeconomic and demographic characteristics of beekeepers in the study area. Graphs and tables were utilized to present and organize the data effectively. Furthermore, inferential statistics such as the chi-square test (for categorical variables) and one-way ANOVA test (for continuous variables) were employed to assess any statistically significant differences among beekeepers.

3.5.2. Food security analysis

Food security can be measured in a variety of ways, as the idea itself is somewhat nebulous (FAO, 2008). Kilocalories consumed is the gold standard for measuring the consumption of food and is widely accepted as one of the gold standards for food security. The food consumption score is a score which able to capture both dietary diversity and food frequency. Moreover, household food security is a function of the availability of food within the country and the level of household resources that are necessary to produce or purchase food as well as other basic needs. The current study used household dietary diversity score and food consumption score as a proxy variable

for food security. While the latter denotes the presence of food availability and frequency, the former signifies the presence of food access and diversity.

In this study, three food security analysis techniques, namely the Household Food Insecurity Access Scale (HFIAS), Household Dietary Diversity (HDD), and Food Consumption Score (FCS), were employed to assess the food security status of the study households. Each of these tools offers unique insights into different aspects of food security, and their combined use provides a comprehensive understanding of the household's food security situation. The HFIAS captures the experience of food insecurity, while the HDD and FCS provide information on dietary quality and food consumption patterns.

Household food insecurity access scale (HFIAS): Food access, which reflects the demand side of food security, has recently been designated as one of the major contributors to food insecurity. In 2006, the Household Food Insecurity Access Scale (HFIAS) was introduced by the USAID-funded Food and Nutrition Technical Assistance Project as a tool to measure the access component of household food insecurity. HFIAS was designed to be user-friendly, easily applicable, and adaptable to different socio-cultural contexts with minor adjustments. HFIAS captures three key domains: 1) anxiety and uncertainty regarding food access, 2) insufficient food quality in terms of variety, preferences, and social acceptability, and 3) inadequate food intake and its physical consequences (Gebreyesus et al., 2015). The scale consists of two types of questions. The first type, referred to as occurrence questions, includes nine items that ask whether specific conditions associated with food insecurity were experienced in the previous four weeks (30 days). Each severity question is followed by a frequency question, which inquires about the frequency of occurrence of the reported conditions within the specified time frame (Coates et al., 2007).

The HFIAS score serves as a continuous measurement of household food insecurity (access) within the past four weeks (30 days). To calculate the HFIAS score, a variable is created for each household by summing the codes assigned to each frequency-of-occurrence question. A higher score indicates a higher level of food insecurity (access) experienced by the household, while a lower score indicates a lower level of food insecurity (access). The HFIAS indicator categorizes households into four levels of

food insecurity (access): food secure, mildly food insecure, moderately food insecure, and severely food insecure. As households affirmatively respond to more severe conditions and/or experience those conditions more frequently, they are categorized as increasingly food insecure.

Household dietary diversity (HDDS): is a measure of the total number of different food groups eaten in the previous 24 hours by any household member at home, including food prepared at home but eaten outside, such as a snack or lunch (Ayele Tiyou *et al*., 2012). This measure is a reflection both of food availability and food access, on the premise that households consume a variety of foods when they have the means to acquire them. HDDS is a simple and easily administered method and classifies each food item consumed by the household into twelve different food groups. A food group is counted only once, regardless of the number of times it was consumed over the last 24 hours, our reference period. This means that the HDDS ranges from a minimum of one to a maximum of 12. A high HDDS reflects a diverse diet and suggests food security while a low HDDS is indicative of food insecurity (Hirvonen *et al*., 2016).

According to FAO (2010), cited by Admassu and Beneberu (2019) household dietary diversity is the number of different foods or food groups consumed over a given reference period. The household dietary diversity score is an attractive proxy indicator for food security and the socioeconomic capacity of a household as it is highly correlated with caloric, protein, and nutrient adequacy, household income, and child nutritional status (Hoddinott and Yisehac, 2002; Swindale and Bilinsky, 2006; Webb *et al*., 2006). Dietary diversity is an indicator that assesses the qualitative aspect of food consumption within a household, indicating the range of different foods available and consumed. It serves as a proxy measure for the nutritional adequacy of individuals' diets. Respondents were asked whether they consumed the 12 food groups and their "yes" responses were coded as 1 and the negative responses "no" were coded as 0 (INNDEX Project, 2021). The next step is summing the dietary diversity variable values of all new food groups and, the potential score ranges from 0 to 12 for HDDS. The higher score indicated that households consumed more diversified food groups. The HDDS of ≤ 3, 4-5, and ≥ 6 imply low, medium, and high dietary diversity respectively.

Food consumption score (FCS): According to FAO (2008) cited by Marivoet (2019) food consumption score is a composite measure that considers dietary diversity, food frequency, and the relative nutritional significance of various food groups. This score can be calculated by evaluating the frequency of consumption of different food groups within a household during the seven days preceding the survey (Hoddinott, 2001). The food consumption score is a proxy indicator of household caloric availability (Marivoet, 2019). The following four procedures are important to calculate the FCS, these are: (i) group all the food items (the 16 food items) into specific food groups (12 food groups), (ii) sum up the consumption frequencies of food items of the same group, and recode the value of each group above 7 as 7, (iii) multiply the value obtained for each food group by its weight (the standard weights for main staples 2, pulses 3, vegetables 1, fruit 1, meat and fish 4, milk 4, sugar 0.5, oil 0.5, condiments 0) and create new weighted food group scores and, (iv) sum the weighed food group scores, thus creating the food consumption score. Based on this score, a household's food consumption can be classified into one of three categories: poor, borderline, or acceptable. FCS of 0-21, 21.5-35, and >35 indicated poor, borderline, and acceptable household consumption respectively.

3.5.3. Econometrics analysis

Regression analysis is a multivariate technique that examines the relationship between dependent and independent variables. It assumes a normal distribution of data and a linear correlation between constructs (Wooldridge, 2012). The current study aims to identify factors determining beekeeping practice in Yeka sub-city, Addis Ababa, Ethiopia. Previous studies have utilized various econometric models such as ordered Probit, ordered logit, multinomial logit, multiple linear regression, and interval regression to identify determinants of beekeeping practice. These studies have employed household, individual, and community-level regression analysis, considering community-level factors, household demographic characteristics, human and physical capital, and access to institutional services (Table 3.1). In this study, household-level regression analysis is applied.

A multiple linear regression model was employed to establish the correlation between a dependent variable and two or more independent variables. The current study focuses

on honey production as the dependent variable, measured in kilograms It is an extension of simple linear regression, which involves only one independent variable. The objective of multiple linear regression is to create a model that captures the relationship between the independent variables and the dependent variable by fitting a line to the observed data. This line can then be used to make predictions of the dependent variable by considering the values of the independent variables (Wooldridge, 2012). Multiple linear regression can be utilized in the field of beekeeping to identify the factors that influence various beekeeping practices (Wallisch, 2022).

The model specification of multiple linear regression was addressed below.

$$Y = B0 + B1X1 + B2X2 + \cdots . + BPXP + \varepsilon$$

Where:

Y is the dependent variable (Honey production in Kg).

X1, X2, ..., Xp are the independent variables (Age of head, sex of head, credit access, access to forage etc.).

β0 is the constant (shows the value of Y when the value of X=0).

β1, β2, ..., βp are the regression coefficients (shows how much Y changes for each unit change in X).

ε is the error term

In multiple linear regression, the coefficient signifies the alteration in the dependent variable when there is a one-unit change in the associated independent variable while keeping all other independent variables constant. The selection and exclusion of independent variables in a regression equation are referred to as model specification (Wooldridge, 2012). It is crucial to carefully choose the most appropriate regression model to prevent specification errors that could undermine the validity of your findings.

The second objective of the study was to investigate the role of beekeeping practice in food security status. Previous studies adopted ordered Probit, ordered logit,

multinomial logit, multiple linear regression, and interval regression models to examine the role of beekeeping practice on households' food security. The current study measures food security using ranking orders like low, medium, high, and poor, borderline, and acceptable food security status. The study was conducted ordered probit model over other possible models.

The ordered Probit model is a commonly employed method for estimating ordinal dependent variables or ordered response models, where the potential values of the dependent variable exhibit a natural ordering. This model, initially introduced by Aitchison (1957), serves as a generalization of Probit analysis to accommodate more than two outcomes for an ordinal dependent variable. The specification of the ordered Probit model is cited as follows.

$$Y = \sum_{k-1}^{k} \square\, BkXki + \varepsilon i$$

Where:

Y → the dependent variable (micro, and small enterprise growth)

Xi-The independent variable to be estimated.

β1- 7 → is the coefficient, in which every marginal change in employee commitment.

εi → the error term

Additionally, the probability of observing the particular ordinal outcome will be organized as:

$$Y * = Xib + ei$$

Where Y* are an ordered response model, xi is the linear combination of different predictors, ei is the standard normal disturbance.

3.6. Major Regression Tests (Model Assumption Tests)

Before fitting the regression, the study has checked normality, multicollinearity, heteroskedasticity, omitted variable test, data validity, consistency, and regression parallel assumptions:

Multicollinearity test: Multicollinearity is a term that is used to denote the presence of linear or exact/perfect relationships among explanatory variables. Multicollinearity can arise when there is more explanatory variable than the number of observations, the use of lagged values, and the change of an explanatory variable over time. If two variables are highly collinear, then this will result in inefficient estimates, and the ordinary least square (OLS) will be unbiased because it will have a large variance or infinite. The problem of multicollinearity is likely to be more common in time-series data than in cross-sectional data (Lindesay *et al*.,1997). To check the presence of multicollinearity between variables the study used variance inflation factor (VIF) and pairwise correlation. The result showed that the mean VIF of the data was 1.25. Therefore, there is no multicollinearity in the data.

Heteroskedasticity: An important assumption of the classical linear regression model is that the population disturbances term is homoskedasticity i.e., they all have the same variance. This means that equal scatter of the error terms around the mean. Heteroskedasticity problems can be distinguished using the Goldfield - Quandt test, White's test, and Breusch-Pagan Godfrey test (Wooldridge, 2012). The study used the Breusch-Pagan test and white's test for the results (Prob > chi2 = 0.2051). Based on the result showed that the study failed to reject the null hypothesis of constant variance and the researcher did not conduct different heteroskedasticity robust procedures (Appendix Table 1).

Normality: In statistics, normality refers to the assumption that when multiple independent random samples are collected from a population and a value of interest (such as the sample mean) is calculated, the distribution of these sample means will form a perfect bell curve when visualized using a histogram. This assumption plays a crucial role in various statistical techniques, including one-sample t-test, two-sample t-test, ANOVA, and linear regression. If this assumption is violated, the reliability of the

test results is compromised, and we cannot confidently generalize our findings from the sample data to the overall population. Accordingly, there is no normality problem in the data set tested by shaprowilk test, and the skewness kurtosis test (Appendix Table 1).

3.7. Description of Study Variable and Hypothesis

3.7.1. Definition of variables

Dependent variables: The dependent variable for the analysis was annual honey production measured in kilograms. Additionally, the study used food security status as a dependent variable to examine beekeepers' food security status.

3.7.2. Independent variables

The independent variables are those variables assumed to determine the beekeeper's food security status. These variables are related to the household demographic, socioeconomic, and institutional factors, and these are explained as follows:

Age of the household head: Age is a quantitative measure expressed in years, and it can exhibit either a positive or negative correlation with the amount of honey produced. The age of the household head is crucial in determining productivity levels and the adoption of innovative beekeeping techniques. Although advanced age can bring experience and resources that enhance honey production, a study conducted by Tigist (2023) found that age has a positive association with beekeeping practices. Additionally, older household heads are more likely to have greater experience and knowledge in beekeeping practices, thus positively impacting household food security. Studies by Gebremedhin et al. (2012) and Tadesse & Algayer (2018) indicate a positive correlation between the age of household heads and their engagement in agricultural practices, including beekeeping, leading to improved household food security. Consequently, being young is likely to have an inverse association with beekeeping practices.

Sex of the household head: This is a dummy variable that is measured as 1 if the household head is male and 0 otherwise. Since female household heads are responsible

for many domestic activities, they may not properly manage their apiaries. Furthermore, men can participate in training and communicate with different actors which can enhance the household's access to information, services, and more knowledge than women which can boost its production and productivity. A study conducted by Andaregie and Tessema (2021) sex of the household head affects beekeeping practices positively. Counterfactually, female-headed households are likely to benefit more from beekeeping practices in terms of enhancing food security due to their active involvement and resourcefulness. Research by Alene et al. (2019) suggests that female-headed households tend to allocate more resources towards food security measures and are more receptive to innovative agricultural practices, including beekeeping. Therefore, being male is expected to affect beekeeping production positively.

Education of the household head: It is a continuous variable that is measured in the formal schooling years of the household head. A household with a better education level is believed to apply scientific knowledge and better manage its apiary and lifestyle in a good manner, hence improving production to fulfill household demand. Literate or households with higher grade education are expected to have better skills and better access to information, and the ability to process information is expected to have a positive effect on household food security status. Education level has affected food security status positively according to a study conducted by Mutua Caroline Nzula, (2018). Additionally, higher levels of education among household heads positively influence the adoption of improved beekeeping practices and subsequently contribute to household food security. Findings from studies by Degefa et al. (2016) and Abate et al. (2020) demonstrate a significant association between the education level of household heads and their propensity to adopt modern agricultural techniques, including beekeeping, leading to enhanced food security. This may help them to produce efficiently and thus is expected to be positively associated with food security.

Family size: Household size includes active workers, babies, and old-aged members of the family. It is the total number of people living in the household working for and dependent on the household for their living. It is measured by the adult equivalent ratio or man equivalent ratio. Ababulgu Nasir et al. (2021) conducted a study that revealed an interesting finding - a larger family size was found to be associated with higher

participation in beekeeping in urban areas. However, it is important to consider that households with a smaller family size may face resource constraints, such as a lack of available labor, which could limit their beekeeping production. Conversely, households with larger family sizes may experience competition for limited resources, potentially leading to restricted beekeeping production. on the other hand, larger family sizes may necessitate higher food production and income-generating activities such as beekeeping, thereby positively affecting household food security. Research by Gebrehiwot et al. (2015) and Alemu et al. (2017) suggests that larger family sizes often drive households to diversify their income sources, including beekeeping, to meet the food and economic needs of all members. Given this context, the variable of household size is hypothesized in this study to have either a positive or negative relationship with beekeeping production.

Frequency of extension contact: It is defined as the frequency of extension officers contacting beekeepers and vice versa, which is measured by the number of extension contacts per month. The information obtained from extension workers has the power to increase the awareness and know-how of beekeepers towards improved technologies. As the extension workers frequently visit and follow up with beekeepers, they may obtain important and influential information (Mekonnen Ayele, 2021). Furthermore, a higher frequency of extension contacts increases access to beekeeping knowledge and resources, leading to improved beekeeping practices and consequently enhanced household food security. Studies by Tesfaye et al. (2019) and Lemma et al. (2021) highlight the positive impact of extension services on agricultural practices, including beekeeping, resulting in increased productivity and food security among participating households. This variable may have a positive relationship to beekeepers' food security.

Beekeeping experience of the household: This is a continuous variable measured in years. It refers to the total number of years that the sample household has been engaged in beekeeping practices. A household with high experience in beekeeping gains knowledge and wider skills that can improve production and productivity (Wallisch C., 2022). Beekeeping experience contributes to food security by providing nutritious honey, supporting pollination for increased crop yields, generating income, and promoting sustainable agriculture. It enhances dietary diversity, improves food

availability, and fosters resilient farming practices, ultimately contributing to a sustainable and secure food supply. Previous experience in beekeeping positively influences the adoption of advanced techniques and management practices, thereby contributing to household food security. Research by Melaku et al. (2018) and Getachew et al. (2020) indicates that households with prior beekeeping experience exhibit higher levels of proficiency in hive management and honey production, translating to improved food security outcomes. Beekeeping experience has a positive relationship with beekeepers' food security status.

Honeybee colony holding: This is a continuous variable that refers to the total number of honeybee colonies a household has. The more the number of colonies, the more the production and increased profitability and higher income of the beekeeper to ensure food security (Schouten, 2020). Another study conducted by Kimaro (2013) found that plenty of colony affects beekeeping productivity positively, which later may affect the beekeeper's food security status. Similarly, greater ownership of honeybee colonies correlates with increased honey production and income generation, subsequently enhancing household food security. Studies by Tefera et al. (2017) and Alemayehu et al. (2021) demonstrate a positive relationship between the number of honeybee colonies held by households and their economic well-being, including food security status.

Off/non-farm activity: It is a dummy variable that takes a value of 1 if any household member engages in non-farm activities, such as petty trading or other non-beekeeping agricultural activities, and generates income from it. If there is no participation in such activities, the variable is set to 0. It can be assumed that the non-farm income earned by a household initially goes towards purchasing food grains and meeting non-food requirements for household members. The access to non-farm income among farmers may enable them to allocate additional resources to beekeeping-related expenses. A study conducted by Chaplin-Kramer et al. (2014) demonstrated that engagement in off/non-farm activities, along with targeted policies, can lead to improved food security outcomes for beekeepers. Engagement in off/non-farm activities complements beekeeping income, leading to diversified income sources and improved household food security. Research by Gebremariam et al. (2016) and Ayenew et al. (2019) suggests that households involved in off/non-farm activities alongside beekeeping

exhibit greater resilience to economic shocks and enhanced food security. Therefore, in this study, it is hypothesized that off-farm income has a positive association with household food security.

Credit access: Credit access is a dummy variable that takes the value 1 when the beekeepers take credit and otherwise. It is an advantage for the development of the beekeeping business. Furthermore, beekeepers who have access to credit are more likely to get beekeeping inputs and equipment (Melathopoulos et al. (2015). Access to credit facilities enables households to invest in beekeeping infrastructure and inputs, thereby enhancing productivity and food security outcomes. Studies by Hailemariam et al. (2018) and Woldegiorgs et al. (2020) indicate that credit access positively influences investment in agricultural enterprises, including beekeeping, leading to improved food security among beneficiary households. Therefore, it is hypothesized that access to credit determines beekeepers positively beekeepers' food security status.

Input access: This is a dummy variable indicating whether the beekeeper has obtained the necessary resources and components during the production season. Inputs encompass various physical and intangible factors involved in the production process. Physical inputs include land, water, technology, and personal protection equipment, while intangible inputs encompass knowledge, information, and market access. Improved beehive technologies, such as modern hives, protective clothes, and effective management practices, have a positive impact on honey production efficiency. These technologies enhance hive productivity, reduce losses, and promote better bee health (Andaregie and Astatkie, 2021). Adequate access to beekeeping inputs such as hives, equipment, and bee colonies may positively influence beekeeping productivity and household food security. Research by Abebe et al. (2015) and Demeke et al. (2019) highlights the significance of input access in beekeeping, with improved access leading to higher honey yields and economic benefits for households, consequently enhancing food security. Therefore, the study hypothesizes a positive association between input access and honey production.

Market information: The variable is also a dummy variable that takes a value of 1 if the household has obtained market information or 0 if not. Beekeepers make market decisions by relying on market price information. However, if markets are poorly

integrated, they may transmit inaccurate price information, resulting in inefficient movement of products. A study addressed by Reda et al. (2018) showed that beekeepers who have market information not only support livelihoods but also contribute to food security and environmental well-being. Access to timely market information enables beekeepers to make informed decisions, optimize honey sales, and enhance household food security. Studies by Girma et al. (2014) and Seifu et al. (2021) suggest that households with access to market information networks achieve better prices for their honey products, contributing to improved income and food security outcomes. Therefore, the variable is expected that it may have a positive relationship with beekeeping production, and food security as well.

Training access: it is also a dummy variable that takes a value of 1 if the household has obtained training in beekeeping practice or 0 if not. Training enables to development of knowledge about the importance of beekeeping, and this may enhance the household to participate more in the beekeeping business. In a study conducted by Jeil et al. (2020), participating in beekeeping-related training has a boost to ensure food security status. By equipping households with the knowledge and skills necessary for successful beekeeping practices, this training contributes to enhanced beekeeping skills, increased honey production, promotion of pollination services, diversification of income sources, and adoption of sustainable farming practices. Through these contributions, beekeepers play a vital role in optimizing honey production, supporting crop pollination, and fostering sustainable agricultural practices, all of which are essential for a stable and secure food supply. Additionally, participation in beekeeping training programs enhances knowledge and skills, leading to improved beekeeping practices and may subsequently contribute to household food security. Research by Admasu et al. (2016) and Fikadu et al. (2020) demonstrates the positive impact of training interventions on beekeeping knowledge, management practices, and income generation, ultimately enhancing food security among trained households. Access to training is hypothesized to affect a household's food security status positively.

Access to forage: The variable is also a dummy variable that takes a value of 1 if the household has access to bee forage or 0 if not. Bee forage provides essential pollination services to crops which may enhance crop yields, pollinated fruits, vegetables, and nuts,

and ecosystem health, leading to increased food availability. contribute to balanced nutrition (Masehela, 2017). Accordingly, the study hypothesis is that access to bee forage may have a positive contribution to food security.

Access to wax: The variable is also a dummy variable that takes a value of 1 if the household has access to bee wax or 0 if not. Access to wax contributes not only to maximizing honey production but also to income, cosmetics, pharmaceuticals, and overall household well-being, positively influencing food security. Access to wax is crucial for maximizing honey production. It enables bees to construct vigorous honeycombs, helps prevent swarming, promotes comb honey production, and creates opportunities for value-added products. By ensuring a steady supply of wax, beekeepers can optimize their honey production and contribute to food security by providing a stable and abundant source of honey. A study by Bogdanov (2004) shows beeswax used for foundation, which is probably the main use, for cosmetics, pharmaceutical products, candles, and other purposes. Furthermore, the availability of beeswax enables value addition and diversification of beekeeping products, thereby enhancing income and food security for households. Studies by Teshome et al. (2018) and Chala et al. (2022) indicate that access to beeswax facilitates the production of value-added products such as candles, cosmetics, and pharmaceuticals, contributing to increased income and food security among beekeeping households. Therefore, it is hypothesized that access to wax have a positive relationship with beekeeping practice and food security status.

Table 3.2: Expected outcome and variable hypothesis for honey production

Variable (Item)	Measurement (Unit)	Variables expected hypothesis with Honey production
Age of head	Year	(-/+)
Sex of head	1=male 0=female	(+)
Education level	In grades	(+)
Family size	Adult Equivalent ratio	(-/+)
Credit access	1=yes 0=no	(+)
Input access	1=yes 0=no	(+)
Market information	1=yes 0=no	(+)
Frequency of extension contact	Number of contacts in month	(+)
Access training of honeybee	Number of oxen owned	(+)
Access to forage	1=yes 0=no	(+/-)
Access to wax	1=yes 0=no	(+)
Off/non-farm	1=yes 0=no	(+)
Access to quality hives	1=yes 0=no	(+)

Source: Own computation based on literature (2023)

CHAPTER 4: RESULTS AND DISCUSSION

Within this chapter, the results of data analysis obtained from both primary and secondary data collection are presented. The chapter consists of six sub-sections, covering various aspects. These include the demographic and socioeconomic characteristics of beekeepers, beekeeping practices, household food security status, factors influencing beekeeping practices, as well as the challenges and opportunities associated with beekeeping practices.

4.1. Demographic and Socio-economic Characteristics of the Respondents

Table 4.1: Variables and results of respondents

Variables (Items)	Number	Percent	Variables	Mean
Sex of head (male)	102	57.95	Age of household head in years	45.11
Credit access (yes)	144	81.82	Education level in grade completed	9.34
Input access (yes)	104	59.09	Average Family size	4.56
Market information (yes)	117	66.48	Number of extension worker contacts	1.47
Access to training (yes)	131	74.43		

Source: Own computation (2023)

Table 4.1 provides an overview of the demographics and socioeconomic characteristics of a sample of 176 household beekeepers. The table presents various variables and their corresponding measurements, as well as the expected results. Most of the heads of households are male (57.95%), with an average age of 45.11 years. Approximately 81.82% of the beekeepers have access to credit, while around 59.09% have access to beekeeping inputs. Regarding market information, 66.48% of the beekeepers reported having access to it. On average, there are 1.47 monthly contacts for training on honeybee extension.

4.2. Beekeeping Practice in Yeka Sub-city

4.2.1. Types of hives

In the study area, beekeeping practices involve three main types of hives: traditional, transitional, and framed. Traditionally, beekeepers predominantly use hives for catching a honeybee swarm in forested areas. According to data from Table 4.2, 7.39% of beekeepers utilize traditional hives. The majority (61.93%) of beekeepers have adopted modern framed hives, while 30.68% prefer transitional hives. Among traditional hives, 5.68% are individually owned, and 1.70% are corporate-owned. Transitional hives rank as the second most used type, accounting for 21.02% of the total sample. Of these, 21.02% are privately owned, while 9.66% belong to corporations. Framed hives emerge as the most popular choice in the sub-city, with 51.70% of households using privately owned framed hives. Additionally, 10.23% of framed hives are corporate-owned. Notably, the ownership of hives and the specific types of hives show statistically significant differences at a 10% level of significance (as indicated in Table 4.2)**.**

Table 4.2: Types of hive and hive distribution by household

Types hives	Ownership status			X^2
	Private (%)	Corporate (%)	Total	
Traditional hive	5.68	1.70	7.39	4.79*
Transitional hive	21.02	9.66	30.68	
Framed hive	51.70	10.23	61.93	

Source: own computation (2023)

Across the study area, the average annual crude honey production varies by hive type. Specifically, traditional hives yield an average of 12.61 kg of honey annually. Transitional hives also contribute an average of 12.98 kg of honey. Framed hives, on the other hand, generate approximately 13.78 kg of honey annually. There is no statistically significant mean difference in honey production based on hive type. This

is because the beekeepers may apply a similar management system regardless of hive type (as indicated in Table 4.3).

Table 4.3: Honey yield by type of hives

Types of hives	Honey yield per kg	
	Mean	F-test
Traditional	12.61	
Transitional	12.98	6.91
Framed	13.78	

Source: Author owns computation (2023)

On average, beekeepers harvested 13.44 kg of honey annually, with a maximum yield of 32 kg. Their income ranged from a minimum of 200 ETB to an average of 1754 ETB. The income of beekeepers remains low due to their practice of consuming the majority of the honey they produce and only selling the remaining portion to their local community. Majority of the beekeeping practice in the study area focuses on producing honey primarily for household consumption, with any surplus honey and being sold locally or at markets. Additionally, the average beekeeping experience was approximately 3 years (Table 4.4).

Table 4.4: Honey production, income, and experience

	Min	Max	Std.	Mean
Annual honey amount in kg	2	32	7.59	13.44
Amount money gained from bee	200	35000	3664.97	1754.14
Beekeeping experience	1	4	0.88	2.63

Source: own computation (2023)

4.2.2. Input availability for beekeeping practices

In the context of beekeeping, essential factors include wax, forage, and hives for optimal honey production. Let’s break down the findings: About 47.73% of the

sampled beekeepers had access to wax, which positively impacts honey production, Conversely, 52.27% of households did not have access to wax. Approximately 61.36% of the sampled households had access to forage which mentioned that their homes were conveniently located near an apiary. However, 38.64% of households lacked easy access to forage. The majority (65.91%) of sampled beekeepers faced challenges in obtaining quality hives according to their preferences. In contrast, 34.09% of beekeepers managed to acquire hives from private suppliers and government to meet their needs (Table 4.5). These insights highlight the importance of addressing wax availability, ensuring proximity to forage sources, and improving hive accessibility for successful beekeeping practices.

Table 4.5: Input availability for beekeeping

Types of input	Responses	
	Yes (%)	No (%)
Access to wax	47.73	52.27
Access to forage	61.36	38.64
Access to quality hive	34.09	65.91

Source: own computation (2023)

4.3. The Household Food Security Status

4.3.1. Household food security status as measured by food consumption score

Food consumption score is a composite score computed based on dietary diversity, food frequency, and relative nutritional importance of different food groups. The relative nutritional importance of the food groups was used as a weight in the computation of the composite score (WFP, 2008). For the current study, households were asked about the frequency of consumption of different foodstuffs during the 7 days preceding the date of the survey.

Table 4.6: Description of food consumption score

Types of food groups	Mean	Standard deviation
Main staples	5.23	1.24
Pulse and legumes	3.93	1.60
Vegetables and leaves	2.76	1.6
Fruits	0.63	1.55
Meat, fish, and eggs	0.30	0.67
Milk and milk products	1.52	1.9
Sugar sweat	4.44	1.08
Oils, fat, and butter	3.77	1.55
Condiments species	3.53	1.96

Source: own computation (2023)

Table 4.6 presents data on household food consumption scores for various food groups, including their mean values and standard deviations. The mean food consumption score for main staples is 5.23, with a standard deviation of 1.24. Pulse and legumes have a mean score of 3.93, with a standard deviation of 1.60. Vegetables and leaves have a mean score of 2.76, with a standard deviation of 1.6. Fruits have a mean score of 0.63, with a standard deviation of 1.55. Meat, fish, and eggs have a mean score of 0.30, with a standard deviation of 0.67. Milk and milk products have a mean score of 1.52, with a standard deviation of 1.9. Sugar sweet has a mean score of 4.44, with a standard deviation of 1.08. Oils, fat, and butter have an average score of 3.77, with a standard deviation of 1.55. Codominant species have a mean score of 3.53, with a standard deviation of 1.96. The food consumption score represents the quantity and variety of food consumed by households, where a higher score indicates better food security and a lower score suggests lower food security.

Based on the result, the research has observed that the main staples have the highest mean food consumption score, indicating that they are a significant component of the household's diet. On the other hand, fruits, meat, fish, and eggs have relatively lower mean scores, indicating a lower consumption of these food groups. It is important to note that the interpretation and significance of these scores may vary depending on the

context and the specific population being studied. Factors such as cultural preferences, dietary patterns, and availability of food items may influence the food consumption scores.

Table 4.7: Food consumption score

Food consumption score	Categorization rule	Frequency	Percent
Poor food consumption score	0-21	10	5.68
Borderline food consumption score	21.5-35	81	46.02
Acceptable food consumption score	>35	85	48.30

Source: own computation (2023)

Within the Food Consumption Score framework, households are categorized into three groups: those with poor consumption, borderline consumption, and acceptable consumption scores. The data presented in Table 4.7 reveals that only a negligible proportion of the surveyed households achieved an acceptable food consumption score. The majority of households (48.30%) fell into the acceptable food consumption category. The proportion of households with borderline consumption scores was 46.02% (81). Of the selected households 5.68% had poor food consumption score

4.3.2. Household food security status as measured by household dietary diversity score

Table 4.8: Household dietary diversity score

Types of food groups	% Yes	% No
Cereals	71.02	28.98
Vegetables	76.70	23.3
Fruits	69.89	30.11
Meat	68.75	31.25
Egg	71.59	28.41
Fish and other sea food	69.89	30.11
Legumes nuts seeds	69.89	30.11
Milk and milk products	71.59	28.41
Oils Fats	69.32	30.68
Sweets	70.45	30.55
White root	72.16	27.84
Spices, condiments & beverages	72.16	27.84

Source: own computation (2023)

Table 4.8 presents the results of measuring household food security status through the household dietary diversity score. The score indicates if households consume specific food groups, with "Yes" indicating consumption and "No" indicating non-consumption.

Based on the HDDS finding, the study observed that 71.02% of households consume cereals, while 28.98% do not. For vegetables, 76.70% of households consume them, while 23.3% do not. In the case of fruits, 69.89% of households consume them, while 30.11% do not. Regarding meat, 68.75% of households consume it, while 31.25% do not. For eggs, 71.59% of households consume them, while 28.41% do not. Similarly, 69.89% of households consume fish or other seafood, while 30.11% do not. When it comes to legumes, nuts, or seeds, 69.89% of households consume them, while 30.11% do not. In the case of milk and milk products, 71.59% of households consume them, while 28.41% do not. For oils and fats, 69.32% of households consume them, while

30.68% do not. Sweets are consumed by 70.45% of households, while 30.55% do not. White root vegetables are consumed by 72.16% of households, while 27.84% do not. Finally, Spices, condiments, and beverages are consumed by 72.16% of households, while 27.84% do not.

The study observed that vegetables had the highest consumption rate among households, with 76.70% of households consuming them. Meat, fish, and other seafood, oil fats, fruits, legumes, and nut seeds had relatively lower consumption rates, ranging from 68.75% to 69.89% of households. Cereals, eggs, milk and milk products, sweets, white root vegetables, spices condiments, and beverages had similar consumption rates, ranging from 71.02% to 72.16% of households. These findings indicate variations in dietary diversity and food consumption patterns among households. The variations may be influenced by factors such as cultural norms, seasonal availability of food items, and socioeconomic conditions.

Under household dietary diversity score, households are classified into three categories: those with low, medium, and high dietary diversity scores. Table 4.9 showed that a very small number of the surveyed households had low dietary diversity scores. Of the selected beekeepers 13.07% had low dietary diversity scores. The proportion of households with medium diversity was also 13.07% (23). The majority (73.86%) of the households had high diversity.

Table 4.9: Status of the household dietary diversity score

Household Dietary Diversity Score	Categorization rule (0-12)	Frequency	Percent
Low dietary diversity score	HDDS≤3	23	13.07
Medium dietary diversity score	HDDS is b/n 4-6	23	13.07
High dietary diversity score	HDDS>6	130	73.86

Source: own computation (2023)

A household that had poor FCS with low HDDS had collected an annual honey yield of 4 kg. Among households with borderline FCS and low dietary diversity, 16.12 kg of honey was harvested. Those with acceptable FCS, and high HDDS had collected 19.04

kg annually. In the borderline FCS category, households with moderate dietary diversity produced 22.1 kg of honey. Among households with acceptable FCS and medium HDDS, 18.11 kg of honey was harvested. Similarly, households that had borderline FCS with high HDDS collected an annual honey yield of 16.51 kg. In the poor FCS category, households with high dietary diversity produced 15.65 kg of honey (Figure 4.1).

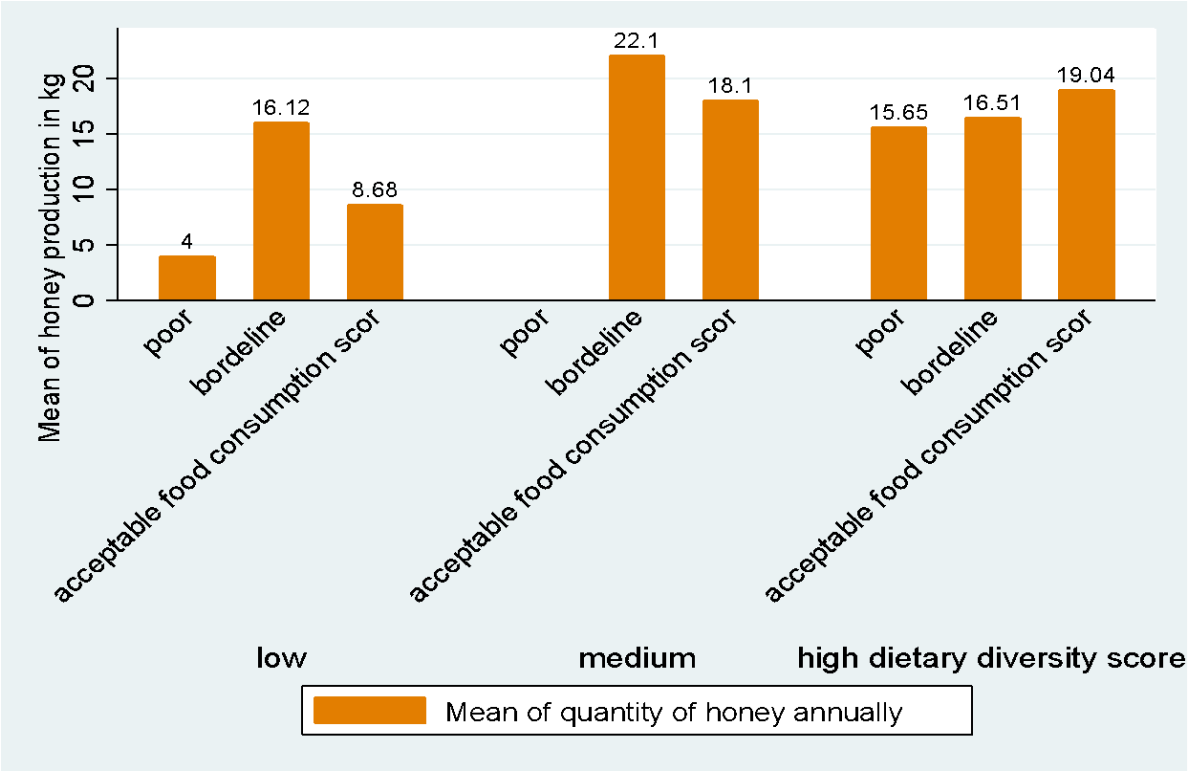


Figure 4.1: Relationship between quantity of honey, and food security status

Source: own computation (2023)

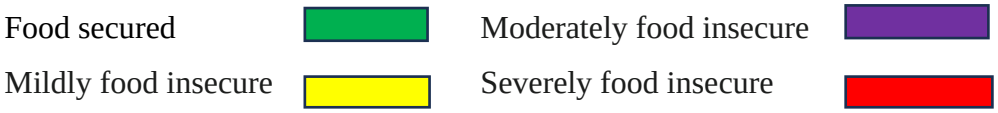
4.3.3. Household food security status as measured by household food insecurity access scale

The survey result showed that 59.09% of the study households experienced some kind of worry fearing that their respective household would run out of food or would not have enough food to eat. About 55.11% of the surveyed households reported that they ate less preferred food at least once over the last 30 days preceding the date of the survey. Of these, 45.46% of the total households experienced the behavior at least three

times in the past 30 days. In the present study's case, 75.57% of the surveyed households reported that their respective household ate a smaller meal at different levels of frequency. The proportion of respondents with ''yes'' answers to the questions if there was a time that no food of any kind in the household observed, any member of the household went to sleep hungry, and any number of households went a whole day and night without eating were 48.3%, 52.84%, 65.91% respectively (Table 4.10).

Table 4.10: Summary of the frequency of the responses to the HFIAS question

HFIAS frequency questions	Happened for the last 30 days in the last year				
	No (%)	Yes (%)			
		Rarely	Sometimes	Often	Total
Worried about food	40.91	26.14	21.02	11.93	59.09
Unable to eat preferred food	45.45	22.73	22.73	8.52	54.55
Eat just a few kinds of foods	44.89	19.89	26.70	8.52	55.11
Eat foods they do not want to eat	28.98	23.30	36.93	10.80	71.02
Eat a smaller meal	24.43	24.43	35.80	15.34	75.57
Eat fewer meals in a day	32.39	58.52	7.39	1.70	67.61
No food of any kind in the household	51.70	46.59	1.14	0.57	48.3
Go to sleep hungry	47.16	44.89	5.11	2.84	52.84
Go a whole day and night without eating	34.09	61.93	3.98	0.00	65.91



Source: Researcher's construction (2023)

A categorical indicator of HFIAS-based food security status categorizes households into four categories: food secure, mildly food insecure, moderately food insecure, and severely food insecure. Food insecurity prevalence was developed based on the categorization scheme of Coates et al. (2007). Table 4.11 shows that only 11.36% (20) of the surveyed households were food secure. All the remaining households were food insecure at different levels. More specifically, 22.04% (39), 35.42% (62), and 31.48%

(55) households had mild, moderate, and severe food insecurity respectively. Despite including the mildly food insecure category within the food secure group, the prevalence of food insecurity remained considerably high at 66.9%. This finding aligns with the results of other similar studies conducted in the country.

Table 4.11: Status of household food insecurity access scale

No	Household food insecurity access scale	Frequency	Percent
1.	Food secured	20	11.36
2.	Mildly food insecure	39	22.04
3.	Moderately food insecure	62	35.42
4.	Severely food insecure	55	31.48

Source: own computation (2023)

4.4. Factors Determining Beekeeping Practices

Before fitting those econometrics models statistical tests such as normality, multicollinearity, and heteroskedasticity problems were tested. VIF was computed to check the existence of multicollinearity between variables that are inserted in ordered Probit and multiple linear regression models. There is no serious multicollinearity problem in the data, VIF =1.25. A heteroscedasticity test (hettest) was also conducted to check the possible heteroskedasticity problem. There is no problem with heteroskedasticity (Appendix Table 1). Therefore, the study did not apply robust heteroskedastic regression to solve the problem. The data normality distribution was also checked using a histogram, Doornik-Hansen test, and skewness/kurtosis test; accordingly, the data is normal. A link test was conducted to check the existence of model specification errors (Figure 4.2).

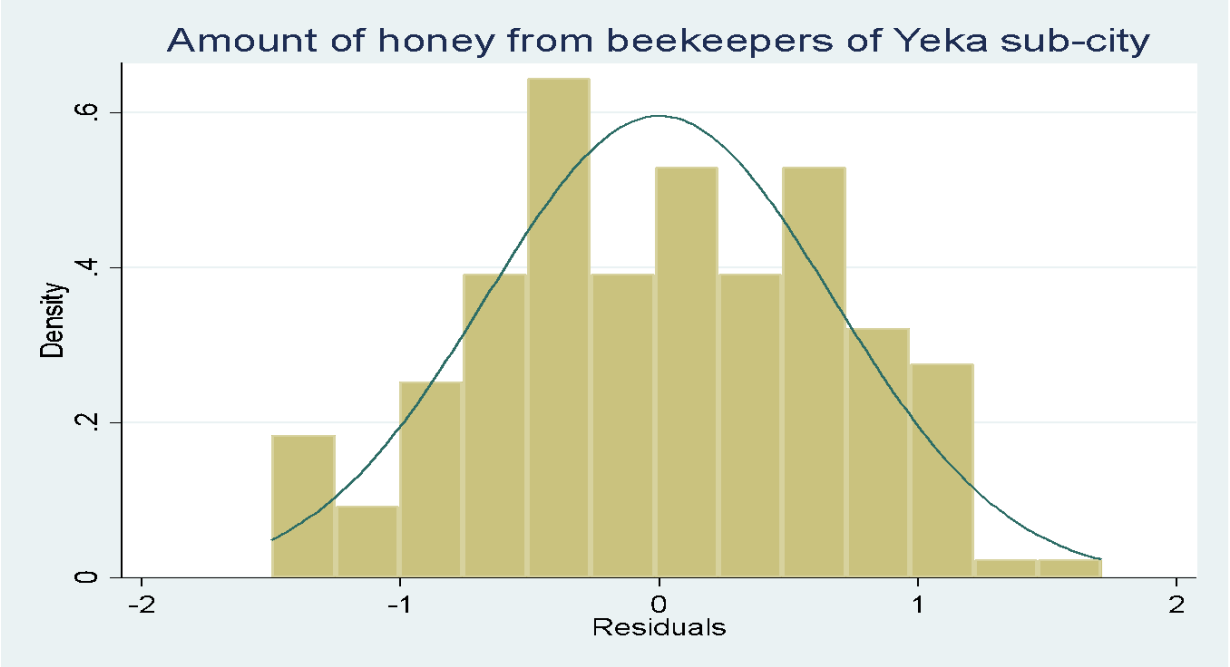


Figure 4.2: Histogram to check the normality of the data and status of honey production

Source: Own survey result (2023)

According to the result in Table 4.12, the likelihood function of the multiple linear regression model for the quantity of honey is highly significant (LR chi2 (15) = 1.90 with Prob > chi2 = 0.024 indicating strong explanatory power of the independent variables. The models passed the overall goodness of fit of the linear regression test. The model result showed that among 12 explanatory variables, 3 variables have significant relationships with the quantity of honey of beekeepers. Those are family size of the head, market information, and access to forage have a significant relationship with beekeepers' quantity of honey (Table 4.12).

Family size: Family size measured as a man equivalent was found to have a positive and significant influence on the quantity of honey at a 5% significance level. The marginal effect shows that as the member of household head increased by one-man equivalent the amount of honey produced increased by 7.2%. The noted correlation implies that larger families may gain advantages from having additional members involved in beekeeping activities**.** In a predominantly agrarian society like Ethiopia, where beekeeping is often a family enterprise, larger households may benefit

from increased manpower available for tending to hives, harvesting honey, and managing colonies, thus leading to higher honey yields. This finding resonates with studies highlighting the positive correlation between household size and agricultural productivity in similar contexts (Asfaw & Admassie, 2004). However, it diverges from findings in more industrialized settings, where larger households might face challenges in coordinating labor or resource allocation, potentially leading to diminished productivity (Davis et al., 2019). The discrepancy underscores the need to contextualize findings within specific socio-economic environments, emphasizing the unique dynamics it plays in Ethiopian rural households and the necessity for tailored interventions to optimize honey production. This result was consistent with the findings of Tigist (2023) that households with larger family sizes were able to produce beekeeping products.

Market information: Market information helps to know output prices to make the right decision, ahead of the production season, regarding which type of products to produce and sell and which products to purchase from the market. Market information significantly and positively affected the quantity of honey at a 1% level of significance. Potential factors could involve educating consumers about the nutritional benefits of honey through market information. Additionally, the growth of the beekeeping industry and subsequent increased demand may lead to improved honey production. Additionally, market information facilitates households' access to details about various honey-related aspects, including pricing**,** seasonal fluctuations**,** and demand for honey, wax, forage, and bee behavior**.** The marginal effect result showed that a beekeeper who has market information increases the amount of money by 48.4%. The result is consistent with the findings of Mutua Caroline Nzula, (2018) which shows that households who have market information can adopt new technologies and may boost honey production.

Beekeeping is a vital source of income for many rural households, access to timely and accurate market information may enable beekeepers to make informed decisions regarding production levels, pricing strategies, and market entry timing. This result aligns with studies emphasizing the role of market information in improving smallholder agricultural outcomes across various contexts (Kariuki et al., 2020).

However, it contrasts with findings suggesting that market information may not always lead to increased productivity, particularly in settings where market access is constrained by infrastructural limitations or where price volatility undermines farmers' confidence in market signals (Minten et al., 2019). The discrepancy highlights the need for targeted interventions to strengthen market linkages and information dissemination channels in Ethiopian beekeeping communities, thereby fostering sustainable honey production and economic development.

Access to forage: As expected access to bee forage significantly and positively affects the quantity of honey at a 1% level of significance. This may be because access to diverse nectar and pollen sources allows bees to collect more food, leading to increased honey production. A variety of forage types ensures a balanced diet for bees, beekeepers near abundant bee forage areas can capitalize on peak flowering periods, maximizing honey collection. Bees foraging in rich environments also contributes to pollination that may enhance flower reproduction, leading to more nectar production and subsequently more honey. Bees communicate forage locations through the waggle dance. Proximity to available forests significantly and positively affected honey production efficiency. The marginal effect result showed that a beekeeper who found access to forage increased the production of honey by 54%. The result agrees with the findings of Mekonnen (2021).

Beekeeping often relies on natural forage resources, and access to diverse and abundant floral sources may directly impact bee health, colony strength, and ultimately honey yields. This result aligns with studies highlighting the importance of forage availability in beekeeping contexts globally, emphasizing the positive relationship between floral diversity and honey production (Garibaldi et al., 2019). However, it contradicts findings suggesting that honey production may not always be solely dependent on forage availability, as factors such as hive management practices, climatic conditions, and beekeeping technologies can also influence productivity (Munyuli, 2016). The inconsistency underscores the multifaceted nature of honey production dynamics and emphasizes the need for holistic approaches that consider both ecological and socio-economic factors to enhance beekeeping outcomes in Ethiopia.

Table 4.12: Determinants of beekeeping practices

Variables	Standard errors	T-value	Marginal effects
Sex of head	0.115	-0.02	-0.002
Education level	0.012	-0.54	-0.006
Family size	0.036	1.99	0.072**
Credit access	0.142	0.52	0.074
Input access	0.112	-0.50	-0.056
Market information	0.168	2.87	0.484***
Fequenc of extension contact	0.053	0.58	0.031
Access training of honeybee	0.126	-0.60	-0.075
Access to forage	0.163	-3.31	0.540***
Access to wax	0.11	0.83	0.091
Off/non_farm	0.109	0.14	0.016
Access to hives	0.117	0.34	0.039
Mean dependent variable=2.510		Observation=176	
F-test =1.902		Prob > F =0.024	
Akaike crit. (AIC)= 391.456		Bayesian (BIC)= 445.354	
** and *** are significant at 5%, and 1 % respectively			

** and *** are significant at 5%, and 1 % respectively

Source: Authors computation (2023)

4.5. Contribution of Beekeeping to Food Security

An ordered Probit model was used to examine the role of beekeeping practice in food security in the study area. The dependent variable is the food security status of sample respondents which has been measured by household dietary diversity, food consumption score, and household food insecurity access scale. The food security of beekeepers was classified into three ordered/interval categorical variables. Therefore, for this nature of data, interval regression, ordered logit and ordered Probit are the possible appropriate models to analyze ordinal or interval variables. In this study interval regression and ordered Probit model were analyzed and compared.

The Probit model result showed the goodness-of-fit test indicates that the selected covariates provide good estimates of conditional density of getting high annual income. The explanatory variables are jointly statistically significant (LR ch2 (13) =30.66; p= 0.0038). In addition, the value of Pseudo R2 was reasonably good (0.12) indicating the good fit of the model.

The parameter estimates of the Probit model provide only the direction of the effect of the independent variables on the dependent variable estimates but do not represent the actual magnitude of change or probabilities. Thus, the marginal effect of the Probit, which measures the probability of being found in the range of annual sales to a unit change in an independent variable was computed. The model result showed that among 12 explanatory variables, 5 variables have significant relationships with food security status. Those are the sex of the household head, quantity of honey, market information, access to wax, and access to forage have a significant relationship with food security status in the study area (Table 4.13).

Sex of household head: The sex of the household head being male was found to positively influence the food security status at a 5% significance level. This result may be because female-headed households are vulnerable to resource constraints like labor, capital, and farming skills, unlike males. Male household heads have held more decision-making power over resource allocation. Moreover, male-headed households may have better access to these resources, enhancing their food security, and may have stronger social networks and community support. More explanations given in the literature for differences between men and women entrepreneurs concerning access to finance can be categorized into discrimination, abilities and preferences, and competition (Melathopoulos et al. 2015). The marginal effects results showed that being a male-headed household increases the probability of being food-secured by 8.3%. This result is in line with the findings of Reda et al. (2018).

The finding that the sex of the household head being male positively influences food security status due to the effect of beekeeping at a 5% significance level may reflect underlying gender dynamics within beekeeping households (Berhanu et al., 2014). In Ethiopian society, where gender roles often dictate access to resources and decision-making power within households, male-headed households may have greater control

over beekeeping activities and resources, leading to improved food security outcomes. This result aligns with studies suggesting that male-headed households tend to have better access to productive resources, including land, capital, and technology, which can enhance agricultural productivity and food security (Doss, 2013). However, it contradicts findings indicating that female-headed households can achieve comparable or even higher levels of productivity through innovative farming practices and access to support services (Quisumbing et al., 2015). The discrepancy underscores the complex interplay of gender, household dynamics, and agricultural livelihoods in shaping food security outcomes in Ethiopia, highlighting the need for gender-responsive policies and interventions to promote equitable access to resources and opportunities for all household members.

Quantity of honey: Quantity of honey is measured as the amount of honey produced by sample beekeepers in kilograms annually. The variable was found to have a positive and significant influence on the status of food security at a 5% significance level. The marginal effect shows that as the amount of honey increased by a kilogram, the status of food secured increased by 0.7%. This may be because consuming honey is a nutrient-rich food containing vitamins, minerals, and antioxidants. Consuming locally produced honey reduces dependence on external food sources. Similarly, the positive relationship may show that a beekeeper promoting beekeeping practices can positively impact both food security and livelihoods. Beekeeping and honey production provide an additional source of income for households. Moreover, increased honey quantity means more sales, which can improve economic well-being and food access. Additionally, bees play a crucial role in pollination which improves crop yields, leading to more diverse and abundant food supplies. Therefore, quantity has a positive contribution to the improvement of food security. This result was consistent with the findings of Wallisch (2022).

Honey production, as a component of beekeeping, not only provides a valuable source of income but also serves as a nutritious food source, thereby enhancing household food security. In Ethiopia, where malnutrition and food insecurity remain prevalent challenges, the ability of beekeeping to generate both economic and nutritional benefits can play a vital role in improving livelihoods and resilience to food shocks (FAO,

2018). This result aligns with studies emphasizing the importance of diversifying income sources and promoting sustainable agricultural practices to enhance food security outcomes (FAO, 2017). However, it may conflict with findings suggesting that the relationship between agricultural productivity and food security is context-dependent and influenced by factors such as market access, income distribution, and dietary preferences (Béné et al., 2019). The discrepancy highlights the need for nuanced approaches to agricultural development that consider the diverse socio-economic and environmental factors shaping food security outcomes.

Access to wax: As expected access to wax exhibits a positive and statistically significant relationship with the food security status at a 10% level of significance. The appropriate justification for this will be if a respondent has easy access to wax, they can effectively engage in honey production, reducing cost and enhancing overall food security. Bees need wax as construction material for their combs. Bees produce wax in their wax glands, which become fully developed in 12- to 18-day-old workers. The main raw materials for wax formation are carbohydrates, i.e., the honey sugars fructose, glucose, and sucrose. The production of wax and the construction of combs in honeybee colonies are influenced by various factors, including nectar flow, brood rearing (egg laying), the presence of a queen, temperature, and the availability of pollen as a protein source (Bogdanov, 2004). The wax economy of bees operates based on the principle of supply and demand, with no wasteful production of wax. In addition to its primary use in foundation production, beeswax is used in cosmetics, pharmaceutical products, candles, and other diverse purposes. The marginal effect result showed that access to wax increased by one unit and improvement of food security probably favors by 6.1%. The result was in line with the findings of Gratzer (2021).

The finding suggests the multifunctional role of beekeeping beyond honey production alone (Tadesse & Algayer, 2018). Beeswax, a byproduct of beekeeping, serves various purposes including candle-making, cosmetics, pharmaceuticals, and food preservation. Therefore, improved access to beeswax may enhance household income diversification and resilience, consequently contributing to improved food security outcomes. This result is consistent with studies highlighting the importance of non-timber forest products, such as beeswax, in rural livelihoods and food security (FAO, 2015).

However, it may diverge from findings suggesting that access to specific beekeeping inputs, such as wax, may not always directly translate to improved food security, especially in contexts where market access, infrastructure, and institutional support are lacking (Berhanu et al., 2014).

Access to forage: Access to forage has a positive and significant relationship with the food security status of beekeepers at a 1 % level of significance. This may be because access to forage is a key factor in the production of honeybees to maximize the yield of honey which may ensure food security. Indirectly, bee forage provides essential pollination services to crops which may enhance crop yields, pollinated fruits, vegetables, and nuts, and ecosystem health, leading to increased food availability and contributing to balanced nutrition. In summary, bee forage may not only directly impact honey production but also pollination and crop yields that contribute to income, nutrition, and sustainable food systems. Therefore, ensuring access to diverse bee forage might be crucial for achieving food security goals. The marginal effect result showed that accessing forage increases the probability of being food-secured by 24.7%. Or the food security status of beekeepers is more likely to increase by 24.7% when bee forage has been accessed. The result was consistent with the findings of Masehela (2017).

Forage availability directly impacts bee colony health, honey production, and ultimately, the economic outcomes of beekeepers. In Ethiopia, where beekeeping often relies on natural forage resources, improved access to diverse and abundant floral sources can enhance honey yields, income generation, and food security among beekeeping households. This result is consistent with studies emphasizing the importance of forage availability in sustaining bee populations and enhancing beekeeping livelihoods (Berhanu et al., 2016). However, it may diverge from findings suggesting that factors beyond forage availability, such as market access, input availability, and beekeeping practices, also influence food security outcomes among beekeepers (Tibebu et al., 2017). The discrepancy underscores the complexity of factors shaping food security in beekeeping communities and the need for integrated approaches that address both ecological and socio-economic determinants.

Market information: Market information had a positive, and significant relationship with food security at a 1% level of significance. The result showed that accessing market information about price, product, and promotions will increase the probability of being food-secured by 17.1%. This may be because when beekeepers have access to accurate market data (such as prices, availability, and trends), they can make informed decisions about production, distribution, and pricing of products. This contributes to stable food supplies and reduces the risk of shortages. In summary, market information may play a pivotal role in ensuring food security by promoting efficiency, risk management, efficient resource allocation, price stability, and informed decision-making across the food value chain. The result is consistent with the findings of Chaplin-Kramer et al. (2014).

In beekeeping communities, where honey production is a significant source of income and food, access to market information can enable beekeepers to make informed decisions regarding pricing, market timing, and value-added opportunities. This result aligns with studies emphasizing the role of market information in improving smallholder agricultural outcomes across various contexts (Kariuki et al., 2020). However, it may conflict with findings suggesting that market access alone may not always guarantee food security, as factors such as input availability, infrastructure, and institutional support also influence agricultural productivity and livelihoods (Minten et al., 2019). The discrepancy highlights the need for comprehensive interventions that address both market access and enabling factors to promote food security and poverty reduction in beekeeping communities.

Table 4.13: Ordered model regression results

Variable	Coefficients	Standard error	Marginal effects
Sex of HH head	0.539	0.228	0.083**
Education level	0.02	0.023	0.003
Family size	-0.068	0.073	-0.011
Credit access	0.089	0.284	0.014
Input access	0.064	0.221	0.010
Market information	1.333	0.367	0.171***
Frequency of extension contact	0.126	0.109	-0.020
Access training of honeybee	0.116	0.242	-0.019
Access to forage	1.251	0.359	0.247***
Access to wax	0.383	0.229	0.061*
Off/non-farm	-0.025	0.217	0.004
Quantity honey produced annually	0.042	0.017	0.007**
Pseudo R-square	0.115		
F-value	Prob > chi2 = 0.0038		

*, ** and*** are denotes 10%, 5% and 1% level of significance

Source: Own survey results (2023)

4.6. Challenges and Opportunities of Beekeeping Practices

The study has applied three focus group discussions and four key informant interviews to assess the challenges and opportunities of beekeeping practice in the study area. It is necessary to adjust the questionnaire to the focus group discussions in triplicate. The discussions from three focus group discussions (FGD) and four key informant interviews (KII) conducted at the Yeka sub-city and sample apiary sites in Woreda 2 were transcribed verbatim. The transcripts were thoroughly reviewed to gain familiarity with the data. Key themes such as challenges and opportunities in beekeeping practices were identified, including input shortages, bee behavior issues, lack of knowledge and skills, space constraints, high input costs, and social opposition. Then open coding was

performed to assign descriptive labels or codes to segments of the data as "input challenges," "bee behavior," "knowledge gap," "space constraints," "input costs," and "social opposition" were used to capture the main challenges and opportunities discussed during the FGDs and KIIs.

The initial codes were organized and categorized into broader themes or categories as input shortages, such as hives, bee colonies, wax, and personal protective equipment, were grouped under the theme of "input challenges", and codes related to social opposition and space constraints were categorized under "Social and Environmental Factors". Then selective coding was conducted to identify the most significant and representative codes. This involved selecting key themes that emerged consistently across the FGDs and KIIs. The coded data were analyzed to draw conclusions and insights from the discussions.

4.6.1 Challenges

It was evident from key informant interviews and focus group discussions that beekeeping in Yeka sub-city faces significant challenges including input shortages such as quality hives, bee colonies, wax, and personal protection equipment, limited space for apiaries, high input costs; bee behavior issues like swarming and absconding, aggressive bee stinging, and apiphobia (irrational fear of bees). These challenges, including poor extension services, knowledge gaps, ant and bird attacks, and apiphobia due to concerns about children's safety and potential conflicts with other animals, are consistent with previous research findings (Belie, 2009; Gratzer et al., 2021; Alemu et al., 2019; Bekele & Kebede, 2020). Additionally, the absence of beekeeping experts within the Woreda Agriculture Bureau structure further compounds the difficulties faced by beekeepers.

The focus group discussion and KII results showed that the price of the input, space limitation, and apiphobia (neighbors' irrational fear of bee stings) are the challenges raised in the discussion. The result is in line with the survey findings presented in Table 4.14 that the majority (40.91%) of the beekeepers had perceived that the price of inputs is expensive. Of total beekeepers, 30.11 were perceived that the price of beekeeping

inputs is fair. The rest 23.3%, and 5.68% of beekeepers perceived as very expensive, and cheap respectively.

Table 4.14: Price perceptions of beekeepers

Perception level	Frequency	Percent
Cheap	10	5.68
Fair	53	30.11
Expensive	72	40.91
Very expensive	41	23.30

Source: Own survey results (2023)

The KII result shows that the sources of beekeeping inputs such as beehives, personal protective equipment, and waxes vary based on factors such as location, access to resources, level of experience, and involvement in beekeeping. Some beekeepers purchase modern hives from commercial suppliers who manufacture and sell beehives, while others construct their own hives. Non-governmental organizations and government initiatives sometimes provide beekeeping training programs that include distributing beehives and other inputs to support beekeepers.

Space limitation and fear of bee stings (apiphobia) are also the raised challenges that limit honeybee production and productivity. According to the survey result 65.91% (116) beekeepers said that their neighbors and family fear bee stings and have complained. Of the sample beekeepers, 34.09% did not fear bee stings, and they were not making a complaint. Additionally, 71.59% of beekeepers had no space for beekeeping production. About 28.41% of beekeepers said that space limitation is not a limitation that hinders honey production (table 4.15).

Table 4.15: Environmental and social factors for beekeeping

Question	Frequency		Percent
Fear of bee sting	Yes	116	65.91
	No	60	34.09
Space for beekeeping	No	126	71.59
	Yes	50	28.41

Source: Own survey results (2023)

The Chaka Project, a significant national development endeavor spanning over 503 hectares of land in Yeka Sub-City, has emerged as a crucial national initiative. However, based on the FGD and KII results, it has been observed that this project has resulted in the displacement of numerous beekeepers who were previously organized within the project site, leaving them with no alternative for relocating their apiaries.

4.6.2 Opportunities

The results of the key informant interviews and focus group discussions revealed numerous opportunities for the advancement of beekeeping and urban agriculture. These opportunities include the proximity to protected forests, favorable agroecology, government support for urban agriculture, the national government program called Bounty of the Basket (Ye Lemat Tirufat) aimed at enhancing honey, dairy, poultry, egg, meat, and fish production, and the chakka project (despite its initial negative impact on beekeepers). Additionally, these opportunities offer advantages such as income generation, improved food consumption, environmental suitability, and job prospects. The presence of both beekeepers and forests creates opportunities for urban residents to participate in beekeeping activities.

Urban agriculture has been attracting the attention of the city administration, as it has been recognized at both national and international levels for its promising potential in enhancing urban food security. In line with this, the city administration has established a commission dedicated to farmers and the development of urban agriculture, aiming to provide support and resources for its growth.

The Bounty of the Basket initiative is an opportunity found in the KII and FGD discussions. A national government initiative called 'Bounty of the Basket' (Ye Lemat Tirufat) is currently underway in Ethiopia, aiming to enhance the production of honey, dairy, poultry, eggs, fish, and meat. The program, which is supported by the prime minister and the Ministry of Agriculture, has shown promising results across the country. In a social media post, the Prime Minister highlighted the success of the 'Bounty of the Basket' initiative launched the previous year, which resulted in an increase in honey productivity to approximately 98 thousand tons per year. Looking ahead, the Prime Minister expressed the goal of doubling the annual honey output for the following year. This ambition takes into account the country's diverse ecological and climatic conditions, which provide a favorable environment for honey production due to the abundant flora and fauna present (Prime Minister, 2023). However, it is crucial to emphasize the importance of focusing on urban beekeeping and giving it the necessary attention, it deserves.

Furthermore, the chakka project is an opportunity if apiculture is integrated into the initiative. The integration is particularly crucial in terms of promoting sustainable biodiversity and attracting tourists to the project site. By incorporating apiary activities, the Chaka Project can enhance its environmental sustainability and offer an additional attraction to visitors.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATION

5.1. Conclusion

The study was conducted on beekeeping practices and its contribution to household food security: the case of Yeka sub-city, Addis Ababa, Ethiopia. Beekeeping is a common activity in numerous areas around the world, with thousands of small-scale beekeepers relying on bees for a living. Beekeeping is the practical management of bees to produce food and agriculture. Beekeeping provides significant contributions to household incomes, enhances the resilience of natural ecosystems, generates employment, and income, and significantly contributes to nutrition and food security. Therefore, the study aimed to assess beekeeping practices and its contribution to food security in the study area.

The fact that about 40.34% of the study households use framed hives for bee production implies that this method is popular and potentially effective for beekeeping. For future beekeepers, this suggests that adopting framed hives could be a viable option, as it has been successfully utilized by a significant portion of the study households. It may be worth considering and exploring further as a potential beekeeping practice.

The finding revealed that the majority (48%) of beekeepers had acceptable food consumption scores implying that a significant portion of the beekeeping population has a satisfactory level of food consumption. This suggests that their nutritional needs are being met adequately, which is likely to positively impact their overall health and well-being. Additionally, it indicates that these beekeepers may have a higher likelihood of maintaining their beekeeping practices and achieving better outcomes in terms of honey production and overall beekeeping success.

Moreover, 74% of the beekeepers had higher dietary diversity suggesting a potential correlation between beekeeping practices and improved dietary diversity. Beekeeping can provide beekeepers with access to a variety of bee products like honey and pollen which can enhance their dietary options. This implies that households may benefit from incorporating beekeeping practices into their livelihood to increase their dietary diversity and potentially improve their overall nutrition. It highlights the potential role

of beekeeping in promoting food security and diversification for beekeepers and their households.

Among the 12 variables considered in the multiple linear regression analysis, three variables, namely family size, access to forage, and market information exhibited significant associations with beekeepers' honey production. The size of the family influences the availability of labor for beekeeping, while access to forage impacts the health and productivity of bee colonies. These findings highlight the influential roles of these factors in shaping beekeeping practices in the study area. Additionally, the ordered probit model analysis demonstrated that increased honey production contributes positively to food security, emphasizing the importance of beekeeping for both income generation and improving food security in households. These results underscore the necessity for targeted interventions and policies to support beekeeping initiatives and enhance food security outcomes within the study area.

5.2. Recommendations

Based on the findings and conclusions presented, the following recommendations are suggested.

Family size, access to forage, and market information significantly influence beekeeping practices in Addis Ababa City, Ethiopia. Targeted interventions in these areas may greatly enhance beekeeping activities and their contributions to local livelihoods. Promoting beekeeping by the city agriculture bureau and civil societies among larger families through community-based training programs can harness available labor for beekeeping practices effectively.

Improving access to forage resources by the city agriculture bureau, Addis Ababa urban beauty and green development bureau, academic institutions like TVETs and civil societies are crucial for sustaining healthy bee populations and maximizing honey production. Therefore, efforts to preserve natural habitats, promote sustainable land management practices, and establish bee-friendly landscapes within urban areas are vital and need to implement agroforestry to enhance bee forage. Furthermore, integrating urban agriculture with a focus on beekeeping within mega projects like the

Chaka Project should prioritize careful space allocation for beekeeping activities, to ensure optimal conditions for bee colonies, benefiting not only both the project and local beekeepers but also emphasizing the significant role of bees in biodiversity conservation and their potential for income generation and employment.

Additionally, enhancing market information and access to markets is essential for beekeepers to sell their honey and other bee products profitably. Providing beekeepers with training on marketing strategies, facilitating linkages with buyers and retailers, and establishing platforms for information exchange and market networking by the city trade bureau and civil socities can help improve market access and boost the economic viability of beekeeping enterprises.

Overall, by addressing the implications of family size, access to forage, and market information on beekeeping practices, policymakers, and stakeholders need to develop targeted interventions that foster sustainable beekeeping initiatives, support local livelihoods, and contribute to the economic development of Addis Ababa city and its residents.

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APPENDICES

Appendice 1: Informed Consent

Dear respondents, this study is conducted entitled on 'Beekeeping Practices and its Contribution to Household Food Security in Addis Ababa: The Case of Yeka Sub-city, Ethiopia' at the Center for Food Security, College of Development Studies, Addis Ababa University, Ethiopia. This questionnaire is designed for the academic purpose of fulfilment of masters degree in food security and development studies. The objective of the research is to identify the factors determining beekeeping practices, analyze the effect of beekeeping in ensuring household food security and assess the challenges and opportunities of beekeeping practices in the study area.

This research at the end would come up with recommendations that could help in planning sustainable urban food security through beekeeping and sustain the communities' livelihood and household food security in the study area. Therefore, we kindly request your cooperation in responding to the questionnaire, while assuring you that all information would be treated with utmost confidentiality and strictly for academic purpose. The information is used purely for research purposes; your answers will not affect any benefits or subsidies you may receive now or in the future. Do you consent to be part of this study? If there are questions that you would prefer not to answer, then we respect your right not to answer them.

Please sign and date here indicating that you agree to participate:

_____ _____ _____

Name Signature Date

Appendice 2: Econometrics problem tests, diagnostic tests, and their decisions

Tests	Hypothesis(H_0)	Types of tests used	Result	Decision
Hetroskedasticity	Constant variance	Breusch-Pagan(hettest)	P= 0.2051	1
Multicollinearity	no multicollinearity	VIF	VIF<10	1
Normality	Error terms are normal	Skewness/Kurtosis(sktest)	P= 0.956	1
		Shapiro-Wilk(swilk)	P=0.36697	1
		Doornik-Hansen(mvtest)	P=0.9338	1
Omitted variable test	No omitted variables	Ramsey reset test(ovtest)	P= 0.2932	1
Model specification error	No model specification error	Linktest	hat = 0.000 hatsq=.004	2

Source: Own survey computation (2023)

NB: 1 = Fail to reject the null hypothesis (H_0**);** 2= Reject null hypothesis (Accept $H_{a)}$

Appendice 3: Conversion of households into man equivalent

Age	Male	Female
Less than 10	0.0	0.0
10-13	0.2	0.2
14-16	0.5	0.5
17-50	1	0.8
Above 50	0.7	0.5

Source: FAO (2005)

Appendice 4: Food consumption score weight

	Food Group	Weight
1	Main staples	2
2	Pulse	3
3	Vegetable	1
4	Fruit	1
5	Meat/fish	4
6	Sugar	0.5
7	Oil	0.5

Source: WFP (2008)

Appendice 5: Questionnaire

Hello Sir/Madam am conducting an academic study to evaluate "B**eekeeping Practices and its Contribution to Household Food Security in Addis Ababa: the case of Yeka Sub-city.** Your participation in this study is voluntary. I will collect relevant data to come up with valuable recommendations for observed problems. To protect your privacy, I will not disclose any private information such as your name and address. If you choose not to participate, there will be no consequences.

Direction: Circle the letter that you choose and write on the space provided for the essay part.

Part one: Demographic characteristics of the respondent

1. Name of household head----------
2. Kebele----------
3. Age of household head----------years.
4. Sex of household head A. Male B. Female C) Other
5. Marital status A. Single B. Married C. Divorced D. Widowed
6. Religion of household A. Christian B. Muslim C. Protestant D. Other (specify)------
7. Education level ----------grades
8. Family size including you

Age	Male	Female	Total
<15			
15-64			
>64			
Total			

Part two: Socioeconomic characteristics of the household

1. Do you have livestock? A. Yes B. No
2. If your answer for Q.1 is yes, livestock Number: Oxen/bulls --------, Cows/heifers -----, Calves --------, Goats -------, Sheep-------, Donkeys --------, Horses ---------, Mules ----------, Chickens ------, Beehives -------, others----------
3. Do you have honeybees? A. Yes, B. No
4. If your response to qu. no 3 is yes what is your ownership status? A. Private B. Corporate
5. If your response to question no 3 is yes how many hives do you have? ----------
6. Which type of beehives do you have? A) Traditional, B) transitional, C) framed D) other
7. How long you have been practicing beekeeping?
8. How many times do you collect per year? A) once B) twice C) three times
9. How many kilograms of honey do you produce per year? ---------kg, and wax---------kg
10. Do any household members have beehives? A. Yes, B. No
11. Do you have access to inputs for your beekeeping business? A. Yes, B. No
12. Do you get hives at a reasonable cost? A. Yes, B. No
13. Do you have access to wax? A. Yes, B. No
14. Is bee forage/feed available near your apiary? A. Yes, B. No
15. How do you estimate the price of inputs? A) Very expensive B) expensive C) fair
16. Did your family/neighbors fear bee sting? A. Yes, B. No
17. Do you have a space for beekeeping? A. Yes, B. No
18. If yes for qu.17, where do you get the space? A. Government B. On the building roof C, on the fence wall D. Rented E. If any other, specify----------

19. How did you start beekeeping? A. By training B. Learning from family C. As a hobbies D. other, specify-------
20. Price of one kilogram honey? ----------birr
21. Annual income generated from beekeeping? ----------birr
22. Total income generated per year? ----------birr
23. Are there any off-farm activities you engaged in? A. Yes B. No
24. What is the price of one colony? And specify sources of the hives and colonies?

Sources	Quantity of colony	Traditional		Transitional		Modern	
		Qt	Price	Qt	Price	Qt	Price
Parents							
Catching swarms							
Buying swarms							
Others							

25. What are the characteristic features of your honeybees?

Behaviors: (A) Docile_____ (B) Aggressive_____ (C) Very aggressive Color: (A)Black_____ (B)Red_____(C)Grey_____ (D)Mixture_____ Size:(A)Big_____(B)Medium_____(C)Small_____ Which one is more productive? Behaviors: _____, Color: _____, Size: _____

Part Three: Information about institutional characteristics

1. Do you get extension contact? A. Yes, B. No,
2. Can you get access to credit in the past year? A. Yes, B. No
3. Do you get market information? A) yes B) no
4. Do you get access to training on bee production? A. Yes, B. No
5. Frequency of extension contact per month? A) once B) twice C) more than
6. Can you list major challenges of honey bee production, and marketing in your local area

Part four: Household Food Security Questionnaires

A. Household Food Insecurity Access Scale (HFIAS) questions

No	In the past 30 days	Responses	Code
1	did you worry that your household would not have enough food?	0=No (skip to Q2) 1=Yes	
1.a	How often did this happen?	1=Rarely (once or twice in the past four weeks) 2=Sometimes (three to ten times in the past four weeks) 3=Often (more than ten times in the past four weeks)	
2.	were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0=No (skip to Q3) 1=Yes	
2.a	How often did this happen?	1=Rarely (once or twice in the past four weeks) 2=Sometimes (three to ten times in the past four weeks) 3=Often (more than ten times in the past four weeks)	
3.	did you or any household member have to eat a limited variety of foods due to a lack of resources?	0=No (skip to Q4) 1=Yes	
3.a	How often did this happen?	1=Rarely (once or twice in the past four weeks) 2=Sometimes (three to ten times in the past four weeks) 3=Often (more than ten times in the past four weeks)	

4.	Did you or any member have to eat some foods that you did not want to eat because of a lack of resources to obtain other types of food?	0=No (skip to Q5) 1=Yes	
4.a	How often did this happen?	1=Rarely (once or twice in the past four weeks) 2=Sometimes (three to ten times in the past four weeks) 3=Often (more than ten times in the past four weeks)	
5.	did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0=No (skip to Q6) 1=Yes	
5.a	How often did this happen?	1=Rarely (once or twice in the past four weeks) 2=Sometimes (three to ten times in the past four weeks) 3=Often (more than ten times in the past four weeks)	
6.	Did you or any other household member have to eat fewer meals in a day because there was not enough food?	0=No (skip to Q7) 1=Yes	
6.a	How often did this happen?	1=Rarely (once or twice in the past four weeks) 2=Sometimes (three to ten times in the past four weeks) 3=Often (more than ten times in the past four weeks)	
7.	Was there ever no food to eat of any kind in your household because of lack of resources to get food?	0=No (skip to Q8) 1=Yes	

7.a	How often did this happen?	1=Rarely (once or twice in the past four weeks) 2=Sometimes (three to ten times in the past four weeks) 3=Often (more than ten times in the past four weeks)	
8.	Did you or any household member go to sleep at night hungry because there was not enough food?	0=No (skip to Q9) 1=Yes	
8.a	How often did this happen?	1=Rarely (once or twice in the past four weeks) 2=Sometimes (three to ten times in the past four weeks) 3=Often (more than ten times in the past four weeks)	
9.	Did you or any household member go a whole day and night without eating anything because there was not enough food?	0=No (the questionnaire is finished) 1=Yes	
9.a	How often did this happen?	1=Rarely (once or twice in the past four weeks) 2=Sometimes (three to ten times in the past four weeks) 3=Often (more than ten times in the past four weeks)	

B. Household food consumption score questionnaire

A household member consumed the following food items of each group and tick the number of days they consumed

No	Food Group	Food items	How many days in the past one week have your household eaten							
			0	1	2	3	4	5	6	7
1.	Main staples	Any foods from wheat, barley, maize, rice, sorghum, Teff, millet, pasta, and other cereals?								
2.	Pulses	Any foods of Beans, Peas, soybean, groundnuts, lentils haricot beans, and others?								
3.	Vegetables	Any foods of Vegetable leaves and others?								
4.	Fruits	Any Fruits? (Apple, mango, papaya, avocado, wild fruits and others)								

5.	Meat and fish	Any Beef, goat, sheep, poultry, eggs, and fish?								
6.	Milk and milk products	Any Milk yogurt and another diary								
7.	Sugar	Any sugar and sugar products, honey?								
8.	Oil	Any oils, fats, and butter?								
9.	Condiments	Spices, tea, coffee, salt, fish powder, small amounts of milk for tea.								

C. Household dietary diversity (HDD) score questionnaire

For the following food groups, please put 1 if any member of the household consumes any food items, if not put 0 within 24 hours periods time.

NO	Food Group	Food item	Yes =1, No=0
1.	Cereals	Any foods made from wheat, Teff, sorghum, and maize, Barely, e.g. Beso, Kolo, porridge, injera, or other locally available grains.	
2.	Vegetables	Any vegetables? (Pumpkin, carrot, squash, onion, tomato, cabbage, head cabbage, lettuce, and other locally available vitamins A rich vegetables)	
3.	Fruits	Any fruits? (Mango, papaya, Avocado, Apple, wild fruits, and 100% fruit juice made from these + other locally available vitamins A rich fruits.	
4.	Meat	Any beef, lamb, goat, wild game, chicken, duck, or other birds, liver, kidney, heart, or other organ meats?	
5.	Egg	Any eggs? (eggs from chicken, duck, guinea fowl, or any other egg)	
6.	Fish and other seafood	Any fresh or dried fish or shellfish?	

7.	Legumes, nuts and seeds	Any foods made from beans, peas, lentils, cowpeas, pigeon peas nuts, Haricot bean, chickpea, soybean, and vetch?	
8.	Milk and milk products	Any cheese, yogurt, milk, or other milk products?	
9.	Oils and Fats	Any food made with oil, fat, or butter	
10.	Sweets	Any sugar, honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolates, candies, cookies, and cakes?	
11.	White root	Any other foods made from roots or tubers?	
12.	Spices, condiments and beverages	Any other foods, such as condiments, salt, spice, coffee, tea, ginger, carmine, and other alcoholic beverages	

Focus group discussion questions

1. What motivates the beekeepers to keep bees?
2. Do you think keeping bees would be a problem in your area?
3. What are the major factors constraining beekeeping in your area?
4. Is there any problem you encountered in beekeeping?
5. Which types of hives are adopted in this area? Why?
6. Where are the sources of the inputs/technologies?
7. What problems did you face in accessing inputs (availability/access, quality, cost of inputs)?
8. How do you think these problems can be solved?
9. What are the main factors to affect your household food security?
10. Is there any difference in food security status between beekeepers and non-beekeepers? What is the difference between these two groups?
11. is there a food utilization difference between beekeepers and non-beekeepers? What is the difference?

Key informant interview

1. What is the trend of beekeeping practices in the past five years in your area?
2. What are the major challenges of beekeeping activities in your area?
3. What are the major opportunities for beekeeping activities in your area?
4. What are the major factors that affect influence household food security?
5. What is the role of government in beekeeping development?
6. Do beekeepers get sufficient extension service and training from any stakeholder in beekeeping?
7. What are the impacts of beekeeping you observed on a household's food security status?