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The Extent of contribution by Urban and Peri-Urban Agriculture in Employment Creation and Income Generation: A Case Study from Hadnet Sub-city, Mekelle, Tigray Region, Ethiopia.

By:

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A thesis

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DECLARATION

This is to certify that this thesis entitled "The Extent of contribution by Urban and Peri-urban Agriculture on Employment creation and Income generation in Mekelle Hadnet Sub-city, Tigray region, Ethiopia" submitted in partial fulfillment of the requirements for the award of the degree of M.Sc., in Agricultural Economics and Policy, Mekelle University, through the Department of Agricultural and Resource Economics, done by Mr. Berhanu Meressa Berhe, ID.No. CDANR/PR 168803/12 is an authentic work carried out by him under our guidance. The matter embodied in this project work has not been submitted earlier for award of any Degree or Diploma to the best of my knowledge and belief.

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As member of the board of examiners of MSc. thesis open defense examination, we certify that we have read and evaluated the thesis done by Berhanu Meressa Berhe and examined the candidate. We recommended the thesis to be accepted as fulfilling the thesis requirement for the degree of Master of Science in Agricultural Economics and Policy.

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LIST OF ACRONYMS

AACPP	Addis Ababa City Plan Project
ADLI	Agricultural Development Led Industrialization
ATT	Average Treatment Effect on the Treated
BoARD	Bureau of Agricultural and Rural Development
CC	Contingency Coefficient
CEA	Controlled Environment Agriculture
CSS	Central Statistical Services
DAs	Development Agents
EPRDF	Ethiopian People Revolutionary Democratic Front
FAO	Food and Agriculture Organization
FDRE	Federal Democratic Republic of Ethiopia
FGD	Focus Group Discussions
OCHA	Office for the Coordination of Humanitarian Affairs
PASDEP	Plan for Accelerated and Sustainable Development to End Poverty
SDGs	Sustainable Development Goals
SMEs	Small and Micro Enterprise
ILO	International Labor Organization
ILRI	International Livestock Research Institute
IMO	International Migration Organization
MoARD	Ministry of Agriculture and Rural Development
MLR	Multinomial Logistic Regression
NPDC	National Professional Development Center on Autism Spectrum Disorders
NGO	Non-Governmental Organization
OLS	Ordinary Least Square
SDPRP	Sustainable Development Program to Reduce Poverty

SSA	Sub-Saharan Africa
SNNP	South Nations and Nationalities people
TBoARD	Tigray Bureau of Agriculture and Rural Development
UPA	Urban and Peri-urban Agriculture
UN	United Nations
UNICEF	United Nations children Fund
UNDP	United Nations Development Program

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Abstract

Urban and peri-urban agriculture (UPA) involves the production of food and non-food items within or near urban areas for household consumption or market sale. In developing countries, rapid urbanization and rural-urban migration intensify unemployment and income scarcity. This study explores the socio-economic characteristics, determining factors, and impacts of UPA on income generation and employment in Mekelle Hadnet sub-city, Tigray region, Ethiopia. Using a multistage sampling technique, data were collected from 305 urban and peri-urban farmers through survey questionnaires, focus group discussions and personal observation during the year 2024. Descriptive statistics and econometric models were employed for analysis. A multinomial logit model (MNL) identified key determinants of participation in UPA, while logit regression estimated propensity scores. A propensity score matching (PSM) model evaluated the impact of UPA on employment and income. Descriptive statistics showed significant differences between higher-participant and lower-participant households. The MNL model identified factors such as age, family size, farm distance, animal feed use, employment status, farm income, costs, and experience as significant in influencing participation. Logit regression further highlighted the significance of age, use of agricultural inputs, and livestock holdings. PSM results demonstrated that participation in UPA positively impacted farm income and employment at a 5% significance level. The average treatment effect on the treated (ATT) was an income increase of Birr 13,103 and one additional employed person compared to untreated groups. The findings suggest that UPA contributes significantly to reducing unemployment and increasing income in urban settings. Therefore, coordinated efforts by local administration, municipal authorities, researchers, and policymakers are essential to support and enhance UPA practices.

Keywords: *Urban and peri-urban agriculture, Multinomial logistic regression, Logit regression model, Propensity score matching, Employment, Income.*

CHAPTER ONE: INTRODUCTION

1.1. Background of the study

The global urban population has grown rapidly in recent decades, intensifying challenges such as poverty and unemployment among the urban poor (UN, 2019). This issue is especially pronounced in developing regions like sub-Saharan Africa (SSA), where urbanization has outpaced infrastructure and economic development. Consequently, ensuring food security for urban and peri- urban residents has become an urgent priority, prompting a shift in development focus from rural to urban areas (Davies *et al.*, 2021).

Ethiopia ranks among the least developed countries globally and is characterized by a predominantly rural population. A substantial portion of its citizens—between 80% and 85%—live in the countryside and rely heavily on agriculture for their livelihoods. This sector forms the backbone of the Ethiopian economy, contributing approximately 36% to the national Gross Domestic Product (GDP). Moreover, agriculture accounts for 75% of the country's export revenues and provides about 73% of all employment opportunities (Anteneh & Hassen, 2023).

Within the agricultural domain, crop production is particularly significant. It occupies the largest share in terms of both land use and output, generating around 68% of the total agricultural GDP. Furthermore, the sector plays a critical role in supporting agro-processing industries by supplying nearly 70% of their raw material inputs (Esk *et al*., 2019).

Despite the growing global trend of urbanization, Ethiopia remains largely rural. According to data from the World Bank, only 19% of the population resides in urban areas, a figure that remains low when compared to many other nations. Nevertheless, urbanization in Ethiopia is advancing at a relatively rapid pace, with an annual growth rate of 4.3% (Ozlu *et al*., 2015).

However, this swift urban expansion has brought with it several socioeconomic challenges. Urban poverty and unemployment have become increasingly pronounced issues. For instance, the proportion of the urban population living in poverty rose from 11% in 2000 to 24%—equivalent to 5.5 million people—by 2018. This trend suggests that while cities are growing, the necessary infrastructure, services, and employment opportunities are struggling to keep pace, exacerbating urban vulnerabilities (WB, 2018).

Unemployment and poverty in urban and peri- urban settings not only reduces income but also imposes a heavy psychological and social toll on individuals and households. The high cost of seeking employment, combined with inadequate access to resources, often results in chronic food and nutritional insecurity (Das & Krishna, 2018).

To address these interconnected issues: urban food insecurity, unemployment, and poverty targeted efforts are required, especially within the framework of the United Nations' Sustainable Development Goals (SDGs), such as achieving "zero hunger" and "zero poverty" (Davies *et al*., 2021). One increasingly adopted strategy to mitigate these urban challenges is the development and expansion of urban and peri-urban agriculture(Pauleit *et al*., 2020).

Urban and peri-urban agriculture is emerging as a critical adaptive mechanism that offers a multifaceted solution to food insecurity, particularly among low-income urban residents. It not only contributes to the household food supply but also facilitates job creation, income generation, and environmental sustainability. Urban and peri-urban agriculture involves cultivating crops, vegetables, and fruits, as well as raising small livestock and processing agricultural products typically at the household or community level; for both personal consumption and local market sales within city limits or nearby areas (Rikolto *et al.*, 2022).

According to United Nations Food and Agriculture Organization (FAO), peri-urban agriculture is also defined as the practices of agriculture around the cities that are competing for resources and satisfies the requirements of urban population. The leading feature which differs from peri-urban and rural agriculture is that peri-urban agriculture integrates into the ecological and economic systems of urban areas (Kaur *et al.*, 2020).

The scale and potential of UPA are considerable. According to Rikolto *et al.* (2022), globally, approximately 68 million hectares of land (4.7%) located within 20 kilometers of city centers or 800 million people which is 10.3 percent of the world's population are currently engaged under cultivation. This reflects the significant and growing role of urban and peri-urban agriculture in global food systems while an estimated 266 million households in urban and peri-urban areas of developing countries are engaged in crop and vegetable production which is 17% of the continent's urban population or 50% of the food consumed especially in food insecure areas.

The relevance and impact of urban and peri-urban agriculture were further highlighted during the COVID-19 pandemic, when global food supply chains were disrupted, and local food systems had to step in to meet rising demands. For instance, urban agriculture initiatives led

to the production and distribution of large quantities of vegetables in cities around the world: 1.35 million kilograms in Quito (Ecuador), 20 tons in just two weeks in Medellin (Colombia), 25 tons over two months in Nantes (France), and over 10 tons in Davao (Philippines) (FAO, 2020). These examples underscore the vital role UPA played in enhancing local food security during times of crisis.

Encouragingly, Ethiopia has begun to see meaningful developments in urban agriculture in recent years. Urban and peri-urban agriculture is gaining attention as a strategic tool for improving the livelihoods of low-income, unemployed city residents (Handalo & Abafita, 2020). Although urban and peri-urban agriculture is not a new concept in Ethiopia, having traditionally involved the rearing of livestock such as poultry, sheep, and cattle, and the cultivation of vegetables and rain-fed crops near homes (Ayele, 2021), there is renewed momentum in formalizing and scaling these practices. Municipal leaders in Addis Ababa, for example, have adopted UPA as a central component of the "Yelemat Trufat" initiative, which aims to promote livelihood diversification and improve food security at both household and national levels.

Urban and peri-urban agriculture in Ethiopia contributes significantly to the supply of essential food items such as eggs, poultry, dairy, and green vegetables—commodities that are vital to the nutritional needs of urban populations. Accordingly to Amsalu's (2020) review, in the harvest season of 2001/02, UPA covered about 155,249 ha of harvested crop area yielding a total of 156,763 tons of crops. When we see its contribution relative to the overall crop production, the shares vary from hardly 0.5 percent (e.g., in pulses, and roots) to 7.9 percent (e.g., in fruits). Despite this progress, however, there remains a substantial gap in empirical data and meaningful results thereof on the extent and effectiveness of urban and peri-urban agriculture practices across the country. In particular, there is a lack of comprehensive research on the socioeconomic, demographic, and structural factors that influence the role of urban and peri- urban agriculture in generating employment and income.

This knowledge gap is especially pronounced in the Tigray region and the city of Mekelle, where more detailed studies are needed to better understand the local dynamics and potential of urban and peri-urban agriculture. Moreover despite recent efforts by local governments to promote and expand urban and peri-urban agriculture (UPA), the sector continues to face significant challenges, largely due to lack of robust empirical evidence regarding its contributions to employment and income generation. To formulate meaningful solutions, it is essential that local urban and peri-urban agriculture initiatives shall take into consideration a

range of socioeconomic, demographic, and institutional factors. Recognizing and understanding these variables is crucial for both government and non-governmental actors seeking to support and scale up the sector. A more informed approach would enable stakeholders to empower urban and peri-urban residents, ensuring they fully benefit from the employment opportunities and income-generating potential that UPA offers.

Therefore, this study seeks to contribute the existing knowledge gap by empirically assessing the role of urban and peri-urban agriculture in employment creation and income generation. In doing so, it aims to contribute valuable insights in to the academic literature and provide evidence-based recommendations for policymakers and practitioners. This research is also particularly timely and relevant; given that many of prior studies have not largely overlooked the socioeconomic dimensions, determinant factors of urban and peri-urban agriculture and its effect on employment and income generation in the context of cities such as Mekelle Hadnet sub-city, Tigray region, Ethiopia.

1.2. Statement of the problem

Unemployment had been a big problem of international economy from the period of great depression when high level of unemployment registered in the world. According to ILO, 2017, "Globally youth unemployment registered nearly 70.9 million and therefore the youth unemployment rate was 13.1 and it had been highest within the Arab States, at 30.0 in 2017.

Sub-Saharan Africa's unemployment rate stood at 7.2 per cent in 2017, basically remaining unchanged. Because of the region's strong labor force growth the number of unemployed increased by over 1 million (ILO, 2017).

Ethiopia is also currently grappling with critical challenges such as rapid population growth (Abera *et al*., 2017). The labor force is expanding more quickly than the economy's capacity to generate new employment opportunities, leading to a persistent rise in urban unemployment. In Ethiopia's urban areas alone, the number of unemployed individuals reached 2,018,479, with an overall unemployment rate of 18.7% (Ethiopian Statistical Services, 2022).

When a growing portion of the workforce is unable to access employment in the formal economic sector, they are either pushed into low-productivity service jobs or revert to subsistence-level traditional agricultural systems, which offer minimal wages and limited economic advancement. Moreover, oversupply of cheap labor can stifle technological innovation and slow industrialization, ultimately increasing poverty and weakening the

demand for manufactured goods. The long-term consequences include reduced savings, lower income levels, and underdeveloped labor skills—factors that hinder the efficient utilization of the country's natural resources.

The COVID-19 pandemic has further accelerated these employment challenges on a global scale (Mamo *et al*., 2022). It led to widespread job losses, reduced working hours, and salary cuts. In Ghana, for example, over 770,000 (2.5%) workers experienced income reductions; more than 700,000 (2.3%) faced shorter working hours, and upwards of 42,000 (0.1%) were laid off (WB, 2020). In Ethiopia, the pandemic led to a significant reduction in both employment and household incomes (Dione, 2020). Ethiopia's unemployment rate increased from 16.5% in the fiscal year 2013 to 17.5 percent in the fiscal year 2020/2021 which is noticeably higher than the rate in rural areas (5.2%) (ESS, 2022). As a result, the national dependency ratio is expected to increase, placing a greater burden on the state to provide basic services such as food, housing, education, and healthcare for a non-productive segment of the population.

Ethiopia also faces internal displacement challenges. According to the International Organization for Migration (IOM) 2019, the country had one of the highest rates of internal displacement globally, primarily due to ethnic conflicts. Prior to 2018, approximately 1,623,716 individuals were displaced. Due to this most of young population within the area exposed to dangerous human trafficking problems with unsafe international migration. So that, most of them are losing their pricier life on this evil journey. This has led to labor shortages in origin (rural) areas affecting food production and increased labor supply in urban centers, thereby intensifying urban unemployment and straining service delivery.

Several empirical studies have explored the contribution and challenges of urban and peri-urban agriculture (UPA) to employment and income generation.

For instance, Tebeje and Bokore (2020), examined how urban agriculture affects household livelihood outcomes, However, their study primarily focused only on urban agriculture general benefits such as food access and dietary improvement, without providing a detailed analysis of how peri-urban agriculture contributes specifically to employment creation and income generation. Additionally, their work did not distinguish between different types of urban and peri-urban agricultural activities- such as crop cultivation, livestock production, or mixed farming- nor did it assess how these varied activities influence livelihood outcomes differently. As a result, their study provides limited insights into the economic and labor

market dimensions of urban and peri- urban agriculture, particularly in the context of income scarcity and youth unemployment.

Yalew (2021) and Dinku *et al.* (2023) focused on the role of urban agriculture (UA) in enhancing urban food systems and ensuring food security. While the study provided valuable insights into the contribution of UA to household nutrition and food supply, it did not explore the economic dimensions of UPA—specifically its impact on employment opportunities and income generation for urban and peri-urban residents. Moreover, the study lacked a disaggregated analysis of different types of UPA activities and how these activities differentially affect household livelihoods.

Determinants of adoption of urban agricultural practices in Eastern Hararghe Zone of Oromia Region and Dire Dawa City Administration, Eastern Ethiopia were conducted by Nigus Gebregziabher *et al*. (2024). This study identifies factors influencing the adoption of urban agricultural practices, such as vegetable farming and livestock production. It finds that variables like education level, land size, credit access, and training significantly affect adoption rates. However, the research not pointed out empirical studies on the determinants of peri-urban agriculture to the extent of contribution by UPA on income and employment creation.

Similarly, the role of urban agriculture in improving household income and dietary diversity: The Case of Bure and Finoteselam Towns, West Gojjam Zone, Amhara National Regional State, Ethiopia was provided by (Shitaye, 2019). This research investigates how urban agriculture contributes to household income and dietary diversity. It finds that urban agriculture plays a significant role in enhancing food security and providing employment opportunities. However, he left out role of peri-urban agriculture in improving household income and employment opportunities and he used also binary logistic model to estimate the impact of UA on income and employment generation.

Whittinghill and Sarr (2021) assessed the sustainability challenges of UPA. However, most of these studies primarily focused on general urban agricultural practices without disaggregating them by activity or considering broader livelihood security aspects like employment and income generation.

In Tigray, Gebru *et al.* (2019) analyzed vegetable growers' contributions to food security in Raya Azebo, Tigray region. However, their study excluded other key urban and peri-urban agriculture activities such as livestock and staple crop production. Similarly, Ayalu *et al.*, 2023 investigated the role of small and medium enterprises (SMEs) in sustainable livelihoods in Mekelle, their contributions to income and job creation, but omitted agricultural activity at household level and the participation of farmers at household level. A study were assessed by Gebregziabher *et al.* (2024), in war-affected areas of Tigray on urban and peri-urban agriculture as a pathway for post-war recovery and resilience focusing on main food supply source during the war, however they left they types of UPA used to mitigate, the factors that affect the UPA practices, its effect on livelihood activities and the descriptive or econometric analysis to interpret the relation and magnitude of UPA .

How open spaces in Mekelle city contributed to crop production during a period of absolute siege was conducted by (Hadush & Gebrekiros, 2024). The available open spaces in Mekelle city contributed 2687 ha of newly cultivated land, producing 3825 tonnes of wheat (Triticum aestivum L.) and 880 tonnes of barley (Hordeum vulgare L.) grain but does not thoroughly assess the economic aspects, such as the profitability of UPA ventures or their potential to provide stable income and employment opportunities.

Analyzing urban agriculture commercialization in Mekelle provided by Hagos *et al*., 2020 examined on specific activity dairy production. However, like many previous studies, their work did not comprehensively assess UPA's impact on both employment and income generation across the full range of farming practices cereals, vegetables and other livestock products.

Unlike these previous studies, the current research distinguishes itself by addressing this gap. It evaluates the extent of contribution by urban and peri-urban agriculture to two critical livelihood security dimensions: employment creation and income generation. It also encompasses a wider range of farming activities: including crop cultivation, livestock production, and mixed farming practiced within Mekelle's Hadnet sub-city.

This study not only fills a significant empirical gap but also provides practical insights for urban and peri-urban agriculture offices, city planners, researchers and policymakers. It examines the key determinants, challenges, and opportunities associated with urban and peri-urban agriculture (UPA) and evaluate its overall effect on urban livelihoods. In doing so, it

aims to inform future planning and development strategies that can reduce unemployment, and strengthen income-generating opportunities in Mekelle and urban/ peri-urban Ethiopia.

1.3. Objective of the Study

1.3.1. General objective:

The general objective of the study is to assess the role of urban and peri-urban agriculture on employment creation and income generation in Mekelle Hadnet Sub-city and its peri-urban areas.

1.3.2. Specific objectives:

The specific objectives of this research are:

1) To analyze socioeconomic characteristics of urban and peri-urban agriculture participant households in the study areas.
2) To estimate the effect of urban and peri-urban agriculture practices on employment and income generation.
3) To examine the determinant factors on the contribution of urban and peri-urban agriculture practices in employment and income generation.

1.4. Hypothesis

$H_{01:}$Urban and peri-urban participants exhibit distinct socio-economic characteristics compared to non-participants. .

$H_{02:}$Participation in urban and peri-urban farming positively affects employment rates and farm income levels among urban and peri-urban households; and

$H_{03:}$Certain socio-economic factors significantly influence the contribution of urban and peri-urban agricultural practices.

1.5. Significance of the Study

Given the challenges outlined above, investigating the socioeconomic contributions of urban and peri-urban agriculture (UPA) is both timely and essential, particularly for urban and peri-urban farming communities. This study enhances our understanding of how UPA contributes to improving the livelihoods and overall well-being of urban and peri-urban populations. By focusing on the role of UPA in employment creation and income generation within the Tigray region of Ethiopia, the research addresses a notable gap in the existing literature on peri-urban areas and adds valuable empirical evidence to a relatively underexplored area.

The findings offer critical insights that can inform more targeted and effective interventions for the development of the UPA sector. They are particularly relevant for policymakers and local development planners tasked with creating enabling environments for sustainable urban and peri- urban agriculture and serve as a foundation for designing policies that support resource allocation, land use planning, and infrastructure development tailored to UPA needs.

Moreover, this research may serve as a springboard for future studies, encouraging deeper exploration into urban agriculture and its intersections with other sectors, including small business development and labor markets. It highlights how urban and peri- urban agriculture can mobilize underutilized human resources, especially in contexts with high unemployment and underemployment. Ultimately, this study not only contributes to academic discourse but also provides practical implications for planning, policy formulation, and sustainable urban and peri- urban development. It can be summarized that unlike previous studies, the current research fills the following critical gaps:

1. Lack of focused analysis on employment and income dimensions: Prior studies often assess urban agriculture (UA) in broad terms (e.g., food security or sustainability), leaving peri- urban agriculture and without directly quantifying its specific contribution to employment creation and income generation.
2. Insufficient use of empirical methods to estimate impact: Few studies rigorously estimate the causal effect of UPA participation on household employment and income outcomes using statistical methods (e.g., Propensity Score Matching), leaving a methodological gap.
3. Limited understanding of determinant factors: There is a lack of research examining what factors (e.g., socioeconomic, institutional, or environmental) influence UPA's effectiveness in generating jobs and income, particularly in conflict-affected or resource-limited settings.
4. Context-specific evidence for policy guidance: Existing literature rarely provides localized, evidence-based insights from regions like Mekelle and similar Ethiopian urban/peri-urban contexts, making it difficult to design effective, context-aware policy interventions only focused on urban agriculture.

1.6. Scope and Limitations of the Study

The scope of this research can be understood through multiple lenses, including thematic focus, geographical reach, and the time and budgetary constraints within which the study was conducted. This research aimed to evaluate the extent of contribution by urban and peri-urban agriculture (UPA) to employment creation and income generation during the fiscal year 2024. To achieve this, a cross-sectional research design was employed, utilizing semi-structured interviews to collect primary data from a sample of household respondents.

Despite its strengths, the study faced several limitations. First, there was a lack of actual counterfactual data for a control group. To address this, the study employed Propensity Score Matching (PSM) as a statistical approach to construct an artificial control group, allowing for comparison between higher-participant and lower-participant households. Second, the study focused on a single sub-city selected purposively, which constrains the generalizability of the findings to the broader region of Tigray or Ethiopia as a whole.

Third, the accuracy of self-reported income and capital data was questionable, as some respondents were inclined to underreport their earnings and assets, likely due to concerns about losing access to government or non-governmental assistance. Fourth, the study was constrained by limited funding and logistical resources. This included delays in data collection, as some enumerators failed to submit questionnaires within the designated timeline due to financial constraints and lack of motivation but despite of systematic planning and building trust on the enumerators it was successfully solved.

1.7. Organization of the Thesis

This thesis is organized in five chapters. The first chapter introduces the background of the study, statement of the problem, objectives, significance, scope and limitation of the study. The second chapter covers relevant literature review. The third chapter deals with the research methodology. The findings of the study are presented and discussed in the fourth chapter. The fifth chapter summarizes, concludes and draws recommendation based on the main findings of the study.

CHAPTER TWO: LITERATURE REVIEW

2.1. Definitions and Concepts

Urban and peri-urban agriculture (UPA):

This refers to the cultivation of crops such as fruits, vegetables, leafy greens, and micro greens and the rearing of livestock including sheep, cattle, dairy animals, poultry, and pigs within city boundaries and in the surrounding peri-urban zones (Rikolto *et al*., 2022). UPA also encompasses the production of animal-derived goods like eggs and poultry meat, and may extend to include non-traditional agricultural practices such as beekeeping, horse husbandry, small-scale aquaculture, and the cultivation of non-food resources, like trees and ornamental plants.

UPA serves a diverse array of functions. It is a crucial source of food access for many urban households, especially those with limited purchasing power. Beyond food production, UPA contributes to livelihood diversification, household income supplementation, environmental improvement, and urban beautification through the development of edible landscapes and green spaces (Valley *et al*., 2018). Depending on the context, UPA may act as a subsistence strategy for low-income households or evolve into a commercial, profit-oriented enterprise.

Moschitz *et al*. (2016) also said “despite its growing relevance, there is no universally accepted definition of UPA”. The term "urban agriculture" generally refers to small-scale farming activities within city limits such as gardening on private plots, community gardens, vacant lots, and even balconies typically geared toward fulfilling household needs. However, it can also include commercial-scale initiatives, such as high-tech rooftop greenhouses or indoor vertical farms.

In contrast, peri-urban agriculture is practiced on the outskirts of cities and often takes place on larger plots of land, ranging from semi-commercial to fully industrial operations (Rikolto *et al*., 2022). UPA as a whole can exist across a spectrum of formality from informal, unregulated activities often overlooked by authorities, to fully formalized and registered agribusinesses managed by professionals. This variability makes UPA both a flexible and vital component of urban food systems and urban development strategies.

2.1.1. Employment and its classification

Employment encompasses both the economically active and economically inactive segments of the population. The economically active population refers to individuals who are either

employed or unemployed but actively seeking work in other words, those participating in the labor force. This group is often referred to as the current labor force. In contrast, the economically inactive population consists of individuals who are neither engaged in any productive work nor available for employment, and therefore do not contribute to or seek participation in the labor market (Ethiopian Statistical Services, 2022).

According to the Central Statistical Services (CSS) of Ethiopia, the size of the economically active population in 2020 was 10,781,225 individuals, representing those who were part of the national labor force. On the other hand, the number of economically inactive individuals was estimated at 6,864,549, constituting 38.9 percent of the working-age population. This group includes individuals engaged in non-income-generating activities such as household responsibilities, school attendance, retirement due to old age or pension, illness or disability, or those considered too young to participate in economic activities.

2.1.2. Income definitions and classifications

Income is broadly understood as the output derived from productivity, encompassing both monetary earnings and in-kind contributions. It reflects the total value of goods and services generated through productive activities, and these outputs are typically measured using market producer prices, regardless of whether they are sold or consumed by the producer. For instance, even self-consumed agricultural produce from personal farms is valued as if it were traded in the market (Ellis, 2000).

The classification of income sources varies across literature. According to Ellis (2000), off-farm income is defined specifically as earnings from wage labor on farms other than one’s own. In contrast, Barrett and Reardon (2005) adopt a broader perspective, defining off-farm income as all income-generating activities conducted away from the farmer's own land or assets, encompassing both agricultural and non-agricultural sectors.

In this study, we adopt the classification framework proposed by Barrett and Reardon 2005, which categorizes income sources along two dimensions: by sector—agricultural versus non-agricultural—and by function—wage employment versus self-employment. This typology enables a more nuanced understanding of household income structures, especially in the context of diverse livelihood strategies such as urban and peri-urban agriculture.

2.2. Types and Characteristics of Urban and Peri-urban Agriculture

Urban and peri-urban agriculture (UPA) can be categorized in several ways, depending on factors such as scale, purpose, structure, and the type of operator involved (Vantuijl *et al*., 2018). These classifications help to understand the diversity of agricultural practices within urban and peri-urban areas.

Urban agriculture (UA) can be characterized significantly in terms of size and scope. At one end of the spectrum, small-scale or semi-scale operations are typically aimed at fulfilling household needs, providing food for personal consumption. These smaller-scale practices may involve individual households or community groups growing crops or raising livestock on a limited area of land. This type of agriculture includes backyard gardens, rooftop farms and gardens, zero-grazing, vacant spaces, containers, on balconies, in fishponds in school gardens, etc. (Gottero *et al*., 2023).

On the other end, peri-urban agriculture (PUA) can also be characterized as large-scale, intensive commercial farms. These operations are designed primarily for market production and are often characterized by high productivity and industrial-scale practices. They may involve significant investments in infrastructure, technology, and labor, and the products are sold to meet the demands of urban populations. This can includes mechanized farming of crops, vegetables, free grazing of livestock, Community gardens for grazing etc.(Gottero *et al*., 2023)

These different forms of UPA cater to various needs, from food security and income generation at the household level to sustainable commercial food production for broader urban and peri- urban markets. The type of operator: whether it is a household, community-group, or large enterprise determines the goals, scale, and methods of agricultural activities in urban and peri-urban settings.

2.2.1. Backyard gardens urban and peri-urban agriculture

Urban agriculture (UA) is often practiced in open-air private home gardens or allotment gardens, as well as in small greenhouses. These practices are typically geared towards producing food for personal consumption. By utilizing small plots of land, UA can significantly reduce the consumption of freshwater resources, while still achieving higher yields compared to conventional farming methods (Kalantari *et al.,* 2017). This approach is particularly effective in urban areas where water resources may be limited, and it offers a

more sustainable alternative to traditional farming practices, enabling urban dwellers to grow food with minimal environmental impact.

2.2.2. Community-based peri-urban agriculture

Community-based peri-urban agriculture (PUA) typically involves vegetable gardens and community orchards, often designed to meet the needs of local populations. It can also encompass municipal agriculture, which refers to initiatives that are supported or managed by local governments. These practices can take the form of small/large scale residential projects, volunteer-run community gardens, or even mission-based enterprises operated by non-profit organizations (Steele, 2017).

Community-based PUA plays a significant role in enhancing food security at the local level, fostering social connections, and providing urban dwellers with access to fresh, affordable produce. These initiatives often emphasize community participation and can contribute to a sense of collective responsibility for sustainable food production within urban and peri-urban environments.

2.2.3. Controlled environment urban agriculture

Controlled Environment Agriculture (CEA) has evolved from simple greenhouses to more complex systems, utilizing a variety of materials and technologies. This progression includes the development of fully automated glasshouses, vertical farms, and rooftop greenhouses. Unlike traditional agriculture, which requires expansive open land, CEA is often referred to as zero-farming, acreage farming, or indoor farming. These terms reflect the fact that CEA takes place in unused or underutilized spaces, such as rooftops and interior spaces within buildings, rather than on traditional farmlands (Specht *et al.,* 2015).

CEA systems are designed to optimize environmental factors such as temperature, humidity, and light to grow crops in a controlled, indoor environment, making them particularly suitable for urban settings where land is scarce. These innovations not only help reduce the environmental footprint of agriculture but also enable food production in densely populated areas, thus supporting local food security and reducing reliance on long supply chains.

2.2.4. Animal production

A modern trend in animal husbandry in peri-urban areas is lifestyle farming or hobby farming, which is typically practiced by smallholders. Unlike fully or part-time commercial animal husbandry, lifestyle farming focuses more on recreation and personal enjoyment

rather than economic output (Pinto-Correia *et al.,* 2017). Despite its recreational aspects, lifestyle farming can also serve practical purposes, primarily meeting household food needs.

This type of farming often involves the raising and breeding of animals such as horses, mules, donkeys, milking cows, beef cattle, goats, poultry, pigs, rabbits, and sheep. While lifestyle farming may not be driven by profit, these activities can still play a crucial role in household food security, providing fresh meat, milk, eggs, and other animal products, which contribute to the nutritional needs of the family. In addition, it offers an opportunity for urban and peri-urban dwellers to maintain a connection to agricultural practices and become more self-sufficient in food production.

2.3. General Importance of Urban and Peri-urban Agriculture

Urban and peri-urban agriculture (UPA) plays a significant role in alleviating poverty and food insecurity, while simultaneously promoting the health of urban residents and supporting the environment (Ning *et al.,* 2022). This dual impact is particularly valuable in rapidly growing urban centers where food access can be limited and environmental sustainability is increasingly under threat.

In a similar vein, urban green spaces are crucial for creating healthy, sustainable, and livable cities for all population groups, especially for those from lower socioeconomic backgrounds (WHO, 2017). These spaces provide not only aesthetic value but also functional benefits such as access to fresh produce and opportunities for community-based farming initiatives.

Urban and peri- urban agriculture contributes significantly to community health and well-being by reducing hunger, improving food access, and enhancing nutrition. Furthermore, it plays a vital role in improving the environmental conditions that directly affect public health. The benefits of urban agriculture are both quantitative and qualitative: it increases the availability of food, directly addressing hunger, while also improving the quality of food, which in turn fosters better overall health and nutrition for urban dwellers.

In essence, urban and peri- urban agriculture not only feeds populations but also contributes to healthier, more resilient communities by fostering sustainable food systems that are accessible to all, particularly marginalized groups in urban environments.

2.3.1. Social benefit

The physical and cultural environments that shape the narrative of Urban and Peri-Urban Agriculture (UPA) are often influenced by deeply entrenched societal structures and potential

injustices that require careful attention. In other words, the introduction of UPA must navigate and adapt to preexisting frameworks, a transition that is frequently guided by policy interventions (Siegner *et al.,* 2018).

While food scarcity in cities highlights some of the challenges that urban farming aims to address, it also exposes deeper, structural social issues that must be tackled for UPA to become truly economically viable and sustainable. Food insecurity is not merely an issue of agricultural production but is a symptom of wider systemic inequities. Increasing agricultural activities within urban spaces does not automatically guarantee improved food security for the urban population, especially when these larger, underlying issues persist (Horst *et al.,* 2017).

In fact, the integration of agriculture into urban environments must be understood as part of a broader social transformation, where economic and social justice issues are addressed. Without focusing on the structural inequalities that contribute to food insecurity, such as poverty, access to resources, and social exclusion, the success of UPA in improving food security may be limited. Thus, for UPA to be a truly effective and sustainable solution, it must be coupled with policies and initiatives that promote social equity and address the root causes of food insecurity in urban areas.

2.3.2. Environmental sustainability

In the context of agriculture, sustainability refers to a practice aimed at maintaining consistent and stable crop and livestock production over the long term Adigun *et al.*(2017). Sustainable agriculture goes beyond simply increasing food production; it focuses on meeting human needs for food, fiber, and other essential resources, all while safeguarding and preserving natural resources.

According to Adeyanju *et al.* (2023), sustainable agriculture plays a pivotal role in mitigating environmental degradation and preventing the depletion of vital forest resources. At the same time, it promotes economic resilience by enhancing agricultural income and contributing to the reduction of poverty. This approach seeks to create a harmonious balance between economic growth, environmental health, and social well-being.

Sustainable agriculture, therefore, is an integrated and holistic system of long-term plant and animal production that is designed to meet the evolving needs of human populations, while ensuring that agricultural practices are environmentally viable, socially equitable, and economically beneficial in the long run. It aims to create a sustainable food system that can

withstand challenges such as climate change, resource scarcity, and shifting market demands, while ensuring food security for future generations.

2.4. Urban and Peri-urban Agriculture in Ethiopia

Overall, 36% of urban households in Ethiopia engaged in agriculture (crop production, livestock production, or both) during the 2021/22 farming season. At the national level, 19% of urban households participated in crop farming and 31% engaged in livestock farming. Regional differences exist in the participation rate. Households from major urban areas, such as Addis Ababa, Dire Dawa, and Hariri reported lower participation in agricultural activities. In contrast, about half of urban households from less urbanized regions such as Somali, SNNP, and Gambella were engaged in agriculture activities (ESS and World Bank., 2023).

For instance, according to a study by Gibtan *et al.* (2023) , urban and peri-urban agriculture (UPA) has become an increasingly important activity for many urban dwellers in Ethiopia. For example, in Addis Ababa, a significant portion of the population engages in UPA primarily to earn additional income. The study found that over half of the respondents (60.8%) participate in UPA activities with the goal of generating supplementary income. Furthermore, UPA plays a critical role in food security, as it contributes significantly to the provision of agricultural products for home consumption. However, UPA is not usually viewed as a full-time occupation; rather, it is often practiced as a secondary activity. The study showed that only 33.4 percent of respondents engage in UPA as a full-time occupation, while 66.6 percent consider it additional work. This indicates that UPA remains an underutilized opportunity in Ethiopia, with potential for expansion and greater impact on livelihoods.

Peri-urban agriculture (PUA) activities in Ethiopia are also highly diversified, with various practices being carried at different locations (such as riverbanks and open fields) and within the peri-urban centers (community gardens and institutional compounds). In Addis Ababa, the most widely practiced PUA activities include horticulture (48.7%), dairy farming (27.4%), and poultry farming (15%), with poultry production mainly focused on meat production and fattening (8.9%) (Girma *et al*., 2019).

Similarly, both urban and peri-urban agriculture is practiced in Eastern Hararghe zone of Oromia region and Dire-dawa city administration, Ethiopia. The sample households in the study areas are female-dominated (65.7%) household heads. The findings also showed that

UPA adopters (71.1%) had considerably more female household heads than non-adopters (53%).

Ambo and Waliso Towns, Oromia Region, Ethiopia, studies revealed that 60% and 93% of respondents practicing UPA were male-headed households, respectively. The majority of urban and peri-urban agriculture practices in Ambo town were dairy (42%), poultry (19%), combination of dairy and poultry production (12%). While, dairy (46%), dairy and other agricultures (24%), and poultry (11%) were the most common urban agriculture practices in Waliso town (Dawit M. *et.al*, 2024).

In Hawassa city urban agriculture plays in improving the livelihood of the urban poor and the challenges of UPA. According to Gelgelo (2022), three forms of urban agricultural activities namely bio-intensive gardening, backyard poultry keeping, and sheep rearing and fattening was introduced results of the study revealed that urban agriculture has a very positive role in changing the livelihood of the urban poor for the better. It has enabled 76% of the respondents to obtain additional income, while serving 51.4% as a food source, and creating employment opportunity for 29%.

These findings suggest that there is substantial potential for UPA to contribute in income generation, employment and food security, yet much of this potential remains untapped, particularly in terms of transforming UPA into a full-time, formalized sector of the urban economy.

2.5. Urban and peri-urban Agricultural Policy and Strategy of Ethiopia

Ethiopia has made significant strides in economic development through comprehensive policies and strategies, such as the Agricultural Development Led-Industrialization (ADLI) strategy, the Sustainable Development Policy to Reduce Poverty (SDPRP), and the Growth and Transformation Plan (GTP) (Dube *et al*., 2019). These initiatives have brought progress in various sectors, but unfortunately, the urban and peri-urban agriculture (UPA) sector has not benefited from this momentum to the same extent (Amsalu Woldie, 2020). The primary reasons for this lack of attention to UPA include:

Lack of focus from policymakers: UPA has not been prioritized by the government, urban planners, and policymakers. Despite the clear potential of UPA in addressing food insecurity and providing livelihoods for urban populations, it has not received the necessary attention in national development strategies.

Absence of extension programs and technology: The sector lacks proper extension services and modern agricultural technologies that could increase productivity and make UPA more sustainable and profitable.

Inadequate land use policies: Land use regulations are often inappropriate for UPA, leading to difficulties in land acquisition and use, which hampers the expansion of urban farming practices.

Health and environmental concerns: The health and environmental dimensions of UPA, such as food safety and waste management, have not been sufficiently addressed, leading to perceptions of UPA as a less reliable or hazardous activity.

Lack of policy frameworks for UPA: Ethiopia does not have a dedicated policy framework to guide UPA. This sector has not been included in key documents such as the National Urban Development Policy (2005), the urban development and construction aspect of PASDEP (2006), and the Urban Lands Lease holding Proclamation (2011). As a result, urban farmers operate without formal recognition or the legal support that could help them improve their practices and secure their livelihoods.

These challenges point to a significant gap in Ethiopia's development policies and urban planning frameworks, highlighting the need for urgent attention to UPA. Developing a comprehensive and supportive policy framework for UPA would provide a clear structure for urban farmers, helping them access resources, markets, and technical support while ensuring that UPA contributes more effectively to urban food security and economic stability.

2.6. Constraints of Urban Agriculture

Urban and peri-urban agriculture (UPA) in Ethiopia faces several challenges that hinder its growth and development, despite its potential to contribute significantly to food security, income generation, and environmental sustainability (Ayele, 2021). Some of the key obstacles include:

2.6.1 Space for cultivation and livestock keeping

Land access and security of tenure remain major challenges for urban farmers (Adamie, 2021). The lack of clear land ownership rights creates uncertainty and reduces farmers' willingness to invest in their activities. This issue is particularly pronounced in Addis Ababa, where urban farmers often operate without formal recognition of their land use, which restricts their ability to expand or improve their agricultural activities.

2.6.2. Lack of market and agricultural technologies

Urban agriculture in Ethiopia is also hindered by limited access to agricultural inputs such as seeds, fertilizers, pesticides, and equipment (Alene & Aga, 2023). Additionally, urban food markets are typically structured to import food from rural areas, and agricultural input firms tend to focus on supporting rural agriculture. This lack of market infrastructure and technological support makes it difficult for urban farmers to increase productivity and access markets efficiently.

2.6.3. Extension contact and institutional service

Another significant challenge is the lack of modern agricultural knowledge and technical support for urban farmers. Many urban farmers are not well-trained in contemporary farming practices, which limit their ability to improve their productivity. Without adequate extension services or institutional support, farmers cannot adopt modern farming methods or optimize their output, thereby limiting the potential of urban agriculture to contribute to food security and income generation (Wonde *et al*., 2022).

2.7. Empirical Literature Review

It's far anticipated that approximately 800 million humans global interact in urban agriculture, and it is concept that globally, generating 15-20 percentage of the world's food access in the mid-1990s (Ahmed *et al.*, 2024). The distinguishing functions of UPA are ecological, social and economic integration within the urban gadget. Those features are stimulated by way of resources like land, hard work, and production and generate impacts via food security, surroundings, economy, fitness (health), poverty and subculture (Rich *et al*., 2018).

Urban agriculture is recognized globally for its potential to address food security and contribute to the economy. Studies have shown that urban agriculture has significant positive effects on household income and food security. For example, a study by Ofordu *et al.* (2022) in Ibadan, Nigeria, found that about 54% of respondents participated in urban farming, with significant income benefits. In Uganda (Kampala city) urban agriculture has been a vital livelihood strategy of urban households; results indicate that; urban agriculture is an evolving urban activity. This evolution and continuities were driven by the merits of urban agriculture (food, jobs and income) to urban dwellers. Urban agriculture also contributed to the economic inclusion of women and the urban poor. There was household resource logic in practicing urban agriculture, especially in the private sector, where jobs were scarce. In view

of these innovations, the urban authorities were supporting urban farmers with demonstrations and certified inputs for farmers in Kampala and beyond.

Peri-urban agriculture (PUA) and its impacts on smallholder livelihoods were studied in Arusha, Tanzania. The peri-urban farming area per household is small with a quarter to one acre but their farming systems had both livestock and crops. Although there are no specific policies on peri urban agriculture, households have changed their farming practices due to government and private sector interventions. It was revealed that peri-urban agriculture provides food and is the main source of income for the smallholders that helps cover health and education costs. The livelihood forms of capital varied across the study area with some having more forms of capital than others (Aremu & Ariyawardana, 2022).

Diversification in peri-urban agriculture study in the Ruhr metropolitan region was also conducted: Younger, risk seeking farmers with secured farm succession and less productive soils are more likely to choose on-farm non-agricultural diversification (employment). Additionally, they found that diversification intensity is positively influenced by proximity to urban areas, as well as a specialization on high value crops and the usage of extension service consultancy (Meraner *et al*., 2018).

In Ethiopia, Yalew 2021, noted that urban agriculture provides opportunities for urban dwellers to diversify their food sources and recycle urban waste, contributing to sustainable urban development and the Addis Ababa City structure Plan AACPP (2017), encompass provisions for enhancing UPA to make sure food protection, economic empowerment via task possibilities, improved production that advantages city dwellers, and environmental protection.

Firehiwot and Degefa (2015)investigated urban agriculture's role in food security within Yeka Sub-City, Addis Ababa. The study found that urban agriculture contributes significantly to household income and food security but also identified challenges such as limited access to land and water. This points to the necessity of analyzing institutional and policy factors affecting urban agriculture.

In Bishoftu a study by Daniel and Getaneh (2016) found that factors like access to land, inputs, credit, and education significantly influenced employment generation in urban agriculture in Ethiopia.

Moreover, Debela and Mohammed (2020), conducted a study in Hawassa, Ethiopia, on the role of urban agriculture in improving the livelihood of the urban poor. Their findings

indicated that urban agriculture led to an increase in household income, with more respondents reporting higher income levels after engaging in urban farming.

Determinants of Urban Agricultural Practices and Its Impact on Household Food Security: In Case of Bako Town, Oromia Regional State, Ethiopia: The result show that age of household heads, marital status, extension contact, total livestock unit, market distance, cooperative membership, and land size influence UPA positively; and family size, dependency ratio, risk preference of household heads, and education level influence UPA negatively. Result from PSM suggests that UPA brought a positive significant impact on household food security (Guta & Irge, 2024).

Impact of agricultural enterprises on employment creation and income generation in Hadiya Zone, Ethiopia: The result revealed that the average increment of household's annually employment creation by about 4 people (33.98%) and income generation by Birr 12,339.00 (32.57%). The result showed that membership in MSAEs (Micro and Small Agricultural Enterprises) had a significant and positive impact on employment creation and income generation and the impact estimates were found to be insensitive to unobserved selection bias (Ababiya, 2020).

Impact of small-holders' cattle fattening on household income generation in Fadis district of Eastern Hararghe Zone, Oromia, Ethiopia: Logit estimation revealed that participation in cattle fattening is significantly influenced by five variables. Age of household head, labor force in family member, market information, access to agricultural extension services and number of livestock are significant variables which affect the participation of the household in cattle fattening practices whereas propensity score matching results revealed that household participated in cattle fattening practice have got 14,071 more farm income and 12,617 total household income in Ethiopian Birr (ETB) than those household that were not participated in fattening practices (Ahmed & Gute, 2018).

2.8. Conceptual Frame Work of the Study

Figure 2.1 presents the policies, institutions, determinant factors, vulnerability contexts, livelihood strategies and livelihood outcomes of urban and peri-urban agricultural practices framework and its impact on household's farm income and employment with the main concepts used, that is, factors, activities, and outcomes

This framework could be used to analyze and visualize how the various livelihood systems affect the activities within urban and peri-urban agricultural practices and how those

activities, in turn, contribute to improved livelihoods, farm income, and employment opportunities for households. The framework seems to break down into five key concepts:

1. Policies (Laws, Cultures, Structures like government sectors and private sectors)

2. Factors (Assets, Infrastructures, Social Capitals, Institutional Factors, Demographics, Location). These factors influence the activities that households engage in to achieve their livelihood goals.

3. Activities/Livelihood Strategies

These are the actions that households engage in to achieve their livelihood goals, which could include various agricultural practices, such as:

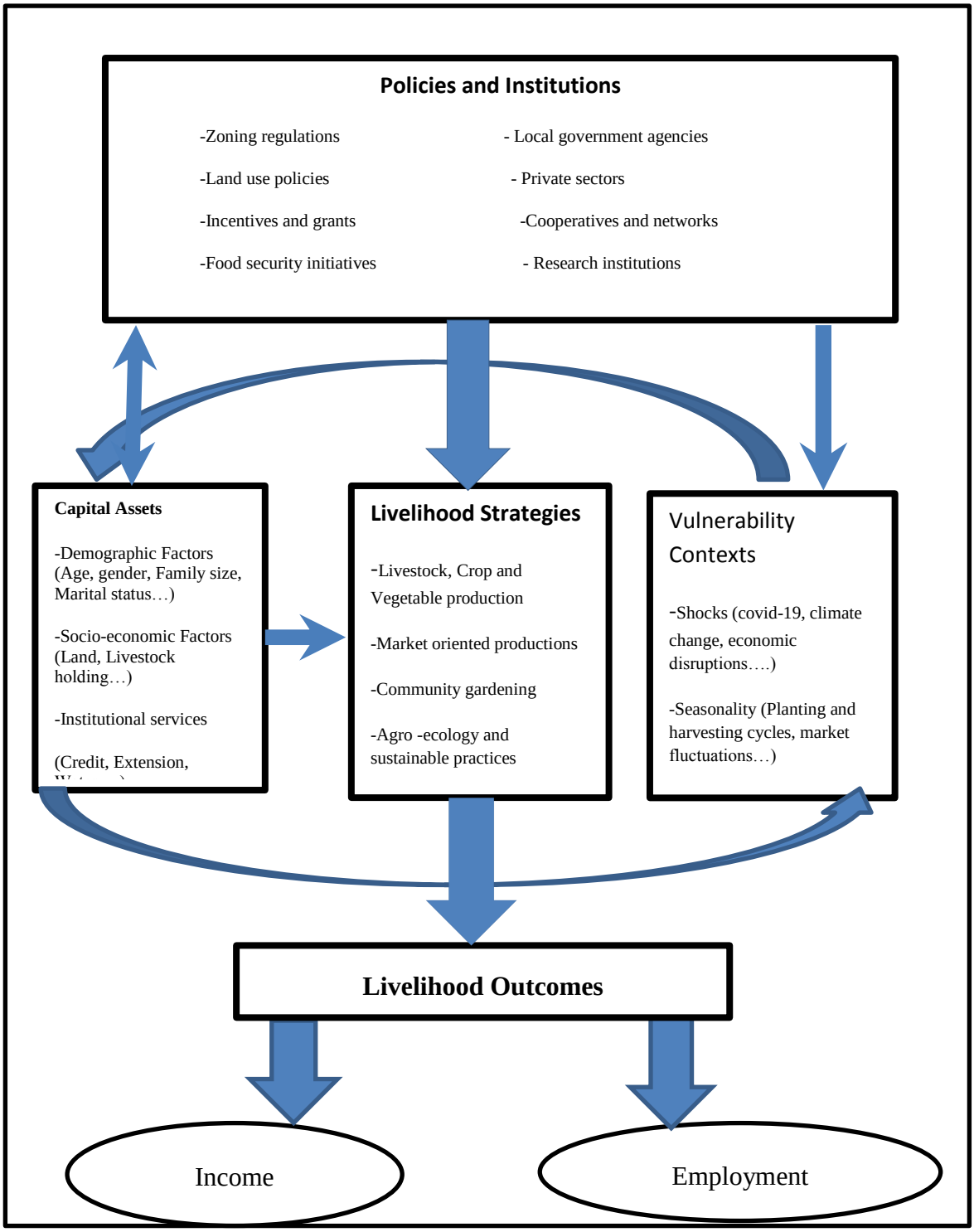
- Crop production, Livestock farming (poultry, dairy, cattle, etc.), Vegetables and fruit production, non-agricultural diversification strategies (e.g., off-farm income, Selling or trading agricultural products in urban or peri-urban markets).

4. Vulnerability Contexts (shocks, seasonality's, critical trends)

5. Outcomes

The outcomes of these activities focus on the economic, social, and environmental impacts that result from urban and peri-urban agricultural practices. These include:

- Farm Income: The revenue generated from selling agricultural products.
- Employment: Job creation both for household members and possibly for others in the community, contributing to overall livelihoods.



Source: Sustainable Livelihood Framework

Figure 2.1: Conceptual framework of the study

CHAPTER THREE: METHODOLOGY

3.1. Description of the Study Area

3.1.1. Location

The capital of the Tigray National regional state, Mekelle, is situated between latitudes 13º 32' north latitude and 39º 28' east longitude. Emperor Johannes 4th founded it in 1860s. It is located 783 kilometers from Addis Ababa in Ethiopia's northern highlands, covering an area of 259.9 square kilometers. The city is fully bounded (360º) by Enderta district in all directions. According to Negese *et al*. (2017), the town territory's primary landforms fall into four categories: flat to gently sloping, gently sloping to rolling, slope to fairly steep, and steeply to very steeply sloping and the city's best peaks are the Enda-Eyesus ridges on the eastern side.

3.1.2. Topography

A young fault block mountain of tiled lime stone beds surrounds it with related intrusive dolomites in the northwest and Dolomite inventory fountain to the east. The common elevation of the metropolis ranges between 2000 to 2200 meters above sea level. The city is cut up inside the north through the drainage gadget of river Ellala.

3.1.3. Population

Tigray's capital, Mekelle, has a population that is occasionally growing. Daily laborers, civil servants, and small-scale traders make up the majority of the town's population. One of Ethiopia's most densely populated cities is Mekelle. It has appeared to be a sub-city. According to OCHA (2017), there are 555,769 people living in Mekelle. Males make up 50.58 percent of this population. As the population grows, so does the construction of residential homes and other financial and social infrastructure. Additionally, Mekelle is anticipated to be the hub of management, politics, change, and enterprise, as well as a route and destination to specialized fields.

Figure 3.1 shows the location map of the study area of Aynalem and Metkel kebelles, Hadnet sub-city, Mekelle, Tigray, Ethiopia.

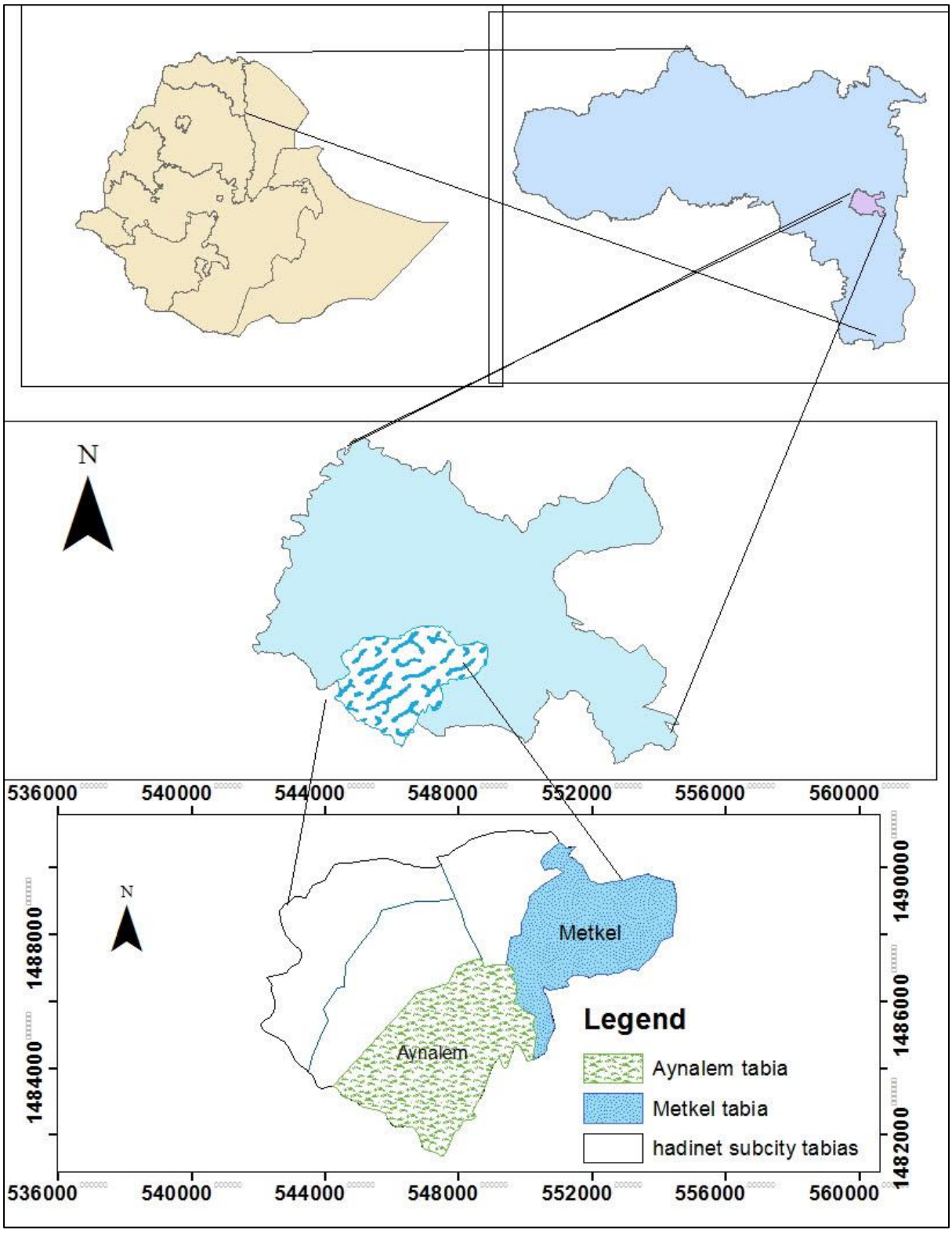


Figure 3.1: Map of Aynalem and Metkel kebelles, Hadnet sub-city, Mekelle

3.1.4. Unemployment

Mekelle town is experiencing a high unemployment rate. According to a 2020 survey by the Central Statistical Authority, the unemployment rate in Mekelle stood at 22.4%. An estimated 41,495 individuals were unemployed, with men making up 40.4% and women 59.6% of the unemployed population.

3.1.5. Source and magnitude of the income

When we see the occupation pattern, income level and poverty line of the city according to the house hold survey done for the Mekelle Structural plan 2014, it can be presented as follows: Private business is the most common form of occupation with about 23.5% of the total respondents. This is followed by government employment which is only roughly one percent less from that of the private business (22.5%). A point worth noting is that multiple employments are very small with only roughly 2.2% of the total and the size of dependents is quite big with a share of 20.8% of the total. The city has a fair degree of household income source diversification. Households with multiple sources of income have a significant contribution with roughly 23%. Salary is the most important income generating 31.7% of the total household income. It is followed by, as might be expected, income from trade which accounts for about 28.8% of the total household income. Households in Mekelle have an average income of roughly 2800 birr per month (Negese *et al.,* 2017).

3.2. Sampling Techniques and Sample Size Determination

To gather both quantitative and qualitative data, selected sample households were interviewed. Quantitative data were used to measure variables, while qualitative data provided additional context. The study applied a probability-based multi-stage random sampling method.

Mekelle was purposively chosen as the study site for three key reasons. First, it is the largest city in the Tigray region, home to a significant number of urban and peri-urban farmers, making it representative of their socioeconomic conditions. Second, there has been limited research conducted on this topic in the area. Third, the study aims to enhance understanding of the contributions of urban and peri-urban agriculture both locally and nationally. Additionally, Mekelle is one of the cities in Tigray that has attempted more to implement a UPA (Urban and Peri-Urban Agriculture) policy framework than other cities of Tigray, allowing for an assessment of related policies, zoning regulations, and support mechanisms within the city.

The study employed a multi-stage sampling method. In the first stage, one sub-city, Hadnet, was purposively selected from the seven sub-cities where UPA is practiced to varying degrees. Hadnet was chosen due to its accessibility to academic and research institutions, socioeconomic diversity, and high participation rate in UPA—approximately 76.5 percent of farm households compared to 45–55 percent in other sub-cities—based on consultations with agricultural extension coordinators and Kebelle-level UPA experts office.

In the second stage, two out of five Kebelle's within Hadnet sub-city were randomly chosen due to their homogeneity that is "Metkel" as urban which practices within city boundaries and densely populated areas and "Aynalem" as peri-urban that is on the transitional zone between urban and rural areas.

In the third stage, households were stratified into two groups: based on seasonal production capacity, technology utilization (fertilizer, improved seed, hybrid livestock)and farming scale(small/large scale or single/mixed activity) to differentiate higher participants and lower participants (Gelan, 2016) (Tebeje & Bokore, 2020). In the fourth stage, using lists provided by Kebelle UPA offices a total of 1284 household level farmers, 1060 from Kebelle Aynalem and 284 from Kebelle Metkel respectively, thus a total of 305 representative samples were then drawn randomly from each category based on proportional to probability size as livestock only, vegetables only, livestock and crops (cereals), livestock, crops (cereals), and vegetables, and Lower-participants (crop only).

Various approaches were considered to determine the appropriate sample size, including conducting a census for small populations, referencing sample sizes from similar studies, using standardized tables, and applying statistical formulas. This study was applied a simplified formula provided by (Yamane, 1967) in order to determine the required sample size at 95% confidence level, degree of variability of= 0.5 and with the level of precision of 5% is:

$$\eta = \frac{N}{1+N(e)^2} = \frac{1284}{1+1284(.0025)} = 305$$

Where n=represents the total sample size, N= represents the number of households size and e=represents the level of precision. Based on the above formula 305 household heads were selected by the researcher.

The distribution of the kebele-wise sample size is given in Table 3.1

Table 3.1: Distribution of sample size

Kebelle's Name	Residence	Total house hold head	Number higher participants	Number lower participants	Proportionally determined sample size		
					Higher Participant	Lower-participant	Total
Aynalem	Peri-urban	1,060 (82.6%)	513 (48.4%)	547 (51.6%)	122	130	252
Metkel	Urban	224 (17.4%)	110 (49.1%)	114 (50.9%)	26	27	53
Total		1,284 (100%)	623 (100%)	661 (100%)	148	157	305

Source: Aynalem Office of urban and peri-urban agriculture (UPA) experts (DAs)

The academic and research institutions were helpful in several ways: First as knowledge generation and innovation by conducting research that advances the understanding of urban and peri-urban agriculture practices, technologies and systems to the respondents, second as interdisciplinary collaboration for UPA intersects with various fields thus facilitates it which lead to a comprehensive approaches to urban and peri-urban agriculture challenges, third as capacity building and education by giving training for experts and community members on urban and peri-urban agriculture practices sustainability and food security, fourth as policy development and advocacy to inform policy makers about the benefits and challenges of urban and peri-urban agriculture.

3.3. Data Type and Sources

The study employed cross-sectional data, focusing on smallholder urban and peri-urban agriculture (UPA) producers as the unit of analysis. Both quantitative and qualitative data were gathered from primary and secondary sources. Primary data were collected through interviews with selected households using a semi-structured questionnaire conducted at their residences. The questionnaire covered various topics to capture key socioeconomic characteristics of respondents. Monthly income from non-agricultural sources was also recorded, as it plays a significant role in determining total household income and the socioeconomic status of urban and peri-urban farmers. All financial figures referenced were based on annual income reports for the 2024 production year. Information regarding employment, income, and other relevant data was gathered from UPA higher participants, lower-participants, and urban agriculture development agents in Hadnet Sub-city.

Secondary data were obtained from both published and unpublished reports issued by government bodies, NGOs, and international research institutions involved in UPA. Policy documents and strategic directives related to urban and peri-urban agriculture were reviewed from the Mekelle urban agriculture offices which are used for triangulation of the results discussed. Additional resources included findings from Mekelle University College of Dry land Agriculture and Natural Resources (CoDANR) research papers, the Tigray Agricultural Research Institute (TARI), and the Ministry of Agriculture and Rural Development (MoARD) yearly report to confirm the findings of the research.

3.4. Method of Data Collection

The survey method, specifically a questionnaire, was used to collect primary quantitative data on the socioeconomic aspects of UPA, its determining factors, and its impact on income generation and employment. The questionnaire consisted of both closed and open-ended questions and was pre-tested and revised accordingly. During the pilot test, twelve UPA owners were randomly selected. For the survey, three enumerators that have greater than 5 years' experience were recruited and trained in both the content and administration of the questionnaire. The data collection took place in July 2024 under the supervision of the principal researcher.

To gather qualitative insights into the socioeconomic characteristics, challenges, and opportunities related to UPA, in-depth interviews were conducted with a sample of UPA owners selected randomly. These interviews provided valuable information. Likewise, officials from the UPA support office were interviewed on various topics, such as factors influencing the extent of UPA contribution, job creation, types of UPA practices, and associated constraints.

Focus group discussions were also used to explore community perspectives on factors influencing adoption, and to engage stakeholders in discussions on common challenges and opportunities in UPA. Two-focus group consisting of sixteen respondents: Eight UPA owners from kebelle Aynalem while eight from kebelle Metkel were formed. The groups have different composition four elder farmers, three youths and one female from each group. A checklist guided the discussion which has seven questions.

In addition, direct observation was used to collect qualitative data on socioeconomic conditions, contribution determinants, and UPA challenges and opportunities through site visits. During these visits, the researcher remained a passive observer. Observations were also

made to evaluate the functionality, sustainability, and general state of the existing UPA initiatives in the sub-city.

3.4. Method of Data Analysis

Both qualitative and quantitative techniques were employed to analyze the data. Descriptive statistics such as frequency distribution, graphs, plots and percentage were employed for the socioeconomic characteristics, challenges and opportunities of UPA households. Multinomial Logistic Regression (MLR) model was used to examine the determinant factors on the adoption of UPA practices, the Logit Regression Model to estimate propensity score, Propensity Score Matching (PSM) model to estimate the effects of urban and peri-urban agriculture practices on employment creation and income generation and Likert scale method composed of a series of five Likert-type items (not-important, less important, undecided, important and very important) were used to describe the opportunities and constraints of UPA.

3.5.1. Model Specification

When the households participate on urban and peri-urban agriculture, they decide to participate in a particular agricultural category. Therefore, the households in the study area take into account the determinants of urban and peri-urban agricultural practices after identifying the types of urban and peri-urban agricultural practice. Multinomial Logit models were used to analyze the determinants of urban and peri-urban agricultural practice. The multinomial (polytomous) logistic regression model is used when the dependent variable has more than two nominal or unordered categories, in which dummy coding of independent variables is quite common.

The generic form of such model is given by

$$y_{ij} = \theta_0 + \theta_1 x_{1ij} + \theta_2 x_{2ij} + \cdots \theta_k x_{kij} + \mathcal{E}_{ij}$$

Y_{ij}=UPA practices which includes UPA lower-participants(crop/cereal only) (0), livestock production only (1), crop production only (2), vegetable (fruit) production only (3), both crop, livestock production (4), crop, livestock, vegetable production (5), which are used as dependent variables.

Checking Model Adequacy

Once a model has been fitted to a given data, it is a good statistical practice to check the adequacy of the model, which is essentially checking the agreement between the observed and fitted values under the model. If the agreement between the observations and the corresponding fitted values is good, the model may be acceptable. If not, the current form of the model will certainly not be acceptable and the model will need to be revised. This aspect of the adequacy of a model is widely referred to as goodness of fit (See appendix-III).

Testing Significance of Model Parameters and the Effect of Adding Terms

In order to test model parameters the distribution of the estimates need to de known. Under certain regularity conditions the maximum likelihood estimates have an asymptotic multivariate normal distribution with expected value equal to the true parameters. A test procedure that uses this general result is the Wald test, which can be used to test individual as well as several parameters at a time (See Table 4.8).

Multicollinearity

Refers to a situation where there is either an exact or approximately exact linear relationship among the predictor variables. In other words Multicollinearity is the degree of redundancy or overlap among explanatory variables. The existence of Multicollinearity makes it hard to get coefficient estimates with small standard error. Then the existence of this situation was conducted by VIF and contingency coefficients to test the Multicollinearity problem among continuous and dummy/categorical variables respectively. If VIF is greater than 10 it shows serious Multicollinearity between independent variables. The mean VIF is found to be 1.52, indicating non-existence of the problem. The value of contingency coefficients ranges between 0 and 1. A value close to 0 refers to weak association and values close to 1indicate strong association, additionally if a contingency coefficient is greater than 0.75 it shows there is strong association among dummy variables (See appendix-II).

Propensity Score Matching (PSM)

In this study, PSM is employed in order to evaluate the impact of urban and peri-urban agriculture on employment and income generation. The matching technique is widely used in impact evaluation in the absence of baseline data and when randomization is very unlikely. Effects estimated with parametric models are more biased and less robust to miss specification of regression functions than those based on matched samples (Rosenbaum & Rubin, 1979).

The alternative to the experimental approach is the use of quasi-experimental approaches, which seek to create, using empirical methods, a comparable control group that can serve as a reasonable counterfactual. These approaches try to estimate the impact of an intervention when individuals are not randomly assigned to treatment and control groups.

Some common quasi-experimental approaches to evaluate the impact of development programs include propensity score matching (PSM), difference-in-difference (DID), regression discontinuity design (RDD), and instrumental variables (IV) estimation (ADB, 2006). The selection of a proper impact evaluation method depends on understanding the assignment rules of the program (Gertler *et al.*, 2016).

As Bennett, 2023 concluded that there is empirical problem when there is typical absence of data concerning the counterfactual: how would the performance of urban and peri- urban farmers have been; if these farmers had not joined the urban and peri- urban farming? The main challenge will be to identify the counterfactual (i.e., identifying suitable comparison group of non-participants whose outcomes provide unbiased estimate of the outcome that participants had from urban and peri- urban agriculture). As a result of non-random selection of urban households into urban and peri- urban agriculture and self-selection problem, simple comparison of participants and non-participants would give biased estimate. This is ordinary least square estimation, which is quite naive because it assumes both groups, do not differ systematically.

Using OLS method would bring a bias into our analysis, as there is a counterfactual problem. We cannot compare two groups when they are systematically different from each other. In this study, propensity score matching technique was adopted to develop the counterfactual group (the control group). Since matching improves the performance of the estimator by imposing the common support condition. This method used statistical technique to create an artificial control group by identifying for every treated observation as an untreated observation that has the most similar (observable) characteristics. The estimator was also cross-sectional estimator since the data was a onetime data. The research adopts two steps to undertake the analysis.

The first step was using Logit model, in estimating the propensity score. The participation decision in UPA was regressed on variables that simultaneously determine participation in UPA as well as impact indicators (income). Logit method was used because the dependent variable (UPA) is a dummy.

The Logit model (L), following Gujarati & Dawn C. Porter (2009) was constructed over probabilities. Accordingly, given the probability of being in the UPA practices (Pi)

$$L_{i=} \ln(p_i/1 - p_i) = Z_i = \beta_1 + \beta_2 x_i + u_i$$

Where, Pi is the probability of higher-participation, (1-Pi) the probability that a household belongs to lower-participants, e =2.71828, i = 1, 2, 3, - --, n, β1=intercept, β2= regression coefficients to be estimated, Xi = pre-UPA participation characteristics and Ui= a disturbance term. Subsequently, inference about the impact UPA practices on the outcome parameters of an individual involve speculation about how this individual would have performed had (s) he not received UPA practices components. Therefore, the standard framework in evaluation analysis to formalize this problem; i.e., the potential outcome approach or Roy–Rubin model was used. The main pillars of this model are individuals, treatment, and potential outcomes. In the case of a binary treatment, the treatment indicator Yi equals one if individual i receives treatment (i.e., if highly participated in the UPA) and zero (i.e., if low- participated in the UPA) otherwise. The potential outcomes are then defined as Yi for each individual i, where i =1... N and N denote the total population. The treatment effect for an individual i can be written as:

$T_i = y_i(1) - y_i(0)$;

Where Ti is the participation/treatment effect for an individual i, Yi (1) and Yi (0) are the potential outcomes with higher and with lower participation, respectively. In our case, the potential outcomes were net annual household income gained from Animal, Vegetable and crop production incomes.

In general, following Heinrich *et al.*,2010, the mean impact of the UPA is obtained by averaging the impact across all the individuals in the population, which is known as the average treatment effect (ATE), and defined as

ATE= $E\ (y_1 - y_o)$

Another parameter of interest is the average treatment effect on the treated (ATT) measuring the impact of the UPA on those households who participated

ATT= $E\ (y_1 - y_0/D = 1)$

PSM has two basic assumptions stated as follows (Heinrich *et al.*, 2010):

Assumption-1-(Conditional Independence Assumption or CIA): there is a set of covariates (X), observable to the researcher, such that after controlling for them, the potential outcomes are independent of the treatment status i.e. (Y1, Y0) ⊥d/X

The CIA is crucial for correctly identifying the impact of the UPA since it ensures that, although higher participants and lower-participants differ, these differences may be accounted for to reduce the selection bias. This allows the lower-participants to be used to construct a counterfactual for the higher participants.

Assumption-2-(Common Support Condition): for each value of X, there is a positive probability of being both treated and untreated i.e. $0 < P(D = 1/X) < 1$

This implies that the probability of receiving treatment (i.e. UPA) for each value of X lies between 0 and 1. This means, by the rule of probability, the probability of not receiving the UPA lies between the same values. This is also known as overlap condition because it ensures that there is sufficient overlap in the characteristics of the participants and non-participants to find adequate matches (or common support). When these two assumptions are satisfied, the treatment assignments are said to be strongly ignorable (P. R. Rosenbaum & Rubin, 2006).

Testing the matching quality: This is checking whether the matching procedure can balance the distribution of different variables or not. Since we are conditioning on propensity score estimation is not to obtain a precise prediction of selection into treatment, but rather to balance the distributions of relevant variables in both groups. While there are different procedures available to check, the basic aim of all of them is to compare before and after matching and if there still exists any difference after conditioning on propensity score. If the differences exist, there is an indication of incomplete matching and suggests remedial for actions (Caliendo & Kopeinig, 2008).

Sensitivity analysis: The final step in the implementation of PSM is checking the sensitivity of the estimated results (Caliendo *et al.*, 2005). Matching method is based on the CIA, which states that the evaluator should observe all variables that are simultaneously influencing the participation decision and outcome variables. The estimation of treatment effects with matching estimators is based on the selection at observables assumption. However, a hidden bias might arise if there are unobserved variables which affect assignment into treatment and the outcome variable simultaneously which abolish the CIA. To check the sensitivity of the

estimated ATT with respect to deviation from the CIA, it is suggested that the use of Rosenbaum bounding approach is appropriate (Rosenbaum, 2002).

Analyzing Likert- scale: These are used to measure respondents attitude to a similar question or statement combined into a single composite score/variable. Likert scale data can be analyzed as interval data i.e. the mean is the best measure of central tendency. To analyze the data it is usually coded as follows: 1=not important; 2=less important; 3=undecided; 4=important; 5=very important. It allows respondents to express their level of importance or not important with a series of statements, providing a quantitative measure of subjective constructs. The scores were summed or averaged across multiple items to create a composite score for the construct being measured.

3.6. Explanations of Variables and Hypothesis Formulations:

Dependent variable: In this study the treatment variable is urban and peri- urban agricultural practices (UPA). The variable is categorical variable and assigned 0=for lower-participant (crop/cereal only producer), 1=for livestock only production, 2=for crop (cereal) only production, 3=for vegetable only production, 4=for livestock and crop (cereal) production, and 5=for livestock, crop (cereal) and vegetables production households. UPA is hypothesized to influence income and employment status of household positively.

Higher participants are individual farmers who are engaged directly in the cultivation, processing and management of urban and peri- urban farming activities. For example those farmers who utilize improved agricultural technologies(fertilizer, improved seed, hybrid livestock's), produce two times per a year/season, experience greater than one year, members of cooperatives, have access to legal farm lands.

Lower participants are those engaged not directly in the day to day farming activities. For instance those farmers whose participation is limited to specific UPA activity (single), low productivity (ones per season /year), have small scale farms (vacant spaces), minimum package of input users(fertilizer, improved seed, hybrid livestock's), no access of legal farm land , and less experienced (less than one year).

Outcome variable: The outcome variables are income and employment. They are continuous variables and are measured by annual net farm income, and number of employees per year. This study also hypothesized that, income and employment status of household are expected to be influenced by UPA positively.

Independent variables: The explanatory variables included in PSM are similar to those mentioned above, except the difference in measurement for some variables. This is because a variable that affects UPA but not income and employment should be excluded and hence to include the covariate variable. The summary of operational variables is depicted in Table 3.2

Table 3.2. Summary of Variable Definition and Measurement

Variable name	Type	Measurement unit	Expected hypothesis on UPA
Outcome variables			
Income	Annual net farm income	continuous variable ETB	+
Employment	Is the total number of employee per year	Number	+
Treatment variables			
UPA	Categorical variable: 0=lower-participant (cereal only), 1=Livestock production only, 2=livestock only, 3=livestock +crop (cereal), 4=livestock, crop (cereal) and vegetable production.		
Control variables			
Age HHH	Age of household head	Continuous measured in years	+/-
Sex HHH	Gender of household head	Dummy takes 0=for female, 1=for male	+
Educ HHH	Education of household head	Continuous measured in years of schooling	+/-
Family size	Family size	Continuous measured in number	+
DR	Family dependency to labor force	Continuous measured in ratio	-
Land size	Land size	Continuous measured in hectare	+
Fertilizer use	Amount of fertilizer used per year	Continuous measured in quintal	+
TLU	Total livestock holding	Continuous measured in number	+
Experience	Farming experience	Continuous measured in years	+
Off-farm income	Annual off-farm income per year	continuous variable measured in ETB	-
Farm cost	Annual total cost of farm per year	continuous variable measured in ETB	-
Farm distance	Distance from farm to home	continuous variable measured in minutes	+

CHAPTER FOUR: RESULTS AND DISCUSSION

This chapter divided in to two sections: Quantitative and qualitative analysis. The quantitative part subdivided into three sub-sections. The first part presents the descriptive statistics on the social, demography, and economics characteristics of the sampled households. The second section, presents the results and discussion on the impact of urban agricultural practices on household farm income and employment in the study area, the third section refers to the results and discussion on the determinants of urban and peri-urban agriculture (UPA) agricultural practice, whereas the qualitative part encompasses FGD discussions on the challenges and opportunities' of urban and peri-urban agriculture (UPA) by urban and peri-urban farmers.

4.1. Descriptive Results and Discussions

4.1.1. Demographic and Socio-economic Characteristics of Respondents

A summary of the socio-economic characteristics of the sampled households used in this study is shown in Table 4.1. Out of the 305 households that were included in this study sample, only 148 (48.5%) of the households were practicing farming highly while 157 (51.5%) were lower-participant. Comparably, results further show statistically significant differences in the households' characteristics between urban and peri- urban agriculture higher participants and lower-participants.

Age of household head: The ages of the household heads surveyed ranged from 23 to 82 years, with an overall average of 49.02 years. When disaggregated, the mean age for urban and peri-urban agriculture (UPA) higher participants was 47.17 years, while for lower-participants it was 50.76 years. Statistical analysis revealed that this age gap is significant at the 10 percent level, indicating a meaningful difference in age distribution between the two groups. This suggests that relatively younger household heads are more likely to participate in UPA activities thus create employment and income opportunities.

Educational Status of Household Head: Education is considered a key determinant influencing a household's capacity to diversify its livelihood strategies. The average years of schooling for UPA higher-participants was 7.07 years of schooling, compared to 6.09 years of schooling for lower-participants. Thus education is a crucial for enhancing awareness and adoption of improved agricultural practices. The statistical analysis showed a significant difference at the 5 percent level in educational attainment between higher-participants and

lower-participants. This implies that education level have a strong differentiator in participation in UPA within the study area.

Farming experience: On average, higher participants had 15.75 years of farming experience, while lower-participants had 14.38 years. This indicates that both groups possess substantial experience in farming. Such experience is assumed to contribute positively to skill acquisition and the efficiency of UPA practices. Experience might improve the farmer's skill at production. Farmers with higher experience appear to have often full information and better knowledge and were able to evaluate the advantage of the practicing UPA is considered. Hence it is hypothesized to affect participation in different livelihood strategies positively (Yesma, 2013).

Distance from Home to Farm: The survey found that the average distance from a household's residence to their farm was 13.6 minutes across the sample. UPA higher-participants had an average farm distance of 8.49 minutes, whereas for lower-participants it was 18.4 minutes. The t-test results confirmed a statistically significant difference at the (1%) level. This implies that proximity to farm plots plays an important role in participation, with closer distances likely enhancing the feasibility of regular farm management and engagement.

Household family Size: The overall maximum household size in the sample was ten individuals and minimum one, with a high mean dependency ratio of 0.29. Specifically, higher-participant households had an average of 5.98 members, compared to 5.38 members for lower-participants. From this we can conclude that, household size is the determinant factor of membership in UPA practices in the study area.

Dependency Ratio: Dependency ratio, defined by the proportion of non-working members (under 18 and over 65 years), was 0.24 for higher-participants and 0.34 for lower-participants, showing a significant difference at the (1%) level. This indicates that lower-participating households tend to have a higher number of dependents, potentially limiting their ability to engage in labor-intensive activities like UPA. Thus, a lower dependency burden may be associated with higher likelihood of participation in urban and peri-urban agriculture (UPA) (Abebe & Bekele, 2014).

Land Holding: On average, higher-participants owned 0.66 hectares of land, while lower-participants held significantly more, at 0.80 hectares. The t-test confirmed that this difference is statistically significant at the (1%) level ($t = 2.9954$). This suggests that lower-participants, with larger land areas, may favor extensive or monoculture farming practices. In contrast,

UPA higher participants, operating on smaller plots, are more likely to adopt intensive, diverse, and localized production methods such as zero-grazing, or use of vacant urban and peri-urban spaces (Tesfaye, 2017).

Tropical Livestock Unit (Holdings): Livestock ownership, measured in Livestock holding Units, averaged 14.22 across the sample, with values ranging from 0 to 32. Higher participants owned an average of 15.4 livestock holding, compared to 8.45 livestock for lower-participants. The difference was statistically significant at the (5%) level. This suggests that larger livestock holdings may encourage or reflect active participation in UPA, as livestock is a key component of integrated urban farming systems.

Off/Non-Farm Income Activities: Households in the study area engaged in a variety of off-farm and non-farm activities, including house rentals, small-scale trade, meat processing, milling, handicrafts, traditional beverage sales, pensions, and guard services. The mean annual off-farm income for UPA higher participants was 70,203.50 birr, compared to 76,502.66 birr for lower-participants. A t-test confirmed that this difference is statistically significant at the (5%) level. While lower-participants had slightly higher off-farm earnings, this may reflect their reduced reliance on farming as a primary livelihood strategy.

Table 4.1: Demographic and socio-economic characteristics (n=305)**.**

Variables	Higher-participant		Lower-Participant		Both		□2/t-value
	Mean	Std	Mean	Std	Mean	Std	
Age hhh	47.17	11.16	50.76	10.67	49.02	11.04	1.9435*
Education	7.07	3.69	6.09	3.17	6.57	3.46	-2.487**
Family size	5.98	1.97	5.38	1.76	5.67	1.89	-2.794***
Dependency ratio	0.24	0.18	0.34	0.22	0.29	0.21	4.0054***
Farm distance to home(minute)	8.49	5.22	18.4	10.04	13.6	9.47	10.741***
Experience	15.75	6.49	14.38	7.57	15.04	7.09	-1.6974*
TLU	15.40	7.75	13.11	8.28	14.22	8.09	-2.491**
Land size	0.66	0.0326	0.80	0.0340	0.73	0.0239	2.9959***
Off-farm income(birr)	70,203.5	26940.8	76,502.6	24986.4	73,446.0	26101.4	2.1185**

Source: Own survey (2024)

4.1.2. Dummy variables characteristics

Sex Distribution of Household Heads: As shown in Table 4.2, the overall sample consisted predominantly of male-headed households, with 77 percent of households led by men and 23 percent by women. Among UPA higher participants, 70 percent were male-headed and 30 percent female-headed, while among lower-participants, 83 percent were male-headed and only 17 percent female-headed. The analysis indicates a statistically significant difference at the 1 percent level, suggesting that male-headed households are more likely to engage in urban and peri-urban agriculture (UPA) than female headed. This may reflect the economic necessity among male-headed households in urban and peri-urban agriculture (UPA). The lower participation of females compared to men is despite of potential cultural and social constraints such as limited access to resources and information that generally hinder their participation in formal economic activities.

Marital Status of Household Heads: The data also reveal that marriage is a dominant household characteristic in the study area. On average, 96 percent of higher participant households and 83 percent of lower-participant households were headed by married individuals. In contrast, 4 percent of higher-participants and 17 percent of lower-participants reported being single, separated, or widowed. The statistical analysis confirms a significant difference at the 1percet level. The high rate of marriage may be influenced by cultural norms that encourage early marriage as a means of maintaining traditional family structures and avoiding social stigma related to single parenthood.

Access to Credit: Credit access is another key factor differentiating UPA higher participants from lower-participants. On average, 44 percent of all sampled households had access to credit services. When broken down, 62 percent of higher participants had credit access compared to only 26 percent of lower-participants. The difference is statistically significant at the 1 percent level, highlighting the critical role of credit access in supporting urban and peri-urban agriculture (UPA) engagement. This access likely facilitates investment in inputs, tools, and farm expansion.

Access to Agricultural Extension Services: Overall, the mean access to agricultural extension services among all households was 39 percent. UPA higher participants had a notably higher rate of extension access at 58 percent, while only 23 percent of lower-participants had such contact. This difference is highly significant statistically (1% level), suggesting that households engaged in UPA benefit more from extension technical support,

which may enhance productivity and encourage utilization of improved practices (Handalo, 2017).

Utilization of Improved Agricultural Inputs (fertilizer, improved seed, and chemicals): Regarding the utilization of improved agricultural inputs, 61 percent of higher participant households reported using such technologies, compared to 29 percent among lower-participants. Conversely, 39 percent of UPA higher participants and 71 percent of lower-participants did not use improved inputs, instead relying on traditional or personal preferences. This gap, which is statistically significant at the (1%) level, indicates a strong correlation between UPA participation and utilization of modern agricultural technologies (Handalo, 2017).

Membership in Civil Associations: The ability to engage in social and economic associations appears to influence household participation in UPA. According to the data, 82 percent of UPA higher participants were active members of civil ("Edir", "Equib", cooperatives, livestock trade etc.) associations, whereas only 31 percent of lower-participants held such memberships. This significant difference, confirmed by a t-test (t = -10.6477) at the (1%) probability level, underscores the importance of social capital and networking in facilitating access to information, resources, and support systems essential for urban agriculture(Taye, 2014).

Table 4.2: Description of sample households for dummy and institutional variables (n=305)**.**

Variables	Higher-participant		Lower-Participant		Both		□2/ t-value
	Mean	Std	Mean	Std	Mean	Std	
Sex-Male	0.70	0.03	0.83	0.04	0.77	0.42	2.7584***
Marital-status-Married	0.96	0.20	0.83	0.37	0.89	0.31	-3.63***
Credit-Access	0.62	0.49	0.26	0.44	0.44	0.49	-6.79***
Extension-Access	0.58	0.49	0.23	0.42	0.39	0.49	-6.57***
Use-of Agri. Inputs	0.61	0.49	0.29	0.46	0.45	0.48	-5.95***
Civil association-membership	0.82	0.38	0.31	0.46	0.56	0.49	-10.65***

Source: Own Survey (2024)

4.1.3. Household farm income and employment

Farm Income: Table 4.3 below summarizes descriptive statistics on the farm income and employment status of the sampled households. To evaluate differences in annual farm income between UPA higher participants and lower-participants, households were asked to report

income derived solely from agricultural total products (volume of produce). This includes revenue from livestock, vegetable, and crop production. The average total farm income across all sampled households was 99,655.49 birr per year. When disaggregated, UPA higher participants reported a higher mean farm income of 113,152.70 birr, while lower-participants reported 86,931.97 birr. A statistical test comparing the mean incomes of the two groups revealed a significant difference at the 1 percent probability level, indicating that participation in urban and peri-urban agriculture is strongly associated with higher farm-based earnings. This shows that urban household farmers were found to be high income earners and the finding confirms that there is significant income difference between the groups. This high income status of UPA higher-participants might increase their ability to procure capital intensive technologies as income level has a positive relationship to technology adoption (Taye, 2014)

Employment Creation: In terms of employment generation, higher participant households reported an average of 7.04 persons employed annually, whereas lower-participant households reported 5.85 persons. This suggests that households engaged in UPA are more effective in creating employment opportunities, either within the household or by hiring labor, likely due to the labor-intensive nature of urban farming. The overall average across all sampled households was 6.11 persons employed per year. The difference in employment levels between higher participant and lower-participant groups was found to be statistically significant at the 1 percent level, reinforcing the role of UPA in enhancing local job creation.

Table 4.3: Description of sample households for Outcome variables (n=305)**.**

Variables	Higher participant		Lower-Participant		Both		□2/ t-value
	Mean	Std	Mean	Std	Mean	Std	
Farm Income	113,152.7	13315.9	86,931.9	9985.8	99,655.4	17584.3	-19.527***
Employment	7.04	2.56	5.85	2.83	6.11	2.76	-3.852***

Source: Own survey (2024)

4.1.4. Extent of participation of households in UPA

As shown the Table 4.4 below, higher participant households take in livestock and crop (cereal) production was the first of all other agricultural practices. That was 49 (16.1%) households participated in livestock and crop (cereal) production. The second is households participating in livestock, crop (cereal) and vegetable production, which covered 37 (12.1%). The 3rd was livestock only production 34 (11.1%), and the 4th is the vegetable only production. Table 4.4 revealed that the percentage of lower-participant is shown highest

157(51.5%) in crop(cereal) only production because of the armed conflict, a complete blockade and disruptions of essential services such as electricity, communications, transportation, banking, and the supply of goods. Moreover, there was an absence of a properly functioning government for two years during the war. These compounded challenges resulted in a catastrophic humanitarian crisis, causing severe disruptions in rural-urban food supply chains. In response to the crisis, communities in Tigray have turned to urban and peri-urban agriculture, growing high-value vegetable crops to support alternative livelihoods during the war (2020—2022) and post war (2023 onwards) (Gebregziabher *et al*., 2024).

Table 4.4: Summarization of household participation in a particular UPA activity (n=305)**.** .

Type of farm activity	Frequency	Percentage
Lower-participant(cereal/crop production)	157	51.5
Livestock only production	34	11.1
Vegetable only production	28	9.2
Livestock and crop(cereal) production	49	16.1
Livestock, crop(cereal) and vegetable production	39	12.1
Total	305	100

Source: Hadnet sub-city, kebelle Aynalem UPA Office (2024)

4.1.5. Description of Rank of Institutional Characteristics of Respondents

Institutional Characteristics and Service Contribution to Employment and Income Generation: According to Table 4.5, various institutional services were evaluated based on their perceived contribution to employment and income generation among sampled households. Access to credit emerged as one of the most influential services. Specifically, 184 households (21.2%) identified it as the first contributor to income opportunities, while 114 households (18.2%) ranked it second for employment generation. This demonstrates that access to credit plays a particularly significant role in enhancing income, surpassing many other institutional services in its impact.

Improved agricultural inputs were also considered highly valuable in employment creation than income generation. About 133 households (21.4%) ranked improved agricultural inputs as the leading factor for employment creation, while 178 households (20.5%) ranked them second in terms of income generation. These inputs include improved seed varieties, pest and disease management technologies, and fertilizers which help increase productivity and

support both job creation and household earnings. Compared to other services, improved agricultural inputs were among the most widely utilized and impactful by UPA participants.

Technical training was another institutional factor considered. Around 110 households (19.6%) ranked it third for employment creation, and 145 households (16.7%) ranked it fourth for income generation. This suggests that skill-building through training programs contributes moderately to enhancing livelihoods, particularly in helping farmers adopt new practices thus creates additional income and employment opportunities.

Extension services were also rated positively by respondents. Approximately 166 households (19.1%) ranked extension visits third for employment generation, and 104 households (16.6%) considered them fourth in relation to income benefits. While not ranked at the top, extension services still play a critical supportive role in providing technical knowledge and farm management guidance. If they are trained diversify their livelihood activities and thus create to improve their income and employment.

Field day participation, which offers exposure to practical demonstrations and farming techniques, was ranked lower in comparison to other services. Around 80 households (12.8%) and 102 households (11.7%) identified field days as the fifth and sixth most influential services for income and employment generation, respectively. It is, generally, believed that the presence of enabling and efficient field day participation at the local level have a direct effect on the innovativeness of farmers. This, undoubtedly, plays a significant role in improving the level of households' income and employment but better for income than employment generation.

Demonstration participation, covering areas such as demonstration of irrigation technique, livestock feeding technique, fertilizer and chemical application technique received the least attention among institutional support mechanisms. About 84 households (13.4%) and 94 households (10.8%) ranked this service fifth and sixth for employment and income generation, respectively. The relatively low participation may be attributed to limited institutional emphasis, reduced outreach by government and non-governmental organizations, or a general lack of public awareness regarding these opportunities thus it has lower potential in income and employment creation but better for employment than income generation.

Table 4.5: Summary of service variables ranked based on employment and income creation (n=305)

Activity		Type of services/access					
		Credit	Technical training	Extension visit	Field day	Demonstration participation	Agricultural inputs
Employment creation	Frequency (%)	114(18.2)	110(17.6)	104(16.6)	80(12.8)	84(13.4)	133(21.4)
	Rank	2^{nd}	3^{rd}	4^{th}	6^{th}	5^{th}	1^{st}
Income generation	Frequency (%)	184(21.2)	145(16.7)	166(19.1)	102(11.7)	94(10.8)	178(20.5)
	Rank	1^{st}	4^{th}	3^{rd}	5^{th}	6^{th}	2^{nd}

Source: Own survey (2024)

4.1.6. **Description of Civil Association Variables Ranked based on Knowledge and Satisfaction obtained on UPA by Family member**.

Participation in social and economic associations: In the study area, a range of social and economic associations have been established with the goal of improving residents' living standards, enhancing business activities, and fostering better communication and collaboration among community members. Social associations include farmer groups, youth and women's organizations, religious associations, and irrigation cooperatives. Economic associations, on the other hand, encompass informal savings groups (like *edir* and *equib*), traders' groups, seed and multipurpose cooperatives, and savings and credit associations.

Based on the statistical analysis of survey data presented in Table 4.6, around 80.7 percent of sampled household heads actively participate in social associations, while 65 percent are involved in economic associations. Conversely, 19.3 percent and 35 percent of respondents reported low or no participation in social and economic associations, respectively. This highlights a higher engagement in socially-oriented groups compared to economically focused ones.

Regarding the perceived benefits of these associations for urban and peri-urban agriculture (UPA), 90.4 percent of respondents affiliated with social associations acknowledged gaining valuable knowledge about UPA, whereas 9.6 percent did not. In economic associations, 92.6 percent of respondents reported that their membership helped them acquire useful information about UPA, while 7.4 percent stated they had not gained such knowledge. The lack of knowledge acquisition among some members may stem from limited access to

extension services, a general lack of awareness, or low motivation to participate actively in these groups.

Table 4.6: Summary of civil association variables ranked based on knowledge and satisfaction obtained on UPA by household heads (n=305).

Type of association		Number of household heads membership			Knowledge on UPA obtained from association		Satisfaction on UPA obtained from association				
		0=No	1=Yes	Total	0= No	1=Yes	1	2	3	4	5
Social	Frequency (count)	58	247	305	24	223	24	67	85	31	16
	Percent (%)	19.3	80.7	100	9.6	90.4	11	30	38	14	7
Economic	Frequency	106	199	305	15	184	13	27	103	29	12
	Percent (%)	35	65	100	7.4	92.6	7	15	56	16	6

Source: Own survey (2024)

Note: 1=stands very low satisfied 2=low satisfied 3=satisfied 4=highly satisfied 5=very high

Satisfaction with associations in relation to UPA knowledge sharing: The survey also assessed satisfaction levels among household head members engaged in UPA with respect to their associations' effectiveness in disseminating knowledge. For social associations, responses showed that: 38 percent were moderately satisfied; 14 percent were highly satisfied, and only 7 percent reported being very highly satisfied.

This suggests a generally moderate to low satisfaction level among social association members in terms of receiving useful information on UPA, indicating potential gaps in outreach, communication, or relevance of services provided.

In contrast, economic association members reported slightly better satisfaction levels: 6 percent were very highly satisfied; 16 percent were highly satisfied, and the majority of them **(56%)** were moderately satisfied.

The satisfaction may create advantage to them because they would enjoy and share any of the benefits of social and economic associations (easy access to agricultural inputs, access to financial service, profit share from cooperatives, access to market information) and more interaction with other farmers and hence the earlier adoption of innovations and experience sharing among farmers thus improve their livelihood.

The relatively lower levels of strong satisfaction in both types of associations suggest several challenges, such as limited economic activities, cultural norms restricting active involvement, and inadequate institutional support from local government or NGOs. These factors may undermine the potential of associations to serve as effective platforms for UPA knowledge transfer and capacity building.

4.1.7. Descriptive Results on Numbers of Jobs Created by farm type

The study assessed employment creation across various forms of farming within the urban and peri-urban agriculture (UPA) sector, aiming to compare employment levels generated by different categories. The findings from the survey indicate notable differences in the number of employment opportunities created depending on the type of farming activity practiced.

Overall, the average number of employees generated annually by households involved in UPA both higher participants and lower-participants were 6.34. When disaggregated, households actively participating highly in UPA showed a significantly higher average of 6.85 employees per year, compared to 5.85 employees per year for lower -participating households. This clear disparity highlights the greater employment potential of UPA higher participants, suggesting that involvement in urban and peri- urban agriculture not only supports food production but also contributes substantially to local job creation.

When the five sub-sectors are distinguished in terms of average number of employees; the livestock and crop sector has the 1st mean employee count of 8.38 per a year, the livestock, crop and vegetable become the 2nd with employee count of 7.15, the livestock only sector is 3rd with a mean employee count of 6.08, 4th the lower-participant sector which is 5.84 and last (5th) the vegetable only sector with 5.78 mean employee count per a year. In the above Table 4.7 the minimum and maximum employee count of UPAs are indicated and the minimum employee count of 2 in all sectors and the maximum employee count of 16 in the livestock ,crop and vegetable sector. The mean values illustrate that the farmers who participated livestock only, livestock and crop, and livestock, crop and vegetable production practices of UPA produced 02.562, 1.303, and 0.238 points more numbers of employee, respectively, than non-participants (Table 4.7). Mainly, the positive difference between the participation of the three UPA practices confirms that the higher intensity of UPA participation was positively correlated with higher numbers of employee generation. Form this it can be concluded that the UPA farming except vegetable sector (not-significant) can have the capacity to enroll more employees from the sectors and the UPA practices in general hires

more employee than non-participant per a year. Consequently, employment had highly significant relationship with the household UPA participant and non-participant (p=0.001). This states that, the increase or decreases in number of employees in the households had significant influence with the higher-participation and lower-participation of the UPA practices. Therefore encouraging this type of sub-sectors has to be given more emphasis.

Table 4.7**:** Total Number of Employees created by farm type (n=305)

Type of farming activities	Statistical tests					
	Obs.	Mean	Std.	Min	Max	F-value
Crop/cereal-only production (Lower- participant)	157	5.85	2.82	2	15	9.799***
Livestock-only production	34	6.08	1.24	3	10	
Vegetable-only production	28	5.78	3.09	3	11	
Livestock and crop (cereal) production	47	8.38	2.82	3	14	
Livestock, crop(cereal) and vegetable production	38	7.15	2.78	2	16	
Average	305	6.34	2.18	2.4	12.4	

Source: Own survey (2024)

4.1.8. Descriptive Results on Types of Jobs Created by Households

As illustrated below in Table 4.8, various types of employment opportunities have been identified in the study area. These include full-time employees, part-time employees, family members working part-time or full-time, and both full-time and part-time self-employment. The adoption of these job types varies across households, and these differences are likely influenced by regional disparities in climate and socioeconomic characteristics.

Part-time employee emerged as the most widely practiced form of labor engagement in the study area. Many farmers reported relying not only on full-time workers but also on part-time and seasonal laborers, particularly during peak agricultural seasons. This flexible labor strategy supports productivity during critical periods. According to the data, UPA participants employed an average of 2.371 part-time workers annually, compared to 2.115 among non-participants.

The second most common job category was full-time employee, which was more prevalent among UPA participants. On average, participant households employed 1.486 full-time workers per year, whereas non-participant households employed 1.242. This suggests that participants in urban and peri-urban agriculture tend to generate more stable employment opportunities, likely due to the continuous labor demands of diversified production systems.

Family labor also played a notable role. For family part-time work, where household members split their time between farm and off-farm activities the average employment was 0.918 persons annually for participants, slightly higher than 0.859 for non-participants. In the case of family full-time labor, the figures were 0.912 and 0.719 for participants and non-participants, respectively. These findings imply that UPA participants rely more heavily on family labor, which may also contribute to reducing household dependency ratios and increasing economic resilience.

The study also examined variations in self-employment within the farming sector. On average, full-time self-employment among participants stood at 0.628, compared to 0.477 for non-participants. Part-time self-employment, however, remained significantly lower, with participants reporting 0.5743 persons per year and non-participants just 0.357. This relatively low uptake suggests a lack of awareness or support for entrepreneurial farming initiatives, particularly in part-time formats.

The low participation in part-time self-employment highlights the need for targeted interventions. Many farmers may lack sufficient knowledge or skills to leverage UPA as a platform for self-business development. This represents an opportunity for policy makers, extension agents, and NGOs to promote job innovation and entrepreneurship in farming, helping to address regional unemployment and support food security.

ANOVA test results (Table 4.8) indicate that differences in employment creation between UPA participants and non-participants were statistically significant at the 1% and 5% levels, across all employment types except family part-time labor. This further reinforces the conclusion that participation in UPA enhances employment generation at the household level more effectively than non-participation.

Nonetheless, while UPA participant households demonstrate stronger employment outcomes, the contributions of non-participant households should not be disregarded. Their engagement in farming though less intensive still plays a meaningful role in household livelihoods and the broader local economy.

Table 4.8: Types of Jobs created on average number of persons per UPAs (n=305).

Types of Jobs/employment Created	Participant		Non-participant		Combined		F-value
	Mean	Std	Mean	Std	Mean	Std	
Full time employed	2.39	1.11	2.12	0.93	1.36	0.8513	4.786**
Part time employed	1.49	0.81	1.25	0.87	2.24	1.0318	6.393**
Full time self-business	0.65	0.57	0.48	0.59	0.55	0.5890	5.052**
Part time self-business	0.59	0.5725	0.38	0.52	0.46	0.5725	12.121***
Family full time job	0.93	0.55	0.73	0.62	0.81	0.5970	8.099***
Family part time job	0.95	0.52	0.87	0.66	0.89	0.5966	0.746
Average	7.06	2.56	5.85	2.83	6.43	2.77	

Source: Own survey (2024)

4.2. Impact of Urban ad Peri-urban Agriculture (UPA) on Employment and Income Generation

According to Khandker *et al*. (2010) impact evaluation is the act of studying whether the changes in well-being are indeed due to the intervention and not to other factors. The main aim of UPA was to improve their livelihood status. To this effect, there is a need to see whether the intervention of UPA has significant influence on the participant households or not. However, to compare the before and after intervention difference, baseline survey was not conducted prior to the intervention of the UPA in the study area. Therefore, this study uses PSM method because PSM is the appropriate method when such kind of problem arises.

This section also presents the entire process or implementation of propensity score matching (PSM) to evaluate the impact of UPA on household employment and farm income. More precisely, it presents the estimation of the propensity score, common support region, matching algorithm and balancing test or robustness. At the end it provides the UPA impact among the participant households.

4.2.1. Estimation of Propensity Score

To address objective three the propensity score matching model was applied. To implement this, the first task was estimating propensity scores and it was computed based on the logistic model. The estimated score used as a tool to balance the observed distribution of covariates across the treated (higher-participant) and the untreated (lower-participant) group (Singh et al., 2011). As shown on Table 4.9, logistic model results, the Chi-square value is 51.9 with p<1% significance level and it suggests the model is well fitted. The pseudo-R2 value is

0.1220 which is fairly low; pseudo-R2 value indicates that how well the model explains the participation probability. A low pseudo-R2 value means participant households do not have much distinct in overall characteristics and hence the match between participant and non-participant households becomes easier. Here, the overall intention was to balance the observed covariates by using propensity score. Therefore, a detailed interpretation for determinants were not discussed since the determinants of urban and peri- urban agricultural practices is discussed more in the above model. However to mention, from all included variables in to the model four variables (age, total livestock holding, access to extension, member of civil association) were found statistically significance. From those, access to extension service, membership to civil association and total livestock holding of household head influence positively at less than 1% p-value. On the other hand, age of the household head influence UPA negatively. The implication could be that farm household participation was more guided by services and associations than demographic and socio-economic factors on employment and income generation of urban and peri-urban areas.

Table 4.9: Estimation of Propensity Score: Dependent variable urban and peri-urban agricultural practice (n=305)**.**

Logistic regression

Number of obs. =305
LR chi2 (17) =51.90
Prob>chi2=0.0000
Log likelihood=-185.32814 Pseudo R2=0.1228

UPA	Coef.	SE	Z	P>|Z|	[95%confidenceinterval]
Age HHH	-.0268482**	.0131399	-2.04	0.041	-0.0526021-0.0010944
Sex HHH	-.349931	.3445112	-1.02	0.310	-1.0251610-0.3252987
Edu. HHH	.055422	.0389795	1.42	0.155	-0.0209763-0.1318203
Family size	.0397237	.0758028	0.52	0.600	-0.1088470-0.1882943
Dependency ratio	-.7205876	.7538469	-0.96	0.339	-2.1981000-0.7569251
Landsize	.4127641	.4659565	0.89	0.376	-0.5004938-1.326022
Fertilizer	.0041927	.2212066	0.02	0.985	-0.4293643-0.4377497
Animal feed	.0482495	.0771187	0.63	0.532	-0.1029004-0.1993994
Farm-home distance	.0123743	.0203684	0.61	0.544	-0.0275471-0.0522956
Credit access	.4075593	.3207904	1.27	0.204	-0.2211783-1.036297
Extension access	.5425155**	.3038199	1.79	0.074	-0.0529606-1.137992
Agri.nputs utilization	-.3206015	.3080782	-1.04	0.298	-0.9244237-0.2832207
Member association	1.293969**	.3764435	3.44	0.001	0.5561530-2.0317840
TLU	.0376472**	.0190926	1.97	0.049	0.0002264-0.0750680
Experience	.0087782	.0191779	0.46	0.647	-0.0288098-0.0463661
Cost farm	-.0000112	7.38e-06	-1.52	0.128	-0.0000257- 3.22e-06
Off-farm income	-2.10e-06	5.68e-06	-0.37	0.711	-0.0000132-9.03e-06

Source: Own computation from survey data (2024)

*/**/*** indicate level of significance at 1%, 5%. 10%.

4.2.2. Defining Region of Common Support

Identification of common support or overlap condition for participant and non-participant households was done in order to estimate causal treatment effects (in this case, UPA practices) since violation of the common support condition is a major source of selection bias (Marchenko & Genton, 2014). It is used the estimated propensity scores to define the common support region and results of data analysis are depicted in Table 4.10. The estimated propensity scores as shown in the Table vary between 0.1425 and 0.9176 (mean = 0.5676) for higher-participant households and between 0.0908 and 0.8437 (mean = 0.4075) for lower-

participant households. Therefore our common support region according to Caliendo and Kopeining, (2008) would lie between 0.1425 and 0.8437. As a result of this restriction, 23 households (16 higher-participant and 7 lower-participant households) were dropped in estimating the average treatment effect.

Table 4.10: Distribution of estimated propensity scores (n=305).

Groups	Obs.	Mean	Std.	Min.	Max.
All households	305	0.4852459	0.20041159	0.0908394	0.9176105
Higher-Participant	148	0.5676809	0.1895306	0.1425778	0.9176105
Lower-participant	157	0.4075364	0.1786037	0.0908394	0.8437603

Source: Own survey result (2024)

4.2.3. Matching Higher-participant and Lower-participant Households

The three commonly used matching algorithms, namely nearest neighbor matching, caliper matching, and kernel-based matching was employed to evaluate the impact of UPA on employment and income creation. The nearest neighbor matching (NNM) method matches each household from the higher-participant group with the household from the lower-participant group having the closest propensity score. There is no one recommended estimator rather testing of different matching estimator and selecting one with different criteria (Singh *et al*., 2011). Therefore, three matching estimators CM, KM and NNM with different band width were employed. The matching can be done with or without replacement of observations. NNM faces the risk of bad matches if the closest neighbor is far away. This risk can be reduced by using a caliper matching (CM) method, which imposes a maximum tolerance on the difference in propensity scores. However, some treated units may not be matched if the dimension of the neighborhood is too small to contain control units. The kernel-based matching (KM) method uses a weighted average of all household in the participant group to construct a counterfactual. The major advantage of the KM method is that it produces ATT estimates with lower variance since it utilizes greater information; its limitation is that some of the observations used may be poor matches.

As suggested the final choice of a matching estimator is guided by different criteria such as equal mean test referred to as the balancing test, pseudo-R2 and matched sample size by (Githungunyi, 2014). Further, the low mean standardized bias and low LR- chi2 value revealed as the best estimator suggested (Singh *et al*., 2011). Therefore, a matching estimator having balanced (insignificant mean differences in all explanatory variables) mean, bearing a low pseudo R2, chi2 and mean standardized biased value and also the one that results in large

matched sample size is preferred in this study. Based on these as shown in Table 4.11, KM estimator with radius 0.25 was selected.

Table 4.11: Performance of different matching estimators (n=305)**.**

Matching Algorithm	Pseudo R2	LR_chi2	(p>chi2)	Mean standard bias	Matched sample size		
					Higher-participant	Lower-participant	Total
KM 0.1	0.009	3.25	1.000	4.4	131	151	282
KM 0.25	**0.008**	**2.89**	**1.000**	**5.3**	**131**	**151**	**282**
KM 0.5	0.036	12.97	0.675	14.1	131	151	282
CM 0.1	0.046	18.30	0.307	10.5	142	152	294
CM 0.25	0.046	18.30	0.307	10.5	142	152	294
CM 0.5	0.046	18.30	0.307	10.5	142	152	294
NNM1	0.037	15.30	0.503	11.1	148	157	305
NNM2	0.022	09.14	0.908	07.8	148	157	305
NNM3	0.021	08.47	0.934	07.7	148	157	305
NNM4	0.018	07.42	0.964	07.4	148	157	305
NNM5	0.018	07.25	0.968	08.0	148	157	305

Source: Own computation from survey result (2024)

Table 4.12 Depicts the matching quality test by using the selected best estimator based on the above criteria. Therefore, it shows that the balancing test of covariates before matching of higher-participant and lower-participant household heads were significantly different in many covariates. But, after matching no significant differences were observed between participant and nonparticipant households.

The distribution of propensity scores before and after matching as shown in table 4.12 below also indicates that estimating the p-score balances the higher-participant and lower-participant groups adequately, a result which highlights the importance of the PSM approach. The 5^{th} and 6^{th}columns on the table shows, the standardized bias before and after matching and the total bias reduction obtained by the matching procedure, respectively. The standardized difference in covariates and propensity score before matching was in the range of 0.1% and 46.6%, but it significantly reduced to the range of 2.7% and 7.5% after matching. And after matching there is no significance difference in all covariates observed.

The PS-test (Balancing Test) in Propensity Score Matching (PSM) is a critical step in verifying whether the matching process has successfully balanced the observed covariates between treated and control groups. In the context of employment and income analysis of Urban and Peri-Urban Agriculture (UPA), this is particularly important for ensuring that any

differences in employment or income outcomes between participants (e.g., UPA practitioners) and lower-participants can be attributed to UPA participation, rather than pre-existing differences.

In evaluating the impact of UPA on employment and income: the treated group is made to include individuals or households participating in UPA whereas the control group includes lower-participants. Moreover, the PS-test checks if the distribution of covariates (e.g., age, education, land size, credit access) is similar after matching. Without a proper PS-test, treatment effects may be biased due to residual confounding.

Table 3.12: Propensity score and covariate balance (PS-Test) (n=305)**.**

Variables	U M	Mean		% bias	% bias reduction	t-test	
		Treated	Untreated			T	p>|t|
Age	U	47.757	50.204	-22.2	82.9	-1.94**	0.053
	M	48.756	49.174	-3.8		-0.31	0.755
Sex	U	0.7027	0.834	-31.5	79.7	-2.76**	0.06
	M	0.748	0.774	-6.4		-0.51	0.613
Education	U	6.885	6.147	21.1	71.7	1.84**	0.066
	M	6.878	6.669	5.5		0.48	0.634
Family size	U	5.878	5.478	21.3	74.1	1.86**	0.064
	M	5.756	5.652	5.5		0.45	0.653
Dependency ratio	U	0.2748	0.318	-21.4	93.8	-1.87**	0.062
	M	0.2770	0.279	-1.3		-0.11	0.909
Land size	U	0.6594	0.801	-34.4	88.7	-3.00**	0.003
	M	0.6833	0.699	-3.9		-0.31	0.757
Fertilizer	U	1.1108	1.062	7.9	-41.1	0.69	0.493
	M	1.1158	1.047	11.1		0.88	0.379
A.Feed	M	2.7297	2.585	7.3	15.4	0.63	0.526
	U	2.6424	2.520	6.2		0.49	0.628
Farm distance	U	11.7700	15.325	-38.1	81.7	-3.33	0.001
	M	12.206	12.857	-7.0		-0.56	0.578
A.credit	M	0.5338	0.343	38.8	80.6	3.39	0.001
	U	0.5115	0.4751	7.5		0.59	0.578
A.extesion	M	0.5000	0.2872	44.6	84.6	3.90	0.000
	U	0.4428	0.409	6.9		0.53	0.593
A.agr.input	M	0.5135	0.389	25.2	81.9	2.20	0.028
	U	0.5191	0.497	4.6		0.36	0.716
TLU	U	15.0680	13.643	22.1	88.0	1.93	0.055
	M	14.8550	14.645	2.7		0.2	0.832
Experience	U	16.0680	14.331	25.2	87.2	2.19	0.029
	M	16.0230	15.801	3.2		0.26	0.796
Farm cost	U	48997	48979	0.1	-4258.6	0.01	0.993
	M	49942	50740	-4.4		-0.34	0.737
Off-farm income	U	71281	76519	-20.2	76.5	-1.76	0.079
	M	73990	72757	4.7		0.38	0.702

Source: Own Survey Result (2024)

Note:* significant at p<10%, **significant at p<5%, *** significant at p<1%

4.2.4. Impact of Urban and Peri-urban Agriculture on Farm income Generating

According to the best matching algorithm estimates [i.e. kernel (0.25) matching algorithm] showed that being higher-participant in UPAs had a positive and significant impact on the amount of household's total annual farm income received in Birr (Table 4.13). As the result indicated that the impact of being higher-participant in UPA activities was significant at 1%. As expressed below in Table 4.13, the mean household's total farm income was about Birr 106,703.05 for treated groups; while the corresponding figure for the control groups was Birr 93,599.41 and the average income difference between treated and non-treated groups were Birr 13,103.64. It implies that the total annual income of the treated groups was almost 12.28% higher than that of total annual income of the control groups. The results indicate that participating in UPA activities increased the total annual income of the household's, which is the god source of income for the household's to solve the problem of income scarcity.

4.2.5. Impact of Urban and Peri-urban Agriculture on Employment Generating

Table 4.13 below presents the results estimating the treatment effects of UPA participation on farm income and employment. Our ATT estimate results in Table 4.13 record differentiated findings regarding the impacts of participation on UPA activity on farm income and employment.

The results of the kernel (0.25) matching algorithm confirm that there were difference between treated and the control household's in terms of total annual employment created by households in number. A comparative analysis shows that treated groups were better than control groups by creating employment opportunities for about 1 person annually (i.e. 15.11% higher than control groups). In this case, the mean employment created by the treated households was about 6.68 persons annually and that of the control households was about 5.68 persons annually. These results confirm that membership in UPA activities increased the employment creation of the households, which is the good remedy for number of jobless individuals in the study area.

Table 4.13: Average treatment effect on treated (n=305)**.**

Variables	Sample	Treated	Control	Difference	Participant (%)	S.E	t-value
Income generation	ATT	106,703.05	93,599.41	13,103.65	12.28	1898.20	6.90***
Employment creation	ATT	6.6870	5.6765	1.0105	15.11	0.38814	2.99***

Source: Author's survey data (2024)

4.2.6. Sensitivity Test for Average Treatment Effect on the Treated (ATT)

As per the methodology outlined, sensitivity analysis is conducted as the final diagnostic to assess how sensitive the estimated treatment effects are to small changes in the propensity score specification. Sensitivity analysis is crucial in verifying the robustness of the estimated treatment effect by (Grilli & Rampichini, 2011).

In Appendix-VII (A), the sensitivity analysis results are reported. The analysis shows that the treatment effect at $\Gamma = 1$ (no hidden bias) is similar across both Qmh+ and Qmh- bounds, indicating that there is no hidden bias and the treatment effect is significant. Moreover, for Γ values ranging from 1.05 to 2, the estimates of the treatment effect remain unchanged. This finding suggests that the potential influence of unobserved factors on the treatment effect is symmetrical and robust, and that any unobserved confounding factors are equally likely to either overestimate or underestimate the treatment effect. However, even if unobserved factors could bias the results, the extent of the bias is limited.

The results indicate that the average treatment effect on the treated (ATT) for farm income is insensitive to external changes. In other words, there are no external variables that could significantly alter the calculated ATT for farm income within the specified range.

Further analysis in Appendix VII (B) examines the Q_mh+ and Q_mh- statistics, which adjust the Mantel-Haenszel (MH) statistic for possible positive or negative selection bias due to unobserved factors. The results indicate that under the assumption of no hidden bias ($\Gamma = 1$), the Q_mh+ and Q_mh- statistics yield similar results, confirming a significant treatment effect.

Additionally, negative values of Q_mh+ suggest a negative selection bias, meaning that participants in UPA activities tend to have lower incomes even in the absence of participation. However, this bias is not significant at the different bound levels and does not substantially impact the treatment effect estimates, whether they are overestimated or underestimated.

These findings suggest that the study's results are insensitive to potential biases, and the positive significant impact of UPA on employment and farm income holds true, even with possible variations in the data. As a result, UPA should be promoted among urban households as an effective strategy to improve livelihoods and reduce poverty.

4.3. Determinant Factors on the Adoption of Urban and Peri-urban Agriculture

In this study, households engaged in urban and peri-urban agriculture (UPA) selected specific categories of agricultural practices. To identify and analyze the factors influencing these choices, a multinomial logit model was employed. The model is suitable for analyzing situations where the dependent variable types of agricultural practices consists of more than two nominal and unordered categories.

Model Diagnostics and Econometric Tests: In order to check the plausibility of the model result the necessary econometric tests, especially for primary data (hetroskedasticity and Multicollinearity) were conducted. The Variance Inflation Factor (VIF) was used to test the Multicollinearity problem among continuous and dummy/categorical variables, respectively. The larger value of Variance Inflation Factor (VIF), usually values exceeds 10 indicates a serious Multicollinearity problem (Greene, 2003). But, the mean VIF value was 1.52 and for each explanatory variable, the VIF ranged between 1.14 and 2.40. The breusch-pagan test for hetroskedasticity show equally distributed error variance (pro >chi2=0.9118) and white test with Ho=homoskedascity is accepted because (pro>chi2=0.01). Hetroskedasticity occurs when the error term does not have a constant variance; thus, the conditional variance of the Y population varies with increases in X.

The effect of independent variable and the IAA test: The test for the effect of the independent variables on dependent variables can be tested by Likelihood ratio (LR) or/and wald test, but LR test is generally considered superior, if the model is complex or the sample is very large, the computational costs of the LR test can be prohibitive, and alternatively wald test can be computed using test without estimating additional models. But, here both LR and Wald test were done and the result was almost the same. It suggests that, the result is against null hypothesis and significant for all independent variables at below 1% significant level.

Reading the model output: The upper parts of the regression result shows, the Log likelihood equal to -247.39 which corresponds to the value of the log likelihood at convergence. For the

probability models log likelihood always negative, because the likelihood itself is always between 0 and 1(Bosman & Thierens, 2000).

Number of observations: it excludes those with missing values and after any if or in conditions has been applied. LR chi2 (76) =331.944, is the value of a likelihood-ratio chi-squared for the test of the null hypothesis that all of the coefficients associated with independent variables are simultaneously equal to zero. The p-value is indicated by Prob>chi2, where the number in parentheses is the number of coefficients being tested at 1 percent significance level (0.0000). Pseudo R2= 0.710 is the measure of fit also known as Nagelkerke's R2. The marginal effect result of the regression for the significance variables are discussed as follows. The magnitude of the coefficient estimates of the independent variables in the multinomial choice models describes the relative probability of a choice to a base-case. However, this gives limited information only its signs and level of significance are relevant. The effect of independent variables on the choice decision can be assessed by the size of its marginal effect. The marginal effect is a measure of the instantaneous effect that a change in a particular explanatory variable has on the predicted probability of the dependent variable. The marginal effect result of the regression for the significance variables are discussed as follows.

The multinomial logit model analysis result (Table 4.14) shows that, out of the total eighteen explanatory variables hypothesized to influence urban and peri- urban agricultural practices four of them significantly influence at least one category/strategy of urban and peri- urban agricultural practices. Among them age of household, extension service, Total livestock holding of household head and farm cost were influenced livestock only production significantly. On the other hand, vegetable only production is significantly determined by family size of the household, employment, and farm income. Livestock and crop/cereal/ production were also significantly influenced by sex, family size, farm distance to home, membered of association, employment, farming experience, farm cost, off-farm income, and on-farm income of households. At the end, sex, family size, farm distance to home, agricultural inputs, association member, employment, farming experience, farm cost. Off-farm income and on-farm income were affected livestock, crop/cereal/ and vegetable production up to 10% level of significance.

Age of household head:- Household heads age influence livestock only production negatively at less than 5% significance level. When the household head age increases by one year; being the other determinants are constant the odds-ratio in favor of the probability of

the household to choose livestock only production decreases by 1.05 (4.7%) times than lower-participants. This result is in line with Nigus et al., 2024, but contrasts with Guta & Kibret, 2022; that concluded as the youngest attitude towards urban agricultural practice less and the older are more likely participate urban agricultural practice, which support the positive relationship between age of household head and livestock production.

Family size:-An increase in family size by one decreases the likelihood of practicing vegetable only production; livestock and crop; vegetable, crop and livestock production by a factor of 1.82 (45.1%), 2.27 (55.1%), and 1.49 (32.7%) times lower than relative to lower-participant being the other determinants constant. In other words, the larger the family size, the higher is the tendency to practice UPA sector, however the family who have more household size estimated to have more active labor force, faces financial/resource problem to satisfy the basic needs and thereby they look for income source like off-farm activity. This is in line with (Guta & Kibret, 2022).

Land size:-Keeping the other factors constant; the probability of urban and peri- urban households to practice urban and peri- urban livestock and crop production; livestock, crop and vegetable production increases by a factor of 6.419 and 21.5 times respectively as the land size increases by 10000 meter squared at the $p<5\%$ significance level than lower-participants. Compared to the landless households, landowners tend to have a higher degree of probability to practicing urban and peri- urban agricultural activities. It is well known that access to farmland is the most critical issue for farm households to stay in urban and peri-urban agricultural practices. This result also supported by (Abera et al., 2017; Whittinghill & Sarr, 2021).

Farm distance to home:-The variable was found to positively affect to two production sectors, and it suggest that other determinants being constant, as the distance increases from the center of home by one unit in this context one minute walking hour the likelihood of practicing crop and livestock; livestock, vegetable and crop production increase by a factor of 1.106 and 1.089 times respectively than lower-participant, and are significant both at 1% that is the distance from home to farm is very small minute nearest to their living home. This means that, location of the farm decreases the ability of household to participate in different urban and peri- urban agricultural activities due to they devote most their time to care for in active labor force family and this decrease the financial as well as the labor power of households to practice urban and peri- urban agriculture in full package.

Extension contact/service:-As expected extension contact influence urban and peri- urban agricultural practice positively, it refers to the access of the household received extension service and this variable is significant at 5% probability level. Other things being constant when household heads who are involved in extension services are 3.29 times more likely to participate in urban and peri-urban agriculture as compared to household heads who are less involved in extension services. The main reasons for possible factor in households' decision to participate in urban and peri-urban agriculture and their level of production since households receive a number of services from extension services like improved seed, chemical, fertilizer, irrigation, including technical services on its production. This survey result is in line with (Guta & Kibret, 2022), (Handalo & Abafita, 2020), and (Houessou *et al*., 2020) who concluded that extension service/contact improves urban and peri-urban agricultural practices.

Utilization of Agricultural Inputs: Improved agricultural inputs refer to household heads get recommended inputs like improved seeds and improved diseases and pests management practices. Contrary to the prior hypothesis, this variable negatively affected the dependent group livestock +crop production at p< 5% significance level. The odds ratio is 0.267; this is that households who got improved inputs are about 3.75 (73.3%) times less likely to participate in urban and peri- urban agriculture as compared to households who get lower-participation.

Membership to social institutions: Membership of households with different forms of formal or informal social institutions would have a possibility to diversify their livelihood choices. This variable was hypothesized to have a significant and positive relationship with livelihood diversification. As expected, membership to social institution has significant and positive influence on livestock and crop production at p<5%. The marginal effect in favor of the probability of choosing livestock and crop strategies compared to all forms of UPA practices is 5.231 times more for higher participants than lower-participants. The marginal effect indicates a unit increase in membership, increases by a factor of participation in livestock + crop activities by a multiple of 5.231. This might be due to the fact that households who are participants of formal and informal institution like saving and credit societies, cooperatives and others would have better access to financial credit, employment opportunities and access to information. The result of this study is in agreement with (Tulu, 2018).

Employment : Keeping the other factors constant; as the number of employee increases by 1 unit the probability of UPA households to practice vegetable only production, and livestock+ crop production increases by 1.429 and 1.213 times more than lower-participants respectively at the p<5% significance level. Compared to the lower-participant households, higher participants tend to have a more degree of probability to practicing UPA activities. Moreover, the result indicates that farmers with a higher employee have positively related and higher contributors to UPA activities. It is well known that access to labor is the most critical issue for farm households to stay in urban and peri- urban agricultural practices. This result also supported by (Ababiya *et al*., 2019).

Tropical livestock unit: The survey result also suggests, as livestock increases by one unit, the likelihood of households' to practice livestock only production increases by a factor of 1.090 times more than lower-participants up to p<5% significance level. In the study area, livestock are the source of cash income and source of power for agriculture. Thus, the household who owned large livestock have a better opportunity to earn more income from livestock production, crop and vegetable production. Moreover, the large herd size has also a great importance in improving soil fertility and farmers' power to implement and to expand his farming activity on time and hence this increases field crop, and vegetable production. This study result also supported by (Hasen, 2022).

Farm experience of household head: According to the expectation farm experiences positively affect the participation of households in livestock +crop and livestock + crop + vegetable production. The marginal effect indicate, for a unit increase in UPA experience, the marginal effect in favor of the probability of the household to choose livestock +crop, and livestock +crop +vegetable activity increases by a factor of 1.089 and 1.095 respectively than lower-participants. The assumption is that more experienced households can understand and identify changes related to farming practices easily. The results are consistent with the findings of (Chou *et al*., 2017).

Farm cost/expenditure: Contrary to the expectation, expenditure on agricultural inputs has positive relationship with UPA activities. It is significant at 5% percent level of significance. This suggests that when a farmer purchased agricultural inputs with 100 ETB, he/she will decrease ETB 294.11(99.9%) times than lower-participants. This result agrees with the finding of (Nasir, 2014) in Ethiopia that expenditure on improved and local seed positively affected farm output. This could imply that when farm household expenditure on farming inputs increases, UPA activity increases by the same unit.

Off-farm income: Off-farm income has positive coefficients in activities of crop and livestock production. The findings suggest that farmers receiving a higher level of off-farm income are more likely to participate in Livestock and crop production. The marginal effect indicates, keeping other factors constant, The coefficient 0.99 (1.00) implies that when the mean yearly farm income entertained by households increase by 10,000 ETB, would increase its contributions to operate Livestock and crop production by a factor of 9,999.81. This implies additional income from off-farm activities can help release credit constraint issues, allowing farmers to invest in innovative agricultural activities such as UPAs to improve farm performance. In their study for Nigus *et al*. (2024) found that participation in off-farm work increases farmers' participation of UPA.

Farm income: Farm income both for financial in input may increase household's participation in various forms of livelihood activities or make them to specialize on the livelihood what they already have engaged in. This variable was hypothesized as it would have a positive relationship with UPA practices. As hypothesized earlier, farm income affected livestock and crop production positively at significance level of P<1%. The marginal effect indicates that keeping other factors constant, an increase household's farm income by 10,000 ETB, increases the odds of participation in livestock and crop production by a factor of about 10,001. It may be due to the fact that, households who have access to gain farm income may have a chance to engage in various UPA, social and economic activities and also to protect their livestock assets depletion mainly due to animal feed shortage and disease. Similarly, Adela and Aurbacher (2018) found the same result for value of asset and farm income versus probability of adoption of irrigation.

Table 4.14: Multi-nominal logit result on the determinants of urban agricultural practices of households (n=305).

Variables	Livestock		Vegetables production		Livestock + Crop production		Livestock + crop + vegetable production	
	Coefficient (SE)	Exp (B)	Coefficient (SE)	Exp (B)	Coefficient (SE)	Exp (B)	Coefficient (SE)	Exp (B)
Age	-0.048** (.027)	0.953	-0.025(0.024)	0.975	-0.022(0.023)	0.98	0.015(.028)	1.015
Sex	-0.274(0.584)	0.761	-0.542(.7610	0.582	2.122**(0.86)	8.35	-1.38**(.649)	0.252
Education	0.082(.078)	1.085	-0.021(0.072)	0.979	0.044(.103)	1.05	0.114(.081)	1.121
Family size	0.169 (.168)	1.185	-0.60***(0.19)	0.549	-0.80***(.196)	0.33	-0.397** (.22)	0.673
Dependency Ratio	2.350(1.597)	10.490	0.902(1.741)	2.465	1.244(1.298)	3.47	-0.97(1.57)	0.381
Land size	1.311(0.866)	3.709	-0.841(1.530)	0.430	3.071(1.283)	6.42	3.071**(1.28)	2.57
Animal feed used	0.194(0.145)	1.215	-1.580(0.422)	0.206	-0.167(0.572)	0.85	0.09**(0.183)	0.665
Farm-home distance	-0.006(0.045)	0.994	-0.007(0.051)	0.993	0.100***(.04)	1.11	.086**(.044)	1.089
Access credit	0.764(0.637)	2.147	0.284(0.589)	1.326	0.167(0.572)	1.18	-0.494(.625)	0.610
A.extesion	1.192**(0.60)	3.292	0.153(0.568)	1.165	-0.062(0.546)	0.94	0.544(.601)	1.740
Utilization of agr. input	-0.612(0.586)	0.542	0.0.16(0.597)	1.016	-1.32**(0.562)	0.27	0.294(.674)	1.342
Association member	0.726(0.736)	2.066	-0.073(0.700)	0.929	1.65**(0.765)	5.23	-0.330(.837)	0.719
Employment	-0.041 (.113)	0.715	0.357**(0.14)	1.429	0.193**(0.09)	1.23	-0.033(.110)	0.967
TLU	0.087**(.035)	1.090	0.037(.034)	1.038	0.037(.032)	1.05	-0.012*(.041)	1.012
Experience	0.035 (.036)	1.036	0.017(0.044)	0.842	0.085**(.038)	1.09	.091**(.043)	1.095
Farm cost	0.000(0.00)	0.999	0.000(0.000)	1.000	.000**(.000)	1.00	.000**(.000)	1.000
Off-farm	0.000(.00)	1.000	.000(.000)	1.000	.000**(000)	1.00	.000(.000)	1.000
Farm income	0.000**(.00)	1.000	.000**(.000)	1.000	.001***(.000)	1.00	.001***(.001)	1.001
Constant	-7.793** (3.197)		-4.392 (3.809)		-18.849*** (3.387)		-23.362*** (14.168)	

Number of obs.: 305 Base category=Non-participants
Pseudo R2 = 0.710 -2log Likelihood=494.783
LR ch2 (76) = 331.944, with prob ch2<.0000
Note: ***, ** and * indicates the significance of probability levels at 1%, 5% and 10%, respectively. Standard errors (SE) in parenthesis and mfx stands for marginal effect

Analysis results in Table 4.15 below show the mean scores of the Likert rating of the benefits considered as opportunities of urban and peri- urban farming by focus group discussions.

Four higher benefits out of six were rated as the most important opportunities of urban and peri- urban agriculture. These include: Interrelated to infrastructure (X=4.0623); Reduced transportation costs for some households dwellers (X=3.72); Linked to cattle market (X=3.67) and Enabling the producers, especially those with the aim of home consumption, a chance to access fresh foods in their backyard (X=3.11) in their respective order for all

respondents while Increased access to fresh vegetables through reducing transportation time and cost after harvesting (X=2.81); Government and stockholders considerations ease for management (X=1.81) were ranked 5th and 6th respectively . This implies that most of the sample respondents could benefit from interrelated to infrastructure services. The practice of urban and peri- urban farming at urban and peri- urban level helps the practitioners' to supplement their income and employment creation.

Table 4.15: Mean Scores of Likert Rating of Opportunities Affecting UPA (n=305)**.**

Opportunities	Not-important	Less-important	Undecided	Important	Very-important	Mean score	Rank
1	23	28	68	95	91	3.67	3rd
2	208	26	19	33	21	1.81	6th
3	14	25	47	63	156	4.06	1st
4	19	20	44	167	55	3.72	2nd
5	24	113	75	57	36	2.90	5th
6	25	33	169	34	43	3.13	4th

Source: Author Survey Result (2024)

Note: The First row stands 1= Linked to cattle market 2= Government and stockholders considerations 3= Interrelated to infrastructure 4= Reduced transportation costs for some households 5= Increased access to fresh vegetables through reducing transportation time and cost after harvesting. 6= Enabling the producers, especially those with the aim of home consumption, a chance to access fresh foods in their backyard.

Analysis results in Table 4.16 shows the mean scores of the Likert rating of UPA considered as constraints to urban and peri- urban farming by the sample respondents. Three factors out of ten were rated as the most important constraints. These include: limited access to farm space (land) (X=3.84), poor city administration and complaints from neighbors (X=3.78); and limited technical experts (X=3.74) for both participants and non-participants in their sample order. This implies that most of the sample respondents could not gate access to space (farm land) for investment in urban and peri- urban farming. They also lacked access to farm agricultural inputs, treatment and access of water with improved technologies which support for UPA diversification. The absence of these critical institutional services coupled with limited access to land are constraints responsible for lowering farm productivity, household income and employment. This finding agrees with that of (Taye, 2014) who identified some of the constraints for the development of urban agriculture in Addis Ababa that include poor

access to land, lack of support services (like farm extension and production inputs supply), and high cost of feeds among others.

Table 4.16: Mean Scores of Likert Rating of Constraints Affecting UPA (n=305)**.**

Constraints*	Not-important	Less important	Undecided	Important	Very important	Mean score	Rank
1	28	39	184	27	27	2.95	4th
2	19	27	61	75	123	3.84	1st
3	14	20	41	175	55	3.78	2nd
4	26	189	36	30	24	2.47	5th
5	12	43	65	77	108	3.74	3rd
6	214	28	15	16	34	1.79	6th

Own survey (2024)

Note: The first column stands 1: for shortage of production inputs, feeds and treatment to vegetables and animals. 2: Lack of enough space to perform effectively for production. 3: Complaints that arise from city administration offices and neighbors regarding aesthetic and sanitary issues. 4: Limited access of water 5: Lack of technical experts and development agents 6: Absence of technologies that promote the UPA.

A focus group discussion (FGD) was conducted with eight urban Livestock, crop, and vegetable farmers. These participants emphasized that UPA is commonly practiced among low- and middle-income households as a key strategy for achieving food security and supplementing household income. They highlighted several factors that contribute to the growth and sustainability of this sector, including the availability of cultivable land, accessible labor, favorable environmental conditions, farmers' personal motivation, and supportive governmental initiatives.

Participants underscored that beyond the physical act of food production, they found the most rewarding aspects of urban farming to be the ability to provide fresh produce for their families, generate additional income, and easily enter the agricultural sector without requiring substantial financial investments. Government support and a readily available labor force were also cited as elements that bolster production capacity.

A notable comment from one household head was: "Access to infrastructure is one of our advantages in the production line, in addition to the good opportunities mentioned in the group discussion." Proximity to farming plots near their homes was another important factor.

This allowed farmers to reduce transportation costs and time, enhancing efficiency in both production and household food supply.

Despite these advantages, the farmers discussed a range of challenges they face. Chief among these were the absence of well-defined governmental policies tailored to urban agriculture, limited access to essential agricultural inputs, and inadequate agricultural extension services. They also pointed to concerns about future risks such as land scarcity, limited access to reliable water sources, and theft, which could further threaten their production efforts.

In a separate discussion point, participants raised environmental concerns—particularly urban flooding. They observed that flooding in their areas had become more severe, largely due to siltation caused by soil erosion from nearby farmlands and improper disposal of solid waste upstream, notably in the vicinity of Awash Hospital, the "Worei River", and various small urban streams. During periods or years with minimal flooding, farmers noted that it is possible to achieve three to four harvests annually, significantly improving productivity and household income through careful and strategic management.

However, the urban vegetable farms also faced regulatory restrictions. In 2020/21, the government suspected that vegetable farms along riverbanks were contributing to the spread of a disease known locally as "Atet." As a result, vegetable cultivation near riverbanks was officially prohibited. Despite this ban, many farmers continued their operations out of necessity, as urban agriculture remained their primary means of livelihood and food security.

Another pressing issue identified by the group was the increasing damage to crops caused by insect pests. This problem, according to the participants, appears to be worsening due to climate variability and broader environmental pollution. They suspect that such ecological changes are creating favorable conditions for pest outbreaks, thereby reducing crop quality and yield.

In summary, the discussions revealed that while UPA farming offers significant benefits in terms of food access, income generation, and low-entry barriers, it also faces considerable challenges ranging from environmental degradation and pest outbreaks to policy gaps and regulatory restrictions.

The focus group discussion involved a total of eight participants, containing eight local farmers. The respondents emphasized the complementary relationship between crop production and livestock rearing, noting that these two farming systems mutually reinforce each other. As a result, many farmers in the area adopt an integrated farming approach that includes both crop cultivation and livestock management. However there is less access to artificial insemination during reproduction.

The decision to engage in a specific farming system is largely influenced by individual land ownership status and recommendations provided by agricultural extension officers. This finding aligns with results from the survey data, which show a statistically significant association between land ownership and the type of farming practiced (t-value = 2.996; p-value = 0.01). Farmers with more secure or larger plots of land are more likely to engage in both crop and livestock production, while those with limited land may focus on one aspect based on suitability and resources.

Participants viewed this integrated approach as an effective risk management strategy. By diversifying their activities, they ensure that if one farming enterprise—either crops or livestock—fails due to environmental, economic, or health-related reasons, they can rely on the other to sustain their livelihoods. For example, income from selling livestock can support families during poor crop seasons, and vice versa.

Moreover, farmers reported utilizing farmyard manure to enhance soil fertility and improve crop yields, while crop residues are commonly repurposed as animal feed—demonstrating a circular use of resources within the system.

While farmers do benefit from technical advice and support from agricultural extension officers, the availability and accessibility of these services remain limited. There are only three extension officers serving the entire area, and due to a lack of adequate facilities and transportation, timely access to each individual farmer is not always possible.

In addition to public support, four private institutions are actively involved in providing assistance to farmers in the area: Mekelle University, the Tigray Development Association (TDA), the Tigray Agricultural Mechanization Research Institution (TAMRI), and Pome Gold Fruits Farm. These institutions offer financial aid to selected farmer groups and provide

training in various agronomic practices, helping to build local capacity and improve agricultural productivity.

Despite the growing engagement in peri-urban farming, currently there are no specific government policies in Mekelle dedicated to supporting this agricultural niche. However, the regional government is pursuing an industrialization agenda, and agriculture is considered a foundational sector in this development strategy. The rationale behind this is that agriculture not only supplies raw materials to emerging industries but also plays a critical role in ensuring food security for the local population.

In conclusion, the discussion highlighted the value of integrated farming systems in enhancing resilience, improving resource efficiency, and supporting livelihoods, while also pointing to the need for more targeted policies and better extension services to support peri-urban agriculture in the context of broader economic transformation.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary

The primary aim of this study was to provide empirical evidence on the socio-economic characteristics of urban and peri-urban agriculture (UPA), identify the determinants influencing participation, and assess its impact on household livelihoods—specifically focusing on employment and income. Additionally, the study explored the challenges and opportunities associated with UPA in the Mekelle Hadnet sub-city of the Tigray region. To achieve these objectives, the study employed various research methodologies, including descriptive statistics for analyzing demographic and socio-economic characteristics, multinomial logit regression (MLR) to identify factors influencing UPA participation, and propensity score matching (PSM) to assess the impact of UPA on household income and employment creation. Furthermore, a Likert scale was utilized to capture the perceived opportunities and constraints of engaging in UPA.

The study was conducted in Mekelle Hadnet sub-city, which has a history of engaging in UPA activities, with a sample size of 305 households. These households were selected from both UPA participants and non-participants, ensuring a comparable socio-cultural and agro-ecological context. The sampling procedure used was multi-stage random sampling, which enabled a representative sample of urban and peri-urban agriculture households.

Data collection involved both primary and secondary sources. Primary data was gathered through a household survey, employing a semi-structured questionnaire to obtain responses from the sample households. Secondary data was sourced from relevant documents, reports, and studies. Data analysis was carried out using a combination of descriptive statistics and econometric models to provide a comprehensive understanding of the research questions.

Key Findings:

1. Contribution to Household Livelihoods:

The study found that 48.5% of the livelihoods of UPA higher-participants were significantly supported by UPA activities, whereas 51.5% of lower-participants reported similar contributions. This suggests a considerable dependence on UPA for income generation and employment. Specifically, the contribution was most notable for households engaged in livestock-only production (11.1%), vegetable (fruit)-only production (9.2%), both livestock +

crop production (16.1%), and a combination of livestock, crop and vegetable production (12.1%) while 51.5 percent crop/cereal production for lower-participants.

2. Demographic Characteristics:

The mean age of household heads was 49.01 years with higher-participants averaging 47.17 years and lower-participants averaging 50.76 years-old. This indicates that both groups are in their active working age, which is critical for sustaining agricultural activities. In terms of land holdings, UPA higher-participants had smaller land sizes (0.54 hectares) compared to lower-participants (1.38 hectares), suggesting that UPA participation might be a necessity for households with limited land resources.

3. Household Size and Dependency Ratio:

The average household size in the sample was 5.98 persons, with a dependency ratio of 0.29. For higher-participants, the average ratio was 0.24, and for lower-participants, it was 0.34, indicating a higher dependency on lower-participants. This suggests that household size and dependency may influence participation in UPA, with larger households potentially less likely to engage in urban and peri- urban farming due to greater economic pressures.

4. Livestock Holdings:

The average livestock holding among the sample households was 14.2 animals, with higher-participants owning a slightly higher number (15.4) than lower-participants (13.1). This indicates that households with higher livestock holdings could benefit more from participating in UPA, and those with fewer holdings might have less incentive to diversify into urban and peri- urban agriculture.

5. Educational Status, Farming Experience and Distance from Home to Farm:

Higher-participants had a significantly more average level of education compared to lower-participants. This indicates that education plays a critical role in enabling awareness, adoption of improved practices, and effective farm management. Both groups have substantial farming experience, with higher-participants slightly ahead. Experience contributes to greater knowledge and better decision-making, which may enhance the participation of UPA practices. Moreover, UPA higher-participants live significantly closer to their farms than lower-participants. Proximity reduces time and labor constraints, allowing for better farm monitoring and more frequent engagement.

6. Off/Non-Farm Income

Lower-participants earn more from off-farm and non-farm activities than higher-participants. This suggests that households with higher alternative income sources may be less reliant on agriculture and thus less motivated to engage in UPA.

7. Sex Distribution of Household Heads and Marital Status

The majority of household heads in the sample were male, and participation in UPA was significantly higher among male-headed households. Although women represented 30% of UPA higher-participants—more than among lower-participants—this gap suggests gender disparities in access to agricultural opportunities. Cultural and structural barriers such as limited access to land, credit, and extension services likely hinder female participation.

Married individuals overwhelmingly represented both groups, but especially among UPA higher-participants (96%). This reflects the stability and support system associated with marriage, which may facilitate joint decision-making, shared labor, and a stronger economic base for undertaking agricultural activities.

8. Access to Credit, extension service and agricultural input utilization

Access to credit services was significantly great among UPA higher-participants. Credit access enables households to invest in inputs, tools, and infrastructure necessary for productive urban agriculture. Similarly, higher-participants in UPA reported substantially more frequent access to extension services compared to lower-participants. Such access likely contributes to knowledge dissemination, adoption of improved practices, and increased productivity. Moreover, there is a strong association between the use of improved agricultural inputs (seeds, fertilizers, technologies) and participation in UPA. Higher-participants were more than twice as likely to use modern inputs as lower-participants, indicating a shift toward more intensive and efficient farming practices.

9. Membership in Civil Associations

Membership in social and economic associations was significantly higher among UPA higher-participants. These associations often provide access to information, networks, credit, and group-based training, fostering an enabling environment for urban agriculture.

Impact of UPA on Employment and Income:

The third phase of the analysis focused on the impact of UPA participation on employment creation and income generation. A comparative analysis revealed that UPA higher-participants created 7.04 employment opportunities annually, while lower-participants created about 5.85 opportunities, making the employment generated by higher-participants 17% higher than that of lower-participants. This difference was statistically significant at the 1% probability level, confirming that UPA participation positively impacts employment creation.

The study also found a significant positive impact of UPA participation on farm income. The average income difference between treated (UPA higher-participants) and non-treated (lower-participants) groups was Birr 13,103.65, representing a (12.2%) higher income for UPA participants. The results indicated that UPA participation significantly improves both employment and income, which are crucial for improving livelihoods and addressing issues of poverty in the region.

Robustness and Sensitivity:

The Propensity Score Matching (PSM) results revealed that the impact of UPA on employment and farm income was robust and insensitive to unobserved selection bias, providing further confidence in the validity of the findings. The sensitivity analysis confirmed that the treatment effects were stable even with potential unobserved confounding factors.

Determinants of UPA Participation and Impact:

The Multinomial Logit Regression (MLR) model was used to analyze the factors influencing UPA participation. The results highlighted several significant determinants:

Positive Factors:

1) Land size, farm distance, animal feed, off/on-farm income, association membership, employment, farm experience and farm costs positively influenced participation in livestock and crop production and the combined livestock, crop and vegetable production.
2) Access to extension services, livestock holding, and farm costs had a positive impact on livestock-only production.
3) Employment and farm income had a positive effect on vegetable-only production.

Negative Factors:

1) Family size, animal feed usage, and age had negative and significant effects on various forms of production, including livestock , crop and vegetable production and vegetable-only production.

Policy Implications:

The findings of this study underline the importance of UPA as a means of improving household livelihoods by providing employment opportunities and enhancing income generation. The study recommends expanding and strengthening the development of UPA in Mekelle and similar urban and peri- urban areas, emphasizing policies and strategies that target UPA practices to maximize their impact on employment and income generation. Special attention should be given to support services, including technical assistance, access to agricultural inputs, and land access, which are critical for enabling more households to participate and benefit from UPA.

Conclusion:

In conclusion, the study provides compelling evidence that urban and peri-urban agriculture (UPA) plays a significant role in improving employment and income in the Mekelle Hadnet sub-city. The results highlight that UPA contributes to household livelihoods, and its expansion could offer a sustainable remedy for challenges such as unemployment and income scarcity. Future policies should support the growth of UPA, ensuring it reaches a broader segment of the population and addresses the various challenges faced by practitioners.

- Participation in urban and peri-urban agriculture is influenced by a combination of socio-economic, demographic, and spatial factors. Younger age, higher education, closer farm proximity, lower dependency ratios, smaller land sizes, and greater livestock holdings all positively influence engagement in UPA. In contrast, households with larger land holdings and higher off-farm incomes are less likely to rely on urban agriculture, indicating a preference for other livelihood strategies. These insights can inform targeted interventions to enhance the effectiveness and inclusiveness of urban agriculture initiatives.

- Participation in urban and peri-urban agriculture is not only shaped by household characteristics like age, education, landholding, and distance to farm, but also by broader Male-headed and married households are more likely to participate.

- Access to credit and extension services strongly facilitates participation.
- Use of modern inputs and membership in civil associations are positively correlated with UPA engagement.
- Gender and social inequality particularly among female-headed households—pose significant barriers that must be addressed to enhance inclusive urban agriculture development.

These findings provide a robust foundation for designing targeted policies that support UPA, especially by improving women's access to resources, enhancing extension service coverage, and strengthening financial and social institution.

- Social and economic associations play a supportive but currently underperforming role in promoting urban and peri-urban agriculture. While participation rates are high, especially in social groups, satisfaction with knowledge-sharing remains modest, and the benefits are not fully optimized. Economic associations appear more impactful for UPA knowledge acquisition, suggesting a need for expanded access and institutional reinforcement. Strengthening these associations with better coordination, training, and resources could significantly boost their effectiveness as catalysts for sustainable urban agriculture development.
- The findings underscore that UPA practices, especially those incorporating livestock and diversified crops, are significant contributors to local employment generation. The statistically significant relationship between employment levels and UPA participation highlights the sector's potential in addressing urban livelihood challenges. Therefore, greater support for diversified UPA systems is essential through policy, training, credit, and infrastructure — to harness its full potential in urban job creation.
- Urban and peri-urban agriculture (UPA) proves to be a significant driver of diverse employment opportunities in urban settings. While UPA higher-participants consistently show higher employment outcomes, especially in formal and entrepreneurial roles, lower-participants also play a role in sustaining local livelihoods. Moving forward, targeted interventions—including labor training, agribusiness development, and inclusive policy frameworks—are essential to maximize the employment potential of UPA across all household types.

5.2. Recommendations

Based on the findings of this study, several recommendations are proposed to improve the livelihoods of urban and peri-urban households through urban and peri-urban agriculture (UPA). These recommendations focus on addressing the key challenges identified and leveraging opportunities to maximize the impact of UPA on employment and income generation.

1. Addressing Family Size and Age-Related Challenges

The study found a negative relationship between family size and the likelihood of participating in UPA. Larger family sizes may discourage participation, potentially due to greater dependency burdens. To mitigate this, it is recommended that financial services be more widely incorporated into UPA, enabling households to improve their income rather than focusing on increasing off-farm employment. Furthermore, although the age of household heads was found to have a negative relationship with livestock-only production, it was statistically significant. Therefore, awareness creation programs should target older household heads to help them understand the benefits of UPA and enhance their livelihood security. Awareness programs should also focus on easy-to-implement agricultural technologies, ensuring that aged farmers can integrate them into their daily practices.

2. Land Administration and Development

Given the positive impact of land size on livestock and crop production but less on the rest of UPA activity, it is crucial to improve land administration in urban and peri-urban areas. The city administration should collaborate with the municipal authorities to create a more conducive environment that addresses the issue of land scarcity. By securing better land access for UPA activities, urban and peri-urban agriculture can play a more significant role in reducing unemployment in these areas.

3. Promoting Knowledge Sharing and Skill Enhancement

The study found that farm experience had a positive impact on UPA practices, especially on livestock and crop and livestock, crop and vegetable production. To foster this, local governments should organize field days, cross-visits, and knowledge-sharing forums where experienced farmers can share best practices. Additionally, short-term training programs should be provided to help less experienced farmers adopt efficient farming techniques. This

approach would help improve efficiency levels by allowing farmers to benchmark their performance against successful models and identify areas for improvement.

4. Farm Distance and Management

The study also revealed that farm distance had a significant positive influence on UPA productivity. Farmers who were able to manage their farms more closely and effectively benefited from this proximity. Therefore, it is essential to encourage farmers to visit their farms more frequently during the growing season to manage farm activities efficiently. Initiatives should be introduced to support proximity to farm sites, helping farmers reduce unnecessary travel costs and improve production efficiency.

5. Strengthening Farmer Associations

The study found that access to associations had a significant positive effect on livestock and crop production but lower on the rest UPA activities. As such, farmers should be encouraged to join both formal and informal associations that offer access to modern agricultural technologies, agricultural information, and institutional support. The government should provide incentives to strengthen existing farmer associations and create new ones to increase farmers' access to technical support and market information, which would help improve their production practices.

6. Enhancing Extension Services

Although extension services had a positive effect on one UPA practices, but less effect on more of UPA activity due to infrequent visit for urban and peri-urban farmers caused by the absence of an independent governing body for UPA activities. Therefore, it is essential for the local government to establish a dedicated urban and peri-urban agricultural office responsible for overseeing UPA activities. This office should ensure that UPA practitioners receive the necessary extension services regularly, similar to rural farmers. This will promote the widespread adoption of best agricultural practices and improve livelihood outcomes in urban and peri-urban areas.

7. Improving Access to Agricultural Inputs

The study showed that access to agricultural inputs significantly affected livestock-crop production, almost negatively. Rising input costs and inadequate access to feed, improved seeds, and fertilizers were identified as major barriers. To address this, policies should be designed to subsidize agricultural inputs and improve input distribution systems for UPA

practitioners. Additionally, technical support and advisory services should be made available to farmers to help them make informed decisions on input use, thereby improving the efficiency of their farming activities.

8. Livestock Management

The study indicated that livestock size positively impacted livestock-only production. Households with larger livestock holdings tend to be more efficient in their UPA practices, reducing the need for off-farm activities. To support this, the government should design policies that address the shortage of animal feed and provide technical guidance on livestock management. This will enhance the efficiency of livestock production systems and help UPA participants maximize their returns from animal husbandry.

9. Farm Cost Management

Farm costs were found to have a significant positive effect on all UPA sectors except for vegetable-only production. To reduce farm costs, it is recommended that the government develop a demand-driven agricultural input service system. This system should aim to reduce the cost of agricultural inputs and ensure that input services are responsive to the needs of farmers. By rationalizing input costs, farmers will have greater access to the resources necessary to improve their productivity.

10. Addressing UPA Challenges

To overcome the challenges faced by UPA practitioners, such as land access, water scarcity, and lack of technological support, the Mekelle Hadnet Sub-city Administration, City Agricultural Office, and other relevant stakeholders should work together to facilitate access to water, promote agricultural technologies, and provide training and technical assistance. Moreover, efforts should be made to integrate UPA practitioners into local administrative systems and ensure they are part of environmental health and sanitation programs to maintain a clean and productive working environment.

11. Financial Support for UPA Households

To encourage urban and peri-urban households to participate in UPA, financial support should be made available through low-interest loans, credit facilities, and input subsidies. These financial resources will help mitigate the initial costs of establishing UPA activities and enable households to improve their income levels and employment generation.

12. Recognition of UPA in National Policy and Urban Planning

National policy-makers, urban planners, and city/town administrators should shift their attitudes towards UPA, recognizing it as a viable economic sector that can significantly contribute to household income and employment. Given that Ethiopia is a labor-rich but capital-poor country, urban and peri-urban agriculture should be promoted as a means of alleviating poverty and improving the welfare of urban households. Additionally, urban and peri-urban agriculture should be integrated into urban planning and development policies.

13. Strengthening the Agricultural Workforce

It is crucial to ensure that specialized agricultural experts are assigned to manage UPA programs. The government should employ trained professionals with practical expertise to guide UPA activities. Training programs should be conducted by these experts, and educational resources such as manuals should be provided to enhance the skills of UPA practitioners.

14. Future Research Directions

While this study focused on a single sub-city, future research should consider expanding the scope to include multiple towns or sub-cities to provide a more comprehensive understanding of UPA's impact. Additionally, the linkage between urban and peri-urban agriculture and rural agriculture in terms of employment and income generation should be explored in future studies. Researchers could also use panel data or time-series data to evaluate the long-term effects of UPA on livelihoods more thoroughly.

In conclusion, for urban and peri-urban agriculture to be successful in improving livelihoods, it is essential to address the challenges identified, promote supportive policies, and ensure sustained investments in the sector. The recommendations provided here aim to strengthen UPA’s contribution to poverty reduction, employment creation, and economic development in urban and peri- urban areas.

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APPENDICES

Appendix-I: Questionnaire for Household Resident of Tabia Aynalem and Metkel.

Appendix-II: Correlation, Multicollinearity and Hetroskedasticity

Appendix-III: Multinomial Logistic Regression Model, Marginal Effect, and Model fitness.

Appendix-IV: Summary Participation in UPA Employment and Farm Income.

Appendix-V: Propensity Score Matching Test.

Appendix-VI: Results of ATT Using Propensity Score Matching.

Appendix-VII: Sensitivity Analysis Tests on Treated (ATT).

Appendix-I:

QUESTIONNAIRES AND CHECKLIST USED FOR THE FIELD WORK/DATA COLLECTION

PART ONE: QUESTIONNAIRE

Enumerator Name----------Sub-city----------Kebelle----------

Code----------Date----------

SECTION 1. GENERAL SOCIO-DEMOGRAPHIC INFORMATION:

1. Name of household head _____ phone number _____
2. Age of household head _____
3. Household head Sex (0= Female 1= male)
4. Education level of household head? 0= illiterate 1= able to read and write 2= if formal put grade ___
5. Major occupation of household head 0= Farmer 1=Civil servant 2= Self employed
6. House hold classification-------A) Rural B) Urban C) Peri Urban
7. Marital status 0= Single 1= Married 2= Widow 3= Divorced
8. Total family size permanently living? _____ Female _____ and Male _____
9. Total family size (permanently living) characteristics

S/no	Family member use code[1]	Age	Sex use code[2]	Education Use code[3]	Farm activities Yes (√) if No (X)		Non-farm activities Yes (√) if No (X)		Off-farm activities Yes (√) if No (X)	
					Active	Non active	Active	Non active	Active	Non active
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

NB use code[1] = 1) Head 2) Wife 3) Son 4) Daughter 5) Relative 6) Raised 7) Specify If Any

Use code[2]=0) Female 1) Male

Use code[3]= 0) illiterate 1) able to read and write and if formal put grade

10. What is your major farming activity? Multiple choice is possible
    0= Livestock production 1= Crop production 2= Vegetable and Fruit production 3=Livestock +Crop 4=Livestock +Vegetable 5=Crop +Vegetable 6=All three

11. Experience of house hold head

Experience	Livestock Production	Crop Production	Fruits and vegetable production	Other activity (specify)
Years				

SECTION 2. SOCIOECONOMIC CHARACTERISTICS AND DETERMINANT FACTORS OF UPA RESPONDENTS

12. Does your family member have land for rainfed crop production? 0 = No 1= Yes
13. Do you have accesses to irrigation? 0= No 1= Yes
14. If you have irrigation what is your source of water? 0 = Common walls 1= Private walls 2=Check dams 3= River diversion 4= Other (if other specify _____)
15. What is your total land holding in Tsimad

No	Land holding	Rainfed	Irrigated	Total
1	Farm size holding			
2	Own farm			
3	Shared in			
4	Rented in			

16. How much Livestock do you have?

Type	Cows	Oxen	Sheep& goat	Poultry	Mules& Donkeys	Homey bee	Other
Amount							

17. What the fertility status of your farm?
    0= Very low 1= low 2= Moderate 4= High 5= Very high
18. Do you apply any agricultural inputs during 2023/24 year? 0 = No 1= Yes
19. If your answer for # 18 is yes, amount of input used and its cost

Input type	Unit	Quantity		Price per unit	Total in birr
		Rain fed	Irrigation		
Fertilizer					
Improved seed					
Chemical					
Animal feed					
Livestock local breed					
Livestock exotic breed					
Labour					
Manure					
Compost					
Other (specify)					

20. Where do you produce your farm?

Activity	Location 0= home 1 = other
Livestock Production	
Crop Production	
Fruits and vegetable production	

21. If at other location what is the distance to your farm in kilometer

Distance	Unit	Location	Farm	Market	FTC	Nearest road
On foot	Minute/Km	Home				
		Farm				

22. What do you suggest your economic status 0= Very poor 1= Poor 2= Average 4= Rich 5= Very rich
23. Do you get any services/access about urban agriculture? Please mention on the table below.

Type of services	0= No 1=Yes	Rank based on employment creation	Rank based on income generation
Credit access			
Technical training			
Extension visits			
Field day participation			
Participation in demonstration			
Get improved seed			
Get fertilizer			
Mechanization			

24. Had you/ family member participated in any civil association/s? _____ 0) No 1) Yes
25. If your answer in #25 is yes fill the following table and did you obtained any additional knowledge on agricultural production

S/No	Economic and social Association	Membership 0 = No 1=Yes	Additional Knowledge on UPA 0 = No 1=Yes	Did you satisfy on the information obtained use code[1]
1	Farmers association			
2	Youth association			
3	Women association			
4	Edir/Equib			
5	Religion member celebrations			
6	Traders' association			
7	Saving and credit cooperatives			
8	Seed Cooperatives			
9	Multipurpose cooperative			
10	Irrigation membership			

NB. Use code[1] 1= very low satisfied 2 = low satisfied 3= Satisfied 4= high Satisfied 5= very high satisfied

SECTION 3A. EFFECTS OF UPA ON EMPLOYMENT CREATION

26. Do you employ people to work on your field?

Activities	Status 0= No 1= Yes
Livestock production	
Crop production	
Fruits and vegetable production	

27. If yes, how many people do you employ?

Type of activity	Livestock Production	Crop Production	Fruits and vegetable production	Other activity (specify)
Land preparation				
Ploughing				
Sowing or planting				
Fertilizer application				
Chemical application				
Weeding				
Harvesting				
Threshing				
Transporting				
Animal herding				
Feeding and cleaning				
Other (specify)				

28. Indicate the type of employment of these employees

Activity	Education					
	Illiterate			Lliterate		
	Youth	women	Men	Youth	women	Men
Part time						
Full time						
Family part time job						
Family full time job						
Full time self-business						
Part time self-business						
Others(specify)						
Total number						

29. How much do you pay your employees per harvest season?

Type of activity	Livestock Production	Crop Production	Fruits and vegetable production	Other activity (specify)
Land preparation				
Ploughing				
Sowing or planting				
Fertilizer application				
Chemical application				
Weeding				
Harvesting				
Threshing				
Transporting				
Animal herding				
Feeding and cleaning				
Other (specify)				

SECTION 3B) EFFECTS OF UPA ON INCOME CREATION

30. Please specify the source and amount of income you obtained from your farm production in the last one-year (2023/24).

Type of farm activity	Unit	Quantity	Price Per Unit (Birr)	Total Annual Income
A. Livestock production				
Cattle trading	Number			
Sheep/Goat trading	Number			
Donkey, Mules	Number			
Milk and milk products	Liter			
Poultry trading	Number			
Poultry products	Number			
Other				
B. Crop production				
Cereals	Quintal			
Legumes	Quintal			
Oil seeds	Quintal			
Other				
C. Vegetable and fruit production				
Tomato	Quintal			
Cabbage				
Onion				
Lettuce				
Carrot				
Mango	Quintal			
Avocado				
Lemon				
Other (specify)				

31. Do you participate in any off/non -farm activity? 0=No 1=Yes
32. If your answer for #32 is yes, please specify the source and amount of income you obtained from off/non-farm activities in the last one year (2023/24).

Type of off/non-farm activity	0=No 1=Yes	Unit	Amount/ Quantity	Price Per Unit (Birr)	Total Annual Income (Birr)
Wage employment in private/public sector		Birr			
Daily labour		Birr			
Masonry		Birr			
Grinding meal		Birr			
From rent animals		Birr			
From remittances		Birr			
From house rent		Birr			
From sales of charcoal and faire woods		Birr			
From relatives		Birr			
Other specify					

SECTION 3: CONSTRAINTS AND OPPORTUNITIES OF UPA PARTICIPANTS AND NON-PARTICIPANT

34a CONSTRAINTS WORKING IN URBAN AGRICULTURE

Next, we will be asking you about the main challenges you are facing in urban farming. Please mention if the listed constraints are a problem and the importance of the problem

S. N	List of constraints / Challenges	Is this a constraint?	Please rank the problems as per the following scale				
		Yes (1) No (0)	Very-Import (5)	Important (4)	Undecided (3)	Less import (2)	Not import (1)
1							

34b. OPPORTUNITY WORKING IN URBAN AGRICULTURE

Next, we will be asking you about the main opportunities you are obtaining from urban farming. Please mention if the mentioned chance is a prospect and the importance of the prospect.

List of Opportunities	Is this a chance?	Please rank the prospects as per the following scale				
	Yes (1)/ No (2)	Very-Important (5)	Important (4)	Undecided (3)	Less important (2)	Not important (1)

PART TWO: CHECK LIST OF FOCUS GROUP DISCUSSION FOR UPA PARTICIPANTS AND NON-PARTICIPANTS

1. What are the most important practices of urban farming in the area?

2. Do UPAs have contribution to employment? If yes, to what extent? To what age group, sex etc.?

3. If your answer to question number 2 is yes, what are the types of employments and what types of employment have more employees?

4 .Do UPAs create income? If the answer is yes, to what extent will they create income?

5. What kinds of supports are provided to UPAs?

6. Do you face any challenges while farming? If yes, can you mention them starting with the most important?

7. What kinds of measures have to be taken to solve the challenges?

8. What are the opportunities engaging in UA in production, marketing and financial aspect?

PART THREE: FOR KEY INFORMANTS

1. What is the contribution of UPAs in improving the livelihood of farm households in general and farm household‘s income and employment in particular?

2. What were important coping strategies to facilitate UPAs in the area?

3. How is the extent of urban farming in this sub-city?

4. Which crop and livestock are commonly produced in this sub-city? Start with the most important.

5. What do you think are the major benefits of UPAs to farm households?

6. What are the major factors that facilitate UPAs?

7. How do you value the significance of urban farming as compared to alternative income generating opportunities?

Appendix II: Correlation, Multicollinearity and Hetroskedacity

```
. corr AgeHH SexHH EduHH Famsize Dratio Landsize Fertilizer22 Totalanimalfeed Farmdisthome Creditaccess Extensionaccess accessagrinputs Ci
> vilmember TLU Experience Costfarm Offfarmincome
(obs=305)
```

	AgeHH	SexHH	EduHH	Famsize	Dratio	Landsize	Ferti~22	Totala~d	Farmdi~e	Credit~s	Extens~s	access~s	Civilm~r
AgeHH	1.0000												
SexHH	0.1239	1.0000											
EduHH	-0.2430	0.0097	1.0000										
Famsize	-0.1211	-0.2025	-0.0787	1.0000									
Dratio	-0.1624	-0.0526	-0.1024	0.2916	1.0000								
Landsize	0.1565	0.2560	-0.1629	-0.0439	0.2121	1.0000							
Fertilizer22	-0.0191	-0.0681	-0.0090	-0.0127	-0.0156	0.2108	1.0000						
Totalanima~d	0.0396	-0.1941	-0.2294	0.1196	0.2690	0.1529	-0.0090	1.0000					
Farmdisthome	0.1865	0.2655	-0.1653	0.0191	0.1856	0.6054	-0.0948	0.1148	1.0000				
Creditaccess	-0.1561	-0.0546	0.1960	0.0337	-0.1693	-0.5025	-0.0175	-0.1388	-0.5334	1.0000			
Extensiona~s	-0.1219	-0.2188	0.0459	0.0036	-0.2338	-0.4241	0.0325	-0.0867	-0.4588	0.3674	1.0000		
accessagri~s	-0.1473	-0.1028	0.2085	0.0312	-0.1568	-0.4115	0.0608	-0.0616	-0.4275	0.3756	0.3452	1.0000	
Civilmember	0.0732	-0.2352	0.0776	0.1812	-0.3374	-0.5494	0.0617	-0.0961	-0.5264	0.3976	0.3745	0.4464	1.0000
TLU	0.0294	-0.2056	-0.1506	0.1373	0.1586	0.0366	0.0442	0.4561	-0.0803	-0.0693	-0.0196	0.0101	-0.0134
Experience	0.0216	-0.1088	0.0212	0.0442	-0.1636	-0.1890	0.0747	0.0718	-0.2213	0.1256	0.1455	0.1844	0.2790
Costfarm	-0.0440	-0.1889	-0.0322	0.0318	-0.0932	-0.1917	0.0252	0.0404	-0.2952	0.1360	0.1160	0.2214	0.2180
Offfarminc~e	0.0146	-0.0718	-0.1293	0.0814	0.2121	0.3599	-0.0137	0.2949	0.3762	-0.2920	-0.2892	-0.2539	-0.3682

	TLU	Experi~e	Costfarm	Offfar~e
TLU	1.0000			
Experience	0.1339	1.0000		
Costfarm	0.1178	0.1287	1.0000	
Offfarminc~e	0.2017	-0.1139	-0.0638	1.0000

- Continuous variables

```
. vif
```

Variable	VIF	1/VIF
Farmdisthome	2.40	0.417302
Landsize	2.35	0.425637
Civilmember	2.25	0.444428
Creditaccess	1.63	0.615016
accessagri~s	1.49	0.672436
Totalanima~d	1.48	0.677464
Dratio	1.46	0.682763
Extensiona~s	1.46	0.685143
Offfarminc~e	1.42	0.703710
TLU	1.38	0.724316
SexHH	1.34	0.747249
Famsize	1.32	0.759731
AgeHH	1.26	0.792821
EduHH	1.20	0.832915
Fertilizer22	1.19	0.837207
Costfarm	1.16	0.864754
Experience	1.14	0.875049
Mean VIF	1.52	

```
. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of Farmtype

         chi2(1)      =     0.01
         Prob > chi2  =   0.9118

. ovtest

Ramsey RESET test using powers of the fitted values of Farmtype
       Ho:  model has no omitted variables
                 F(3, 284) =      0.33
                  Prob > F =      0.8067
```

Appendix-III: Multinomial Logistic Regression Model, Marginal Effect, and Model fitness.

Case Processing Summary

		N	Marginal Percentage
Major farm activities	non-participant	157	51.5%
	Livestock production	34	11.1%
	Vegetable(fruit) production	28	9.2%
	Livestock and crop production	49	16.1%
	Livestock,crop and vegetable(fruit) production	37	12.1%
Valid		305	100.0%
Missing		0	
Total		305	
Subpopulation		305[a]	

a. The dependent variable has only one value observed in 305 (100.0%) subpopulations.

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	2091.790	1148	<.001
Deviance	609.404	1148	1.000

Pseudo R-Square

Cox and Snell	.510
Nagelkerke	.546
McFadden	.263

Model Fitting Information

Model	Model Fitting Criteria -2 Log Likelihood	Likelihood Ratio Tests Chi-Square	df	Sig.
Intercept Only	826.727			
Final	609.404	217.323	68	<.001

Parameter Estimates

Major farm activities[a]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
Livestock production	Intercept	-27.081	9.729	7.748	1	.005			
	age of household in years	-.076	.059	1.638	1	.201	.927	.826	1.041
	Education of house hold head in years	.141	.160	.773	1	.379	1.151	.841	1.576
	Family size in numder	1.167	.525	4.939	1	.026	3.212	1.148	8.990
	Total farm cost birr	-3.605	1.638	4.843	1	.028	.027	.001	.674
	Total amout of improved seed in Killogram	.000	.000	12.962	1	<.001	1.000	1.000	1.000
	Ffarm distance from home in woking minute	.059	.181	.106	1	.745	1.061	.744	1.511
	Total Live stock holding unit in number	.579	.165	12.356	1	<.001	1.785	1.292	2.465
	Total experience of household head in year	.062	.088	.492	1	.483	1.064	.895	1.264
	Off-farm net income per year in birr	.000	.000	.153	1	.696	1.000	1.000	1.000
	Total number of employee per year in number	.236	.342	.474	1	.491	1.266	.647	2.476
	Farm net income per year in birr	.000	.000	9.698	1	.002	1.000	1.000	1.001
Vegetable(fruit) production	Intercept	-5.523	8.623	.410	1	.522			
	age of household in years	.043	.054	.624	1	.429	1.044	.938	1.161
	Education of house hold head in years	.221	.152	2.121	1	.145	1.247	.926	1.680
	Family size in numder	.815	.487	2.804	1	.094	2.259	.870	5.864
	Total farm cost birr	-2.475	1.549	2.554	1	.110	.084	.004	1.751
	Total amout of improved seed in Killogram	.000	.000	13.388	1	<.001	1.000	1.000	1.000
	Ffarm distance from home in woking minute	-.121	.162	.556	1	.456	.886	.646	1.217
	Total Live stock holding unit in number	.265	.157	2.851	1	.091	1.304	.958	1.774
	Total experience of household head in year	-.158	.080	3.909	1	.048	.854	.731	.999
	Off-farm net income per year in birr	.000	.000	.057	1	.811	1.000	1.000	1.000
	Total number of employee per year in number	.207	.316	.429	1	.513	1.230	.662	2.285
	Farm net income per year in birr	.000	.000	2.868	1	.090	1.000	1.000	1.000
Livestock and crop production	Intercept	-43.014	10.169	17.894	1	<.001			
	age of household in years	.013	.058	.047	1	.828	1.013	.904	1.135
	Education of house hold head in years	.220	.163	1.824	1	.177	1.246	.906	1.714
	Family size in numder	.348	.544	.408	1	.523	1.416	.487	4.115
	Total farm cost birr	-2.795	1.652	2.862	1	.091	.061	.002	1.557
	Total amout of improved seed in Killogram	.000	.000	12.863	1	<.001	1.000	1.000	1.000
	Ffarm distance from home in woking minute	.041	.182	.049	1	.824	1.041	.728	1.489
	Total Live stock holding unit in number	.281	.166	2.863	1	.091	1.324	.957	1.832
	Total experience of household head in year	.141	.088	2.542	1	.111	1.151	.968	1.369
	Off-farm net income per year in birr	.000	.000	.749	1	.387	1.000	1.000	1.000
	Total number of employee per year in number	.535	.342	2.448	1	.118	1.707	.874	3.334
	Farm net income per year in birr	.001	.000	18.471	1	<.001	1.001	1.000	1.001
Livestock,crop and vegetable(fruit) production	Intercept	-46.489	10.207	20.745	1	<.001			
	age of household in years	-.003	.059	.003	1	.954	.997	.888	1.118
	Education of house hold head in years	.208	.161	1.658	1	.198	1.231	.897	1.689
	Family size in numder	.685	.540	1.609	1	.205	1.985	.688	5.723
	Total farm cost birr	-3.049	1.652	3.407	1	.065	.047	.002	1.208
	Total amout of improved seed in Killogram	.000	.000	10.200	1	.001	1.000	1.000	1.000
	Ffarm distance from home in woking minute	-.013	.183	.005	1	.941	.987	.689	1.412
	Total Live stock holding unit in number	.366	.165	4.902	1	.027	1.442	1.043	1.993
	Total experience of household head in year	.084	.089	.893	1	.345	1.088	.913	1.296
	Off-farm net income per year in birr	.000	.000	.263	1	.608	1.000	1.000	1.000
	Total number of employee per year in number	.387	.343	1.277	1	.258	1.473	.752	2.884
	Farm net income per year in birr	.001	.000	19.599	1	<.001	1.001	1.000	1.001

a. The reference category is: non-participant.

Appendix-IV: Summary Participation in UPA Employment and Farm Income

```
. tab Farmtype,sum( Farmincome)
```

Type of farming of household head	Summary of Farm net income per year in birr		
	Mean	Std. Dev.	Freq.
non parti	68837.925	9303.117	53
Participa	94045.694	12020.466	252
Total	89665.328	15021.207	305

```
. tab Farmtype,sum( Employment )
```

Type of farming of household head	Summary of Total number of employee per year in number		
	Mean	Std. Dev.	Freq.
non parti	3.943	1.610	53
Participa	6.841	2.710	252
Total	6.338	2.778	305

```
. *summary of ps

. sum _pscore if Farmtype==1
```

Variable	Obs	Mean	Std. Dev.	Min	Max
_pscore	148	.5553255	.1891135	.1495211	.8981006

```
. sum _pscore if Farmtype==0
```

Variable	Obs	Mean	Std. Dev.	Min	Max
_pscore	157	.4191836	.1546037	.0748102	.7801929

```
. sum _pscore
```

Variable	Obs	Mean	Std. Dev.	Min	Max
_pscore	305	.4852459	.1849438	.0748102	.8981006

```
. sum _pscore, detail
```

psmatch2: Propensity Score

Percentiles		Smallest		
1%	.1357031	.0748102		
5%	.223062	.0938667		
10%	.25574	.132012	Obs	305
25%	.3354231	.1357031	Sum of Wgt.	305
50%	.4719073		Mean	.4852459
		Largest	Std. Dev.	.1849438
75%	.6438215	.8729232		
90%	.7445727	.8779477	Variance	.0342042
95%	.7820083	.8883743	Skewness	.1551944
99%	.8729232	.8981006	Kurtosis	2.097959

Appendix-V: Propensity Score Matching Test.

```
. pstest AgeHH SexHH EduHH Famsize Dratio Landsize Fertilizer22 Totalanimalfeed Farmdisthome Creditaccess Extensionaccess accessagrinputs
> TLU Experience Costfarm Offfarmincome,sum both
```

Variable	Unmatched / Matched	Mean: Treated	Mean: Control	%reduct: %bias	%reduct: |bias|	t-test: t	t-test: p>|t|	V(T)/ V(C)
AgeHH	U	47.757	50.204	-22.2		-1.94	0.053	1.23
	M	48.756	49.174	-3.8	82.9	-0.31	0.755	1.30
SexHH	U	.7027	.83439	-31.5		-2.76	0.006	.
	M	.74809	.77483	-6.4	79.7	-0.51	0.613	.
EduHH	U	6.8851	6.1465	21.1		1.84	0.066	1.14
	M	6.8779	6.6691	6.0	71.7	0.48	0.634	1.17
Famsize	U	5.8784	5.4777	21.3		1.86	0.064	1.22
	M	5.7557	5.652	5.5	74.1	0.45	0.653	1.23
Dratio	U	.2748	.31834	-21.4		-1.87	0.062	0.89
	M	.27702	.27973	-1.3	93.8	-0.11	0.909	1.17
Landsize	U	.65939	.80102	-34.4		-3.00	0.003	0.87
	M	.68328	.69928	-3.9	88.7	-0.31	0.757	0.91
Fertilizer22	U	1.1108	1.0617	7.9		0.69	0.493	1.13
	M	1.1158	1.0466	11.1	-41.1	0.88	0.379	1.14
Totalanimalfeed	U	2.7297	2.5854	7.3		0.63	0.526	0.85
	M	2.6424	2.5202	6.2	15.4	0.49	0.628	0.81
Farmdisthome	U	11.77	15.325	-38.1		-3.33	0.001	1.04
	M	12.206	12.857	-7.0	81.7	-0.56	0.578	1.15
Creditaccess	U	.53378	.34395	38.8		3.39	0.001	.
	M	.51145	.47471	7.5	80.6	0.59	0.554	.
Extensionaccess	U	.5	.28662	44.6		3.90	0.000	.
	M	.44275	.40997	6.9	84.6	0.53	0.593	.
accessagrinputs	U	.51351	.38854	25.2		2.20	0.028	.
	M	.51908	.49651	4.6	81.9	0.36	0.716	.
TLU	U	15.385	13.643	22.1		1.93	0.055	0.75
	M	14.855	14.645	2.7	88.0	0.21	0.832	0.73
Experience	U	16.068	14.331	25.2		2.19	0.029	0.64*
	M	16.023	15.801	3.2	87.2	0.26	0.796	0.73
Costfarm	U	48997	48979	0.1		0.01	0.993	0.92
	M	49942	50740	-4.4	-4258.6	-0.34	0.737	0.86
Offfarmincome	U	71281	76519	-20.2		-1.76	0.079	1.18
	M	73990	72757	4.7	76.5	0.38	0.702	1.00

* if variance ratio outside [0.72; 1.38] for U and [0.71; 1.41] for M

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.094	39.68	0.001	23.8	22.2	74.6*	1.26	8
Matched	0.008	2.89	1.000	5.3	5.1	21.0	1.63	0

* if B>25%, R outside [0.5; 2]

.

Appendix-VI: Results of ATT Using Propensity Score Matching.

10. Farm Income

```
. psmatch2( Farmtype AgeHH SexHH EduHH Famsize Dratio Landsize Fertilizer22 Totalanimalfeed Farmdisthome Creditaccess Trainingaccess Exten
> sionaccess accessagrinputs TLU Experience Costfarm Offfarmincome ),kernel outcome( Farmincome)bwidth(0.25)common logit ate

Logistic regression                             Number of obs     =        305
                                                LR chi2(17)       =      43.98
                                                Prob > chi2       =     0.0003
Log likelihood = -189.28482                     Pseudo R2         =     0.1041
```

Farmtype	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
AgeHH	-.0153355	.0123196	-1.24	0.213	-.0394815	.0088106
SexHH	-.4461295	.3386014	-1.32	0.188	-1.109776	.2175171
EduHH	.0486316	.038585	1.26	0.208	-.0269936	.1242568
Famsize	.1220927	.0714705	1.71	0.088	-.0179869	.2621723
Dratio	-1.318651	.7243798	-1.82	0.069	-2.738409	.1011076
Landsize	-.0441654	.4419007	-0.10	0.920	-.9102748	.8219441
Fertilizer22	.101239	.2174054	0.47	0.641	-.3248678	.5273457
Totalanimalfeed	.0407321	.0762545	0.53	0.593	-.108724	.1901882
Farmdisthome	-.0048287	.0199361	-0.24	0.809	-.0439027	.0342454
Creditaccess	.4486223	.3175726	1.41	0.158	-.1738085	1.071053
Trainingaccess	-.5910736	.2871318	-2.06	0.040	-1.153841	-.0283057
Extensionaccess	.632927	.3063059	2.07	0.039	.0325784	1.233276
accessagrinputs	-.087223	.2954177	-0.30	0.768	-.6662311	.491785
TLU	.0363374	.0188552	1.93	0.054	-.0006181	.0732928
Experience	.0234548	.0194355	1.21	0.228	-.0146381	.0615476
Costfarm	-7.25e-06	7.42e-06	-0.98	0.328	-.0000218	7.28e-06
Offfarmincome	-4.70e-06	5.64e-06	-0.83	0.404	-.0000158	6.35e-06
_cons	.0075756	1.22522	0.01	0.995	-2.393811	2.408962

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Farmincome	Unmatched	108477.027	91339.6497	17137.3773	1761.4928	9.73
	ATT	106703.053	93599.4072	13103.6463	1898.20218	6.90
	ATU	91408.4437	102714.203	11305.759	.	.
	ATE			12140.9478	.	.

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support		
	Off suppo	On suppor	Total
Untreated	6	151	157
Treated	17	131	148
Total	23	282	305

2. Employment

```
. psmatch2( Farmtype AgeHH SexHH EduHH Famsize Dratio Landsize Fertilizer22 Totalanimalfeed Farmdisthome Creditaccess Trainingaccess Exten
> sionaccess accessagrinputs TLU Experience Costfarm Offfarmincome ),kernel outcome( Employment )bwidth(0.25)common logit ate
```

Logistic regression

Number of obs	= 305
LR chi2(17)	= 43.98
Prob > chi2	= 0.0003
Log likelihood = -189.28482	Pseudo R2 = 0.1041

Farmtype	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
AgeHH	-.0153355	.0123196	-1.24	0.213	-.0394815	.0088106
SexHH	-.4461295	.3386014	-1.32	0.188	-1.109776	.2175171
EduHH	.0486316	.038585	1.26	0.208	-.0269936	.1242568
Famsize	.1220927	.0714705	1.71	0.088	-.0179869	.2621723
Dratio	-1.318651	.7243798	-1.82	0.069	-2.738409	.1011076
Landsize	-.0441654	.4419007	-0.10	0.920	-.9102748	.8219441
Fertilizer22	.101239	.2174054	0.47	0.641	-.3248678	.5273457
Totalanimalfeed	.0407321	.0762545	0.53	0.593	-.108724	.1901882
Farmdisthome	-.0048287	.0199361	-0.24	0.809	-.0439027	.0342454
Creditaccess	.4486223	.3175726	1.41	0.158	-.1738085	1.071053
Trainingaccess	-.5910736	.2871318	-2.06	0.040	-1.153841	-.0283057
Extensionaccess	.632927	.3063059	2.07	0.039	.0325784	1.233276
accessagrinputs	-.087223	.2954177	-0.30	0.768	-.6662311	.491785
TLU	.0363374	.0188552	1.93	0.054	-.0006181	.0732928
Experience	.0234548	.0194355	1.21	0.228	-.0146381	.0615476
Costfarm	-7.25e-06	7.42e-06	-0.98	0.328	-.0000218	7.28e-06
Offfarmincome	-4.70e-06	5.64e-06	-0.83	0.404	-.0000158	6.35e-06
_cons	.0075756	1.22522	0.01	0.995	-2.393811	2.408962

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Employment	Unmatched	6.91891892	5.96178344	.957135479	.312537199	3.06
	ATT	6.6870229	5.67648581	1.01053709	.338142584	2.99
	ATU	5.93377483	6.59340322	.659628382	.	.
	ATE			.822639166	.	.

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support		
	Off suppo	On suppor	Total
Untreated	6	151	157
Treated	17	131	148
Total	23	282	305

Appendix-VII: Sensitivity Analysis Tests on Treated (ATT).

Table-A Farm income

```
. mhbounds Farmincome,gamma(1(0.05)2)

Mantel-Haenszel (1959) bounds for variable Farmincome

Gamma         Q_mh+     Q_mh-     p_mh+     p_mh-
----------------------------------------------------
    1             .         .         .         .
 1.05             .  -.059699         .   .523803
  1.1       -.059699  -.059699   .523803   .523803
 1.15       -.059699  -.059699   .523803   .523803
  1.2       -.059699  -.059699   .523803   .523803
 1.25       -.059699  -.059699   .523803   .523803
  1.3             .  -.059699         .   .523803
 1.35             .  -.059699         .   .523803
  1.4       -.059699  -.059699   .523803   .523803
 1.45       -.059699  -.059699   .523803   .523803
  1.5       -.059699  -.059699   .523803   .523803
 1.55       -.059699  -.059699   .523803   .523803
  1.6       -.059699  -.059699   .523803   .523803
 1.65       -.059699  -.059699   .523803   .523803
  1.7       -.059699         .   .523803         .
 1.75       -.059699  -.059699   .523803   .523803
  1.8       -.059699  -.059699   .523803   .523803
 1.85       -.059699  -.059699   .523803   .523803
  1.9       -.059699  -.059699   .523803   .523803
 1.95       -.059699  -.059699   .523803   .523803
    2       -.059699  -.059699   .523803   .523803

Gamma : odds of differential assignment due to unobserved factors
Q_mh+ : Mantel-Haenszel statistic (assumption: overestimation of treatment effect)
Q_mh- : Mantel-Haenszel statistic (assumption: underestimation of treatment effect)
p_mh+ : significance level (assumption: overestimation of treatment effect)
p_mh- : significance level (assumption: underestimation of treatment effect)
```

Table- B-Employment

```
. mhbounds Employment ,gamma(1(0.05)2)

Mantel-Haenszel (1959) bounds for variable Employment

Gamma         Q_mh+     Q_mh-     p_mh+     p_mh-
----------------------------------------------------
    1             .         .         .         .
 1.05             .  -.059699         .   .523803
  1.1       -.059699  -.059699   .523803   .523803
 1.15       -.059699  -.059699   .523803   .523803
  1.2       -.059699  -.059699   .523803   .523803
 1.25       -.059699  -.059699   .523803   .523803
  1.3             .  -.059699         .   .523803
 1.35             .  -.059699         .   .523803
  1.4       -.059699  -.059699   .523803   .523803
 1.45       -.059699  -.059699   .523803   .523803
  1.5       -.059699  -.059699   .523803   .523803
 1.55       -.059699  -.059699   .523803   .523803
  1.6       -.059699  -.059699   .523803   .523803
 1.65       -.059699  -.059699   .523803   .523803
  1.7       -.059699         .   .523803         .
 1.75       -.059699  -.059699   .523803   .523803
  1.8       -.059699  -.059699   .523803   .523803
 1.85       -.059699  -.059699   .523803   .523803
  1.9       -.059699  -.059699   .523803   .523803
 1.95       -.059699  -.059699   .523803   .523803
    2       -.059699  -.059699   .523803   .523803

Gamma : odds of differential assignment due to unobserved factors
Q_mh+ : Mantel-Haenszel statistic (assumption: overestimation of treatment effect)
Q_mh- : Mantel-Haenszel statistic (assumption: underestimation of treatment effect)
p_mh+ : significance level (assumption: overestimation of treatment effect)
p_mh- : significance level (assumption: underestimation of treatment effect)
```

Appendix-VIII- Permission letter from the department to concerned sectors of city