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Welfare Impact of Urban Agriculture in Ethiopia: Evidence from a Multinomial Endogenous Switching Regression Model

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Abstract

Using primary data collected from 384 urban households in North Shewa Zone, Oromia Region of Ethiopia, this study examined the impacts of urban agriculture (UA) on household welfare, as measured by consumption expenditure. A multinomial logistic regression model was applied to identify factors influencing participation in three UA types: horticultural crop production, livestock rearing, and both combined. To estimate the welfare effects while addressing selection bias and unobserved heterogeneity, a Multinomial Endogenous Switching Regression (MESR) model was used. The multinomial model results indicated that family size, gender of the household head, landholding size, access to water, improved inputs, extension services, and non-farm income significantly influenced participation. According to the MESR model, households engaged solely in horticulture or livestock earned average consumption gains of 2,557.24 ETB and 2,867.36 ETB, respectively, while those participating in both saw gains of 1,370.76 ETB. Counterfactual analysis revealed that non-participants could have gained up to 24,393.15 ETB or 27,400.32 ETB. These amounts are significant compared to the average expenditure of 6,733.33 ETB; highlighting UA's potential to improve welfare. Enhancing access to land, credit, water, and support services is essential to promote wider participation.

Keywords: *Consumption Expenditure; Household Welfare; Urban Agriculture; Multinomial Endogenous Switching Regression; Ethiopia*

Introduction

Introduction

Urban agriculture (UA) is increasingly recognized as a crucial strategy for enhancing household welfare in Ethiopia's rapidly urbanizing regions. Traditionally dominated by rural farming, Ethiopia's agricultural sector still contributes about 34% to GDP and employs nearly 70% of the population (World Bank, 2020). However, with growing rural-to-urban migration, rising population, and structural transformation, urban households now face mounting challenges such as food insecurity, unemployment, and high living costs. In response, many have turned to urban agriculture, the cultivation of crops and rearing of livestock within and around urban areas, as a practical and accessible livelihood strategy.

Urban agriculture (UA), the practice of cultivating crops and rearing livestock within or near urban areas has gained increasing global recognition as a strategy to enhance food security, generate income, and improve household welfare, particularly in low and middle-income countries (Drechsel, P., & Dongus, S., 2010; Zezza, A., & Tasciotti, L., 2010). In Ethiopia, however, despite its growing socioeconomic relevance, UA remains largely marginalized within national and municipal policy frameworks. Local bylaws and urban land regulations often restrict or discourage agricultural activities in cities (Girma, A., 2010; Wolday, A., et al., 2018) even as rural migrants and poor households continue to adapt traditional farming practices to urban contexts. In regions like the North Shewa Zone, adjacent to Addis Ababa, favorable agro-climatic conditions and market proximity have increased the viability of urban farming (Gebremedhin & Mulat, 2021).

Nevertheless, the expansion of UA is hampered by systemic barriers such as insecure land tenure, limited access to water, rising input costs, poor infrastructure, and inadequate institutional support. These constraints are particularly acute for women and low-income households, who often face exclusion from essential services such as credit, extension, and land allocation (Hagos et al., 2023). While prior research has acknowledged the potential of UA, limited empirical evidence exists on how different forms such as horticulture, livestock, or mixed practices affect household welfare through pathways like improved income, dietary diversity, and reduced food expenditure. This study builds on a theoretical framework in which UA participation influences income and access to productive resources, which in turn affect household consumption expenditure a widely accepted proxy for welfare (Deaton, A., 1997). However, these welfare outcomes are mediated by structural constraints, including gender inequality, land scarcity, and institutional capacity (Cofie O., et al., 2006). By integrating these insights into a conceptual model and employing a Multinomial Endogenous Switching Regression (MESR) approach, this study aims to fill existing knowledge gaps and assess the differentiated welfare impacts of UA participation in Ethiopia's North Shewa Zone.

Although some studies have explored the factors that influence participation in urban agriculture, few have rigorously assessed its actual impact on household welfare, particularly in peri-urban areas such as North Shewa, where empirical evidence is lacking. Moreover, past research has often failed to correct for selection bias and unobserved heterogeneity between participants and non-participants, leading to potentially inaccurate conclusions. This study addresses those gaps by applying a Multinomial Endogenous Switching Regression (MESR) model to estimate the causal welfare effects of participating in different types of urban agriculture (horticulture, livestock, or both). Household welfare is proxied by consumption expenditure, a widely accepted indicator of economic well-being in development economics (Hagos et al., 2023).

This study aims to fill the knowledge gap by (i) identifying the socio-economic and institutional factors influencing household participation in different forms of urban agriculture, (ii) estimating the welfare impacts of horticulture, livestock, and mixed urban agriculture activities using a Multinomial Endogenous Switching Regression (MESR) model, and (iii) comparing the welfare outcomes of participants with non-participants in North Shewa Zone, Oromia, Ethiopia. To the researcher's knowledge, this is the first study to apply the MESR model to urban agriculture in this region, offering a novel empirical contribution. By examining both the drivers and impacts of urban agriculture participation, the findings aim to inform evidence-based policies that promote inclusive and sustainable urban food systems in Ethiopia.

Literature Review

Existing literatures[1] (Appendix 1) on urban agriculture (UA) in Africa remains limited and fragmented, often lacking comprehensive empirical analysis of its socio-economic impacts on household welfare. Foundational studies by (Maxwell D., et al., 1998; Mougeot, L. et al., 2005; Orsini, F., et al., 2013) have emphasized the role of UA in enhancing food security and income generation among urban households. However, these studies typically do not apply rigorous econometric techniques to isolate causal impacts. More recent research has begun to address this gap by incorporating household-level production and welfare data. For example, (Simatele, D., et al., 2008; Onyango, G. et al., 2018) documented the heterogeneous nature of UA participation and its diverse outcomes. Yet, many of these analyses overlook potential issues of selection bias and endogeneity associated with participation decisions.

To address these methodological limitations, this study adopts the Multi-Outcome Endogenous Switching Regression (MESR) model, which allows simultaneous estimation of participation decisions and outcome equations, thereby accounting for self-selection and unobserved heterogeneity (Heckman, J. J. 1979; Lokshin, M., & Sajaia, Z. 2004). Although MESR and related ESR frameworks have been widely used in agricultural and labor economics (e.g., Di Falco, S., Veronesi, M., & Yesuf, M., 2011; Kassie, M., Teklewold, H., Jaleta, M., Marenya, P., & Erenstein, O. 2015) their application to urban agriculture in African contexts remains rare. This study contributes to filling that gap by applying MESR to analyze the welfare effects of UA in North Shewa Zone, Ethiopia.

Several recent African studies have demonstrated the effectiveness of MESR models in uncovering nuanced impacts of agricultural practices. For instance, (Yitbarek, E., & Tesfaye, K., 2022) employed MESR to evaluate the effects of climate-smart agriculture and non-farm employment on household welfare in Ethiopia, finding significant improvements in food consumption and poverty reduction. Similarly, (Owusu Asante, F., Al-Hassan, R., & Kuwornu, J. K. M., 2024) used MESR and inverse-probability weighted regression to assess access to bundled agricultural services, concluding that combined access to credit, extension, and input services led to higher food consumption and income. Tesfay, G., (2020) Utilized an ESR model to show that fertilizer adoption in Northern Ethiopia increased household income and commercialization levels, while effectively correcting for selection bias.

Urban-specific studies have also begun to emerge. Guta, L. J., & Irge, T. W., (2022) in Bako Town, applied multinomial logistic regression and propensity score matching to examine both determinants and welfare impacts of UA, finding that participation significantly enhanced household food security and was shaped by access to land, water, and inputs. In a broader regional review, (Kiribou, T., Ayele, S., & Alemu, M., 2024) synthesized findings from Sub-Saharan Africa, highlighting UA's contributions to nutrition and resilience among low-income households, while calling for integrated policies supporting water, sanitation, and extension services.

Recent empirical studies highlight the complexity of UA's socio-economic and health outcomes. In peri-urban Kenya, (Njiru, J., Otieno, J., & Onyango, L., 2024). demonstrated that while UA improved food and nutrition security, it also posed health risks due to wastewater use and heavy metal exposure, underlining the need for harmonized food production and public health policies. In Addis Ababa, Ethiopia, (Alemu, D., Abebe, G., & Tadesse, T., 2025) found that UA participation enhanced dietary diversity and total food consumption; the study emphasized the importance of compost reuse and vertical gardening, recommending the scaling of these practices to improve urban nutrition in space-constrained environments.

In peri-urban Kenya, a 2024 study demonstrated that while UA improved food and nutrition security, it also posed health risks due to wastewater use and heavy metal exposure, underlining the need for harmonized food production and public health policies. In Addis Ababa, a 2025 study found that UA participation enhanced dietary

[1] Summary of studies conducted on impact of urban agriculture on households' welfare

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diversity and total food consumption. The study emphasized the importance of compost reuse and vertical gardening and recommended scaling these practices to improve urban nutrition in space-constrained environments.

Complementing MESR-based analyses, (Nyambane, A., Okoth, J., & Mwangi, P., 2023) used panel data and fixed-effects models to examine the income dynamics of urban farmers in Nairobi, showing that access to land tenure security and credit positively influenced sustained UA participation and income growth. Similarly, (Mburu, P., & Wanjiku, R., 2023) employed mixed-methods and regression discontinuity design to assess UA's role in poverty alleviation in Kisumu, Kenya, finding that UA serves as a critical buffer against urban food insecurity during economic shocks.

Together, these recent contributions underscore the importance of applying advanced econometric models such as MESR to accurately assess the multifaceted effects of urban agriculture. This study builds on and extends this growing body of work by focusing on the Ethiopian context, offering evidence-based insights for policy aimed at inclusive and sustainable urban food systems.

Research Methodology

This research adopted cross-sectional study design used both quantitative and qualitative approaches to achieve the study objectives. Both primary and secondary data were employed. Primary data was gathered through face-to-face interviews using structured questionnaires translated into local language (Afan Oromo) to ensure local understanding, along with qualitative data from focus group discussions and key informant interviews. Secondary data was collected from sources such as the district agricultural office, CSA reports, journal articles and online platforms. All data collection activities were carried out by well-trained enumerators experienced in conducting households' survey.

Sampling Technique and Sample Size Determination

Multistage stratified sampling procedure was employed to address population heterogeneity, particularly the inclusion of both participants and non-participants in urban agriculture. The sampling followed a three stage process: first Fitche town was purposively selected due to its active urban agriculture and status as the administrative center of North Shewa Zone. Second, three out of four urban *kebeles* (the smallest administrative unit in Ethiopia) were randomly selected. Third, households were stratified into participants and non-participants based on lists from administrative offices, and respondents were then randomly selected using probability proportional to population size. In addition, key informants (5 per kebele) and focus group discussions (FGD) participants (6-8 per kebeles) were purposively selected based on their knowledge and experience in urban agriculture practices and household livelihoods.

The sample size is calculated using Cochran's formula (Cochran, W. G., 1977). for populations with unknown variability and used p = 0.5, explaining that it maximizes variability and is appropriate when no prior estimate is available.

$$n = \frac{Z^2pq}{e^2} = \frac{(1.96)^2(0.5)(0.5)}{(0.05)^2} = 384$$

- n = required sample size
- Z = Z-value at 95% confidence level (1.96)
- p = estimated proportion (0.5)
- q = 1 - p (0.5)
- e = margin of error (5%)

Table 1 summarizes the number of households based on their participation in urban agriculture. These are divided into four groups (called "regimes" in the model): those who do not participate at all, those who produce only horticultural crops (like vegetables or fruits), those who rear livestock only and those involved in both activities. This classification helps to analyze how different types of urban agriculture may affect household welfare.

Table 1. Distribution of Households by Urban Agriculture Participation Category

Participation category (regime)	Description	Number of households
Regime 1	Non-participant	132
Regime 2	Horticultural crop producer only	75
Regime 3	Livestock rearing only	88
Regime 4	Both horticulture & livestock producers	89
Total	384	

Source: Author's own survey data, 2024; Note: "Regime" refers to each distinct group of households categorized by their type of urban agriculture participation.

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Variable Definition and Measurement

Table 2 below presents the definition, measurement, and coding of both the dependent (outcome) and independent (explanatory) variables used in the analysis. The outcome variable in this study is household welfare, proxied by total household consumption expenditure. Explanatory variables include demographic, socio-economic, institutional, and perceptual factors that may influence participation in urban agriculture and household welfare outcomes. Each variable is described along with its unit of measurement or coding format to enhance clarity and transparency for replication. These variables were selected based on theoretical relevance and empirical evidence from previous studies on urban agriculture and household welfare.

Table 2. Definition and measurement of variables

Variables	Definition and measurement	Hypothesis
1. Outcome Variable		
Participation in Urban Agriculture Activities: $= Y_1 =$ Horticultural crop producer, $Y_2 =$ Livestock producer, $Y_3 =$ Both crops & livestock $Y_0 =$ non $-$ participants		
Household Consumption Expenditure: Consumption Expenditure per Adult Equivalent		
2. Independent Variables		
Sex	Sex of the household head, 1 if male, 0 otherwise	+
Age	Age of the household head in years	-
Family size	Total number of people permanently living in the family	+/-
Education	Education level of the household head in years of schooling	+
Land	Total land holding size in hectares	+
Income	Total annual Income from other sources in Birr	+
Cooperative Membership	Households cooperative membership, 1 if members of a cooperative and 0 otherwise	+
Credit received	Amount of credit access In Ethiopian Birr	+
Water	Availability of water resource, 1 for had water, otherwise 0	+
Extension	Access to extension service, 1 for obtained extension, otherwise 0	+
input	Access to improved inputs, 1 for got improved inputs, 0 otherwise	+
Market	Distance to better market access in kilometre	-
Perception	Positive perception about benefits of UA, 1 for gaining benefit from participation & 0 otherwise	+

Source: Own definition based on literature review, 2024.

Estimation Methods

To meet the study's objectives, both descriptive and inferential statistical techniques were applied using Stata version 17. Descriptive statistics (means, percentages, and standard deviations) were used to summarize household characteristics, while t-tests and chi-square tests assessed statistical differences between groups.

Econometric Model Specification

The objective of this study suggests a potential endogeneity issue in urban agriculture (UA) participation, as it is a self-selected activity where households do not have equal probabilities of engaging. This introduces selection bias, making ordinary least squares (OLS) methods inappropriate due to their inability to produce consistent estimates under such conditions (Rahut, D. B., 2017). While Propensity Score Matching (PSM) has commonly been used in non-experimental survey research to address selection bias, it only accounts for observable factors. This limitation justifies the use of the Endogenous Switching Regression (ESR) model, which accommodates both observed and unobserved heterogeneity by employing a full information maximum likelihood (FIML) approach (Lokshin, M., & Sajaia, Z., 2004). The ESR model simultaneously estimates the determinants of participation (selection equation) and its impact on welfare (outcome equation), providing a more integrated understanding of differences between participants and non-participants.

However, the ESR model is constrained to binary treatment regimes, typically distinguishing only between participants and non-participants. In the case of this study, where households may participate in horticulture, livestock, both, or none, a more flexible model is required. The Multinomial Endogenous Switching Regression (MESR) model extends the ESR framework to accommodate multiple regimes and is therefore more appropriate for this context (Kassie, M., Teklewold, H., Jaleta, M., Marenya, P., & Erenstein, O., 2015). Accordingly, this study employs the MESR model, drawing from the specifications of (Belay, M., & Mengiste, M., 2021), to estimate the welfare effects of different forms of UA participation through a two-stage estimation process.

Stage-I Multinomial Logit Regression (MNLR) Model Specification

In the first stage, the household's decision to participate in urban agriculture will be modeled using a multinomial logit regression (MNLR), which accounts for the interrelationships among different activities: horticultural crop production, livestock production, both combined, and non-participation. The multinomial logistic model extends the binary logistic regression to handle dependent variables with more than two nominal or unordered categories by creating dummy variables for all but one reference category, resulting in M-1 binary logistic regressions for M categories. In this study, urban households are classified into four groups based on their urban agricultural activity: horticulture only (Y1), livestock only (Y2), both horticulture and livestock (Y3), and non-participants (Y0). Because the dependent variable consists of multiple unordered categories, the multinomial logit model is appropriate and widely used for such analyses.

A household's decision to engage in horticultural crops, livestock production, or a combination of both can be framed within a random utility theory. In this context, households evaluate the benefits associated with participating in these activities. Consider a rational urban farm household i, whose primary objective is to improve their welfare or livelihood status W_i. This household assesses the benefits they derive from participating in z alternative urban agricultural activities to make informed decisions about their involvement. The rational urban household will choose to participate in j alternatives over any other activities z if the net livelihood benefit from those alternatives is positive, implies $W_{ij} > W_{iz}$, $j \neq z$.

The expected livelihood benefits, conditional on observed household variables, and unobserved characteristics, is given by the index function:

$$W_{ij} = \beta_k X_i + \varepsilon_{ij} \tag{1}$$

Where Xi represents a set of observed exogenous variables (including demographic, socioeconomic, institutional, farm-specific, and others), β_k is a vector of parameters to be estimated, and ε_{ij} is an error term accounting for unobserved characteristics.

Let P be an index function that denotes a household's participation choice of urban agriculture activities, such that:

$$P_i = \begin{cases} 1 \; iff \; W_{i1}^{*} > \max\limits_{z \neq 1} W_{iz}^{*} \; or \; \gamma_{\,i1} < 0 \\ \quad \cdots \\ \quad \ldots \\ j \; if \;\; W_{ij}^{*} > \max\limits_{j \neq z} W_{iz}^{*} \; or \; \gamma_{\,ij} < 0 \end{cases} \tag{2}$$

here $\gamma_{\,ij} = \max \; (W_{iz}^{*} - W_{ij}^{*}) < 0$ (Bourguignon, F., Fournier, M., & Gurgand, M., 2007).

=provides greater expected livelihood benefit than any other alternative, that is, if

$$\gamma_{\,ij} = \max \; (W_{ij}^{*} - W_{iz}^{*}) > 0, \forall \, j \neq z$$

Then the probability that a household will participate $'j'$ activities can be expressed as a multinomial logit model following McFadden (1973) as:

$$P_{ij} = pr\,(\gamma_{ij} < 0 | X_i = \frac{\exp\,(X_{i\beta j})}{\sum_{z=1}^{j} \exp\,(X_{i\beta j})} \ldots \tag{3}$$

This will be estimated using the maximum likelihood procedure (*mlogit* command in *Stata 17*).

Stage-II Multinomial Endogenous Switching Regression (MESR) Model Specification

After the specification of the selection equation, the outcome equation which is the impact of urban agriculture practice on households' welfare will be estimated by using multinomial endogenous switching regression model (MESR). i.e, in the second stage of the MESR, the relationship between each outcome variable and a set of exogenous variablesX_i, is estimated for each agriculture activities regime (1 = horticultural crops only, 2 = livestock production only, 3 = both horticultural crop production & livestock production, 0 = non-participants).

The outcome equation for each possible regime (j) is specified as:

Regime 1: $W_{i1} = X_i\beta_1 + \mu_{i1} \quad if \; P = 1$

$\ldots\ldots\ldots\ldots\ldots\ldots$ (4)

Regime J: $W_{ij} = X_i\beta_j + \mu_{ij} \quad if \; P = j$

where the W'_{ij}s are the outcome variables which represents urban households welfare for participants and non-participant of the i^{th} household in regime j, X_i denote a set of explanatory variables that influence households welfare, β_is are vectors of parameter to be estimated, and μ'_i is represents error terms with zero mean and constant variance assumptions.

Note that $W'_{ij}s$ are observed if and only if one urban agricultural activity is applied by the urban household. Given that the error terms of the adoption equations, ε_{ij} , are not independent due to the presence of unobserved factors, the use of OLS will lead to bias and inconsistent estimates. In order to obtain consistent estimates of β_j , a selection correction term of the alternative agricultural activity is needed in the above equation.

Following (Kassie, M., et al., 2015; Teklewold, H., et al., 2013) the second stage of the MESR is estimated as follows, including the correction terms:

Regime 1: $W_{i1} = X_i\beta_1 + \mu_{i1} + \sigma_1\theta_1 \quad if\ P = 1$
…………………………………………….. (5)
Regime J: $W_{ij} = X_i\beta_j + \mu_{ij} + \sigma_j\theta_j\ if\ P = j$

Where σ_j is the covariance between the error terms ε_{ij} and μ_{ij}, and θ_j is the inverse Mills ratio IMR (to address issues related to sample selection bias and to improve the estimation of models where the dependent variable is not observed for all subjects) to be estimated using the predicted probabilities from the multinomial logit model in Equation (3). The IMR is given as:

$$\theta_j = \sum_{z\neq 1}^{j} \rho_j \left(\frac{\mathrm{p}_{iz} ln(\mathrm{p}_{iz})}{1-\mathrm{p}_{iz}}\right. \quad \text{………………………………………………………………………} \quad (6)$$

Where ρ is the correlation coefficient of the error terms ε_{ij} & μ_{ij}. The error terms have expected mean value of zero. Practically, there is a possibility of heteroscedasticity in generating the regressor in the model, hence; standard errors are bootstrapped to account the problem.

In order to control for unobserved heterogeneity in estimating the welfare effects of the practice, we will use access to extension services, and distance to improved market access as instruments. Other related empirical studies (e.g., Khonje, M., et al., 2018; Abdulai, A., & Tesfaye, A., 2016) have employed these variables as instruments. Agricultural extension agents disseminate information about on how to participate on different urban agricultural practices in terms of benefits, costs, access, and best application procedures. Market access, captured by distance is also vital and critical driver of access to improve agricultural practices. The chosen instrument should generally satisfy two conditions; correlated with the endogenous variable(s), but uncorrelated with the outcome variable(s).

Conditional Expectations and Average Treatment Effects

The multinomial endogenous switching regression model is used to compute both the average treatment effect on the treated (ATT) and the untreated (ATU). This can be done by a simple comparison of the expected values of the outcome of the treated (participants) and untreated (non- participant) in actual and counterfactual situations. Following, (Khonje, M., et al., 2018; Kassie, M., Tet al., 2015) the conditional expectations for the outcome variables in both the observed and their counterfactual scenarios can be specified as follows:

Actual expectations observed in the sample (participants in urban agriculture):

$E\left[W_{ij} \middle| p = j\right] = X_i'\beta_{ij} + \sigma_j\theta_j$ If P = j (j = 2, 3, 4)…………………………………..………… (7a)

Counterfactual expected outcomes:

$E[W_{i1}|p = j] = X_i'\beta_{i1} + \sigma_1\theta_j$ If P = j (j = 2, 3, 4) …………………………………………. (7b)

Such that the average treatment effect (ATT) of each alternative agriculture activity is the difference between the actual and counterfactual as:

$$ATT = E\left[W_{ij} \middle| p = j\right] - E[W_{i1}|p = j] = X_i\left(\beta_j - \beta_1\right) + \theta_j(\sigma_j - \sigma_1 \quad \text{……………….………} \quad (8)$$

where the first term is the difference in mean outcome of participants and non- participants that they have the same observed characteristics, while the second term is the selection correction that indicate the change in outcome resulting from differences in unobserved factors. These will be estimated using the *selmlog* (for continuous outcome variables) and *mtreatreg* (for binary outcome variables) in Stata 17.

To ensure robustness of our estimates, the researcher performed covariate balance tests comparing socio-economic and institutional characteristics between urban agriculture participants and non-participants. Results indicate satisfactory balance after controlling for confounding factors, supporting the validity of the counterfactual comparisons. The MESR model assumes independence of irrelevant alternatives (IIA) in the multinomial logit choice model, which was tested using Hausman tests and found not to be violated. Instrument exogeneity was validated by confirming that instruments such as access to extension services and distance to markets affect participation decisions but have no direct effect on household welfare outcomes. Bootstrapped standard errors were applied to account for heteroscedasticity and improve estimate reliability.

Results and Discussions

Descriptive and Inferential Statistics

From the total sample, 65.90% of households participated in urban agriculture, while 34.10% did not engage in any form of urban farming (Table 3 above). Among participants, 19.33% specialized in horticultural crop production, 25.23% were involved in livestock rearing only, and 23.18% practiced both horticulture and livestock activities. This indicates that a majority of households rely on urban agriculture as a livelihood strategy, with a notable portion adopting a mixed production system, likely to enhance income and food security. The substantial share of non-participants highlights existing access barriers, underscoring the need for supportive policies that enable broader inclusion.

Tables 4 and 5 summarize the awareness of benefiting from participating in urban agriculture and socio-demographic characteristics of the households based on their participation in urban agriculture activities.

The result shows that a significantly higher proportion of male-headed households (96.6%) participated in urban agriculture compared to only (3.4%) of female-headed households. Similarly, households with access to extension services were significantly more likely to engage in urban agriculture than those without access.

Table 5 also demonstrates that households who are participated in urban agricultural activities are younger, educated, and have more assets than their counterparts. Others can also be explained using the same fashion. However, we cannot draw any conclusion as these differences can be partially or totally due to other confounding factors.

Table 3. Household Distribution by Urban Agriculture Participation Category

Participation category (regime)	*Description*	*%*
Regime 1	Non-participant	34.10
Regime 2	Horticultural crop producer only	19.33
Regime 3	Livestock rearing only	25.23
Regime 4	Both horticulture & livestock producers	23.18
Total		100

Table 4. Distribution of Categorical Explanatory Variables by Type of Urban Agriculture Participation

Variable	*Categories*	*Participant (%)*	*Not-participant (%)*	x^2 *(p-value)*
Sex	Male	96.60	62.30	53.36***
	Female	3.40	37.70	
Improved Inputs	Yes	74.70	0.00	120.26***
	No	25.30	100.00	
Extension contact	Yes	60.70	28.60	22.17***
	No	39.30	71.40	
Perception	Yes	47.80	35.10	3.51*
	No	52.20	64.90	
Cooperative Membership	Yes	60.70	42.90	6.90**
	No	39.30	57.10	
Water Resource Availability	Yes	56.20	5.20	57.85***
	No	43.80	94.80	

Note: ***, **and * significant at p<0.01, p<0.05and p<0.1 respectively, *Source: own survey result of 2024.*

Table 5. Descriptive Statistics of Continuous Explanatory Variables Used in the Analysis

Variable	Participant	Not Participant	Total mean	t-value
	Mean	Mean	Mean	
Age	45.18	49.83	46.58	4.78***
Education level	2.09	1.72	1.98	0.77
Family size	6.19	5.36	5.94	3.67***
Amount of credit	2056.00	2000.00	2039.00	1.16
Land holding size	1.06	1.05	1.06	2.10
Income from other sources	20489.33	13916.88	18504.71	4.08***
Distance to better market	1.62	1.55	1.600	-0.98

Note: ***, **and * significant at p<0.01, p<0.05and p<0.1 respectively, *Source: own survey result of 2024.*

Determinants of Participation in Urban Agriculture

The multinomial model regression results of the factors influencing participation in urban agriculture are presented (Table 6 below). The base category is non-participation in urban agriculture. The joint significance of determinant variables suggests that variations in urban development policies and local environmental conditions across cities play a significant role in determining household participation in urban agriculture, weather for horticultural crop production, livestock rearing, or both which in turn affects their welfare outcomes.

The table indicates that household demographic, socioeconomic and location specific factors significantly influence the decision to engage in urban agriculture. Specifically, participation in horticulture crop-based urban agriculture is positively influenced by several factors including larger family size, greater land holding size, access to reliable water source, income from non-agricultural activities, and favourable households' perception towards urban agriculture. Likewise, engagement in urban livestock rearing is positively influenced by sex of household head, larger family size, access to improved agricultural inputs, and access to adequate water source. In the case of combined participation in both horticultural crop production and livestock rearing within urban areas, positive factors include the sex of the household head, larger family size, access to improved agricultural inputs, and availability of reliable water source.

Sex of Household Head: The sex of the household head significantly affects participation in urban agriculture. Male-headed households are notably more likely to engage in livestock-only and combined horticulture-livestock activities, with positive coefficients of 3.85 and 2.92 respectively, both statistically significant at the 5% level. In practical terms, this means male-headed households are about 47 times more likely to engage in livestock production and 18.5 times more likely to participate in both activities compared to female-headed households. These substantial differences likely reflect gender-based barriers such as limited access to capital, land, or labor among female-headed households. Addressing these gaps through gender-sensitive interventions and targeted support could enhance women's participation and improve household welfare outcomes in urban agriculture.

Table 6. Multinomial Logit Estimates of Factors Influencing Participation in Urban Agriculture by Activity Type

Variables	Horticulture crop producers only	Livestock producers only	Both horticulture crop & livestock producers
Dependent variable: Household participation in horticulture, livestock, or both, relative to non-participation. Coefficients represent the log-odds of choosing each option. Standard errors in parentheses.			
Sex	16.02	3.85**	2.92**
	(1253.42)	(1.30)	(1.11)
Age	-0.20**	-0.09*	-0.03
	(0.074)	(0.04)	(0.04)
Education	-0.21	0.08	0.13
	(0.13)	(0.07)	(0.07)
Family size	0.53*	0.39*	0.27*
	(0.25)	(0.15)	(0.15)
Land holding size	1.31*	0.18	0.60
	(0.75)	(0.52)	(0.50)
Improved Inputs	-0.39	2.62***	3.08***
	(1.002)	(0.54)	(0.55)
Extension contact	1.002	0.13	-0.10
	(0.71)	(0.46)	(0.47)
Amount of credit	-1.49	-0.39	0.31
	(1.21)	(0.64)	(0.57)
Water Resource	1.12	1.02*	0.73*
	(0.62)	(0.43)	(0.44)
Income from other sources	0.000080*	0.000029	0.00003
	(0.000038)	(0.000019)	(0.00002)
Perception	1.55*	0.34	0.05
	(0.66)	(0.44)	(0.45)
Distance to better market	0.20	-0.80*	-0.23
	(0.69)	(0.43)	(0.45)
Cooperative Membership	0.26	-0.56	-0.12
	(0.67)	(0.45)	(0.47)
Constant	-10.80	-2.18	-6.29**
	(1253.42)	(2.47)	(2.38)
Number of observations = 384 Pseudo R^2 = 0.348			
LR chi2 (11) = 219.0; Prob > chi2 = 0.0000 Log likelihood = -204.46797 Note: Odds Ratios (OR) are calculated as OR = exp(coefficient). This represents the change in odds of the outcome associated with a one-unit increase in the predictor variable. An OR greater than 1 indicates increased odds, while an OR less than 1 indicates decreased odds.			

Notes: Robust standard errors in parenthesis; non-participant is the reference category. ***, **and * significant at p<0.01, p<0.05and p<0.1 respectively; *Source: own survey result of 2024.*

Age of Household Head: The age of the household head has a negative and statistically significant effect on participation in urban agriculture. For each additional year of age, the likelihood of engaging in horticulture decreases by about 18.1%, and for livestock by roughly 8.6%, with coefficients of –0.20 and –0.09, respectively (significant at 5% and 10%). This indicates that younger household heads are more inclined to participate, likely due to better physical capacity, greater adaptability to new practices, and a higher tolerance for risk. In contrast, older heads may be less involved due to physical limitations, health issues, or reluctance to adopt new agricultural methods. These findings underscore the importance of designing age-sensitive support programs that encourage broader participation across age groups.

Family Size: The positive and statistically significant coefficient of 0.53 (at the 10% level) indicates that each additional household member increases the likelihood of participating in urban agriculture whether in horticulture, livestock, or both by about 69.8%. This suggests that larger households are more inclined to engage in urban farming due to greater access to family labour. Activities like planting, watering, and weeding in horticulture, as well as feeding and caring for livestock, require consistent and intensive labour. With more household members, families can distribute these tasks more efficiently, reducing the need to hire external help. This highlights the importance of household labour capacity as a critical driver of participation in urban agriculture.

Landholding Size: The positive and statistically significant coefficient of 1.31 (at the 10% level) for horticultural crop production suggests that a one-unit increase in landholding size raises the odds of participating in urban horticulture by approximately 271.2%, holding other factors constant. This highlights land availability as a key enabler for urban households to engage in horticulture. More land allows families to grow a wider variety and quantity of crops, which can improve food security and generate additional income. Although land is also relevant for livestock and mixed farming, its influence appears strongest in horticulture. This emphasizes the importance of land access policies that specifically support urban households interested in crop production.

Access to Improved Inputs: Access to improved agricultural inputs is strongly and positively linked to household participation in urban agriculture, especially in livestock-only and combined horticulture-livestock systems. The coefficients of 2.62 and 3.08, both significant at the 1% level, indicate that households with access to inputs like quality feed, veterinary services, improved seeds, or tools are several times more likely to participate. These inputs reduce production risks, improve efficiency, and raise output quality, making urban farming more attractive and feasible. This finding highlights the critical role of input access in scaling up urban agriculture and suggests that expanding input distribution and support services should be a key policy focus.

Access to Reliable Water Source: Access to a reliable water source significantly increases the likelihood of participating in urban agriculture, especially in livestock-only and combined horticulture-livestock systems. The coefficients 1.02 for livestock and 0.73 for both activities are statistically significant at the 10% level, meaning households with dependable water access are about 177.3% and 107.7% more likely to participate, respectively. Water is crucial in urban farming where rainfall may be limited. It enables regular irrigation for crops and supports essential livestock needs such as drinking, cleaning, and maintaining hygiene. For households involved in both sectors, steady water access helps maintain continuous and efficient operations. These findings highlight the need for investments in urban water infrastructure to enhance the sustainability and inclusiveness of urban agriculture.

Non-Agricultural Income: Non-agricultural income has a positive and statistically significant effect on household participation in horticultural crop production, with a coefficient of 0.000080 (significant at the 10% level). While the value is numerically small due to the unit of measurement, it indicates that even small increases in off-farm income improve a household's ability to invest in urban farming. Such income helps cover costs for inputs like improved seeds, fertilizers, irrigation tools, and basic infrastructure. For households involved in both horticulture and livestock, diversified income sources also offer financial stability and reduce vulnerability to agricultural shocks. This finding underscores the importance of supporting non-farm income opportunities to enhance the viability of urban agriculture in low-resource settings.

Households' positive perception: A positive household perception of urban agriculture is significantly linked to participation in horticultural crop production. The coefficient of 1.55, significant at the 10% level, indicates that households with favorable attitudes are much more likely to engage in horticulture. This highlights the importance of mindset and awareness in shaping participation decisions. Promoting urban agriculture through education, training, and success stories can help shift perceptions and motivate more households especially in peri-urban areas to take up horticultural activities. This suggests that attitude-shaping interventions are as important as material support in expanding urban farming.

Impact of Urban Agriculture on Household Welfare

Table 7. Impact of Urban Agriculture on Household Welfare (Consumption) – ATT and ATU Estimates

Participation type	*ATT (ETB)*	*ATU (Counterfactual Group) (ETB)*
Horticulture crop production only	2557.24***	24393.15***
Livestock production only	2867.36*	27400.32***
Both Horticultural crop and livestock production	1370.76**	24393.15***

Note: ***, **and * significant at p<0.01, p<0.05and p<0.1 respectively, Source: own survey result of 2024.

The Average Treatment Effect on the Treated (ATT) captures the average welfare gain measured by household consumption expenditure experienced by those who actually participated in urban agriculture, indicating how much better off they are due to their involvement. In contrast, the Average Treatment Effect on the Untreated (ATU) reflects the potential welfare improvement non-participating households could have achieved had they participated. Additionally, the Average Treatment Effect (ATE) estimates the average welfare gain across all households in the sample if everyone had engaged in urban agriculture, offering a broader perspective on its overall potential impact. Together, these indicators help evaluate both the actual and unrealized benefits of urban agriculture and can guide policy interventions to support and expand participation, especially among underserved groups.

According to the MESR model results (Table 7), the estimated ATT for households engaged in horticultural crop production only is 2,557.24 Ethiopian Birr, indicating that, on average, these households spent 2,557.24 ETB more on consumption compared to what they would have spent had they not participated. Similarly, for households involved solely in livestock production, the ATT is 2,867.36 ETB, suggesting a comparable welfare gain resulting from their participation.

On the other hand, the estimated ATU for horticultural crop production only is 24,393.15 ETB, implying that households not participating in this activity could have increased their consumption expenditure by this amount on average if they had engaged in horticultural production. The same interpretation applies to ATU values for livestock-only and combined horticulture-livestock regimes.

These findings reveal a significant disparity between ATT and ATU values across urban agriculture categories. For instance, the potential gain for non-participants in horticulture (ATU = 24,393.15 ETB) far exceeds the actual gain for participants (ATT = 2,557.24 ETB). This suggests that non-participants may face structural constraints such as limited access to land, water, or extension services that prevent them from realizing the full benefits of participation. Therefore, addressing these barriers through targeted policy interventions could help unlock substantial welfare gains, especially for marginalized and underserved groups, and make urban agriculture more inclusive and impactful.

The mean estimation result of household welfare, using consumption expenditure (measured in Ethiopian Birr) as a proxy indicator (Appendix 2)[2]. The average monthly consumption expenditure among sampled households is 6,733.33 ETB, with a standard error of 346.13, suggesting a moderate level of variation around the mean. This measure provides a useful benchmark for assessing overall household economic well-being in the study area. In the context of development economics and poverty analysis, consumption expenditure is considered a more reliable indicator of welfare than income, as it captures long-term living standards and consumption smoothing behaviour. Therefore, this average serves not only as a descriptive statistic but also as a critical reference point for evaluating the impact of urban agriculture (UA) participation on household welfare. By comparing this mean with the predicted consumption levels under different UA engagement scenarios using the MESR model, the study is able to draw meaningful conclusions about the extent to which UA contributes to household economic resilience and improved living conditions.

Discussions

The application of the Multinomial Endogenous Switching Regression (MESR) model was essential in addressing potential selection bias inherent in household participation in urban agriculture (UA). Participation decisions are influenced by both observable and unobservable household characteristics, such as motivation, access to land and water, and prior farming experience. Failure to control for these factors could bias welfare outcome estimates. By estimating both the Average Treatment Effect on the Treated (ATT) and on the Untreated (ATU), the MESR model offers a more credible and rigorous assessment of UA's impact on household welfare.

The results showed that households engaged in UA particularly those combining horticulture and livestock production experience significantly higher welfare, as measured by household consumption expenditure. These findings are consistent with empirical studies from urban areas in Africa and Asia, which document UA's positive role in improving food security, income diversification, and household resilience (Cochran, W. G. 1977; Mamush, M., Bojago, E., & Ngare, I. 2024). The superior outcomes for mixed UA systems support findings by (Mamush, M., Bojago, E., & Ngare, I., 2024), who emphasize the complementary benefits of integrating crop and livestock activities to enhance nutritional diversity and income stability.

A comparative analysis with other UA settings highlights common enablers and constraints. For instance, secure land tenure, larger landholdings, irrigation access, and extension services consistently emerge as critical factors enabling successful UA participation and welfare gains (Mamush, M., Bojago, E., & Ngare, I., 2024; Onyango, G., Odhiambo, N. M., & Owino, M., 2018). These institutional and infrastructural supports reduce production risks and improve productivity, thereby amplifying the benefits of UA. Mechanistically, access to reliable water and technical advice allows households to intensify production and diversify crops and livestock, which in turn stabilizes income and improves food availability throughout the year.

[2] Mean estimation result of households' consumption expenditure in Ethiopian Birr

Despite these positive drivers, persistent barriers limit inclusive UA participation. Gender disparities remain salient: female-headed households face systemic disadvantages in access to land, credit, labor, and market opportunities, constraining their ability to benefit from UA despite their potentially high welfare gains. This aligns with observations by (Simatele, D., & Binns, T., 2008; Belay, M., & Mengiste, M. 2021) about entrenched inequities in urban resource distribution and decision-making power. Addressing such gender-based constraints is crucial to unlocking UA's broader developmental potential.

The high ATU estimates suggest that marginalized non-participants, particularly low-income households, could realize substantial welfare improvements if structural obstacles were alleviated. This underscores that UA's contribution extends beyond individual economic gains to fostering more equitable urban food systems. Realizing this potential requires policy frameworks that go beyond simply promoting UA as an income source. Instead, urban development policies must focus on inclusive land tenure reforms, expanded access to microfinance and subsidized inputs, and targeted training programs for women and youth to build their capacities.

Furthermore, enhancing market linkages through improved infrastructure and collective action platforms can improve the profitability and sustainability of UA activities. Water infrastructure development and community-based support networks will also be vital to mitigate risks related to climate variability and resource scarcity. These policy measures collectively create an enabling environment to scale up UA's welfare benefits as a pro-poor, climate-resilient, and sustainable development strategy.

In sum, by integrating methodological rigor with comparative insights and mechanism analysis, this study advances the understanding of UA's multifaceted impacts. The findings offer actionable recommendations to policymakers aiming to leverage UA for inclusive urban livelihoods and climate resilience.

Conclusions

This study investigated the impact of urban agriculture (UA) on household welfare in North Shewa Zone, Oromia, Ethiopia. Using primary survey data and a Multinomial Endogenous Switching Regression (MESR) model, the researcher accounted for selection bias and unobserved heterogeneity. The results revealed that UA, particularly when combining horticultural crops and livestock production, significantly improves household consumption expenditure. Participation was strongly influenced by factors such as gender, land size, water access, input availability, and household size. The high welfare gains estimated for non-participants suggest substantial untapped potential, especially among low-income and female-headed households. Based on these findings, three key policy recommendations are proposed: (i) integrate urban agriculture into urban land-use planning with clear and enforceable land tenure security to encourage investment and sustained participation; (ii) promote adoption of space-efficient and sustainable practices such as vertical farming, compost reuse, and water-saving technologies to maximize productivity in limited urban spaces; and (iii) enhance access to microcredit, subsidies for inputs, and targeted training programs aimed at disadvantaged groups, including female-headed households, to reduce barriers to entry and improve livelihoods. Despite its contributions, this study has limitations. It relies on cross-sectional data and self-reported consumption figures, which may affect the accuracy and causality of the results. Furthermore, the analysis does not capture the long-term sustainability, environmental impacts, or potential for job creation associated with urban agriculture. Future research should employ panel data to better assess these dynamics and examine the role of urban agriculture in promoting not only household welfare but also broader environmental sustainability, employment generation, and climate resilience in rapidly urbanizing regions.

References

Abate, T., & Getahun, S. (2025). Urban agriculture and household nutrition in Addis Ababa: An econometric assessment. Urban Agriculture & Regional Food Systems, 10(1), e30015. https://doi.org/10.1002/uar2.30015

Abdulai, A., & Tesfaye, A. (2016). The impact of urban agriculture on food security: Evidence from Ethiopian cities. *Food Policy*, *65*, 13–23. https://doi.org/10.1016/j.foodpol.2016.10.007

Abebaw, D., & Haile, M. (2013). The impact of land certification on investment and productivity: Evidence from Ethiopia. Land Economics, 89(2), 284–302. https://doi.org/10.3368/le.89.2.284

Alemu, D., Abebe, G., & Tadesse, T. (2025). Urban agriculture, dietary diversity, and nutritional outcomes in Addis Ababa. Journal of Urban Food Systems, 12(1), 45-62.

Appiah, N. (2016). Urban agriculture and household welfare: An analysis of Ghana's recent experience. Master's thesis, University of Ghana. Retrieved from UGSpace.

Belay, M., & Mengiste, M. (2021). The ex-post impact of agricultural technology adoption on poverty: Evidence from North Shewa Zone of Amhara Region, Ethiopia. *International Journal of Finance & Economics*, 1–11. https://doi.org/10.1002/ijfe.2479

Bourguignon, F., Fournier, M., & Gurgand, M. (2007). Selection bias corrections based on the multinomial logit model: Monte-Carlo comparisons. *Journal of Economic Surveys, 21*(1), 174–205.

Cochran, W. G. (1977). *Sampling Techniques* (3rd ed.). New York: John Wiley & Sons.

Cofie, O. O., Drechsel, P., & Danso, G. (2006). Promoting urban agriculture as a climate change adaptation strategy: A case study of Accra, Ghana. International Development Research Centre (IDRC). RUAF/ IWMI.

Deaton, A. (1997). The Analysis of Household Surveys: A Microeconometric Approach to Development Policy. Washington, DC: The World Bank.

Di Falco, S., Veronesi, M., & Yesuf, M. (2011). Does adaptation to climate change provide food security? A micro-perspective from Ethiopia. American Journal of Agricultural Economics, 93(3), 829–846. https://doi.org/10.1093/ajae/aar006

Drechsel, P., & Dongus, S. (2010). Dynamics and sustainability of urban agriculture: Examples from sub-Saharan Africa. Sustainability Science, 5(1), 69–78. https://doi.org/10.1007/s11625-009-0097-x

Gebremedhin, M., & Mulat, A. (2021). Urban agriculture in Ethiopia: Prospects and challenges. *Journal of Agricultural Development, 8*(2), 45–62.

Girma, A. (2010). The role of urban agriculture in food security in Addis Ababa. *Ethiopian Journal of Development Research, 32*(1), 45–67.

Guta, L. J., & Irge, T. W. (2022). Determinants of urban agricultural practices and their impact on household food security: Evidence from Bako Town, Oromia Regional State, Ethiopia. Economics, 11(4), 167–189. https://doi.org/10.11648/j.eco.20221104.12

Hagos, S., Tadesse, M., & Birkhäuser, R. (2023). Socioeconomic barriers to urban agriculture: A focus on marginalized groups in Ethiopia. *Gender and Development, 31*(4), 593–609.

Heckman, J. J. (1979). Sample Selection Bias as a Specification Error. Econometrica, 47(1), 153–161. https://doi.org/10.2307/1912352

Kassie, M., Teklewold, H., Jaleta, M., Marenya, P., & Erenstein, O. (2015). Understanding the adoption of a portfolio of sustainable intensification practices in eastern and southern Africa. Land Use Policy, 42, 400–411. https://doi.org/10.1016/j.landusepol.2014.10.001

Khonje, M., Manda, J., Alene, A. D., & Kassie, M. (2018). Analysis of adoption and impacts of improved maize varieties in eastern Zambia. World Development, 66, 695–706.

Kiribou, T., Ayele, S., & Alemu, M. (2024). Urban agriculture and food security in Sub-Saharan Africa: A systematic review. Urban Agriculture & Regional Food Systems, 9(1), e20022. https://doi.org/10.1002/uar2.20022

Lokshin, M., & Sajaia, Z. (2004). Maximum likelihood estimation of endogenous switching regression models. The Stata Journal, 4(3), 282–289.

Mamush, M., Bojago, E., & Ngare, I. (2024). Determinants of adoption of urban agriculture (UA) as climate-smart agriculture (CSA) and its impact on food security: Evidence from Wolaita Sodo City. Discover Sustainability, 5(1), 168.

Masha, M., Bojago, E., & Ngare, I. (2024). Determinants of adoption of urban agriculture (UA) as climate-smart agriculture (CSA) practices and its impact on food security: Evidence from Wolaita Sodo city, South Ethiopia. Discover Sustainability, 5(1), 168. https://doi.org/10.1007/s43621-024-00365-5

Maxwell, D., Levin, C., & Csete, J. (1998). Does urban agriculture help prevent malnutrition? Evidence from Kampala. Food Policy, 23(5), 411–424. https://doi.org/10.1016/S0306-9192(98)00043-3

Mburu, P., & Wanjiku, R. (2023). Urban agriculture and poverty alleviation in Kisumu: Evidence from regression discontinuity analysis. Development Studies Quarterly, 36(3), 211-230.

McFadden, D. (1973). Conditional logit analysis of qualitative choice behavior. In P. Zarembka (Ed.), Frontiers in Econometrics (pp. 105–142). Academic Press.

Mougeot, L. J. A. (2005). Agropolis: The Social, Political, and Environmental Dimensions of Urban Agriculture. Earthscan.

Mutuku, J., & Mwangi, L. (2024). Peri-urban farming and household food security in Kenya: Benefits and risks. Food Security, 16(2), 343–359. https://doi.org/10.1007/s12571-024-01475-8

Mwangi, W., Kariuki, S., & Njeru, M. (2021). Market access and smallholder farm profitability: Evidence from Kenya. Journal of Development Studies, 57(4), 645–662. https://doi.org/10.1080/00220388.2020.1793765

Njiru, J., Otieno, J., & Onyango, L. (2024). Urban agriculture and public health: Risk assessment of wastewater use in peri-urban Kenya. Environmental Health Perspectives, 132(4), 340-352.

Nyambane, A., Okoth, J., & Mwangi, P. (2023). Land tenure security and income dynamics of urban farmers in Nairobi: Panel data evidence. Urban Economics Review, 29(1), 77-94.

Onyango, G., Odhiambo, N. M., & Owino, M. (2018). Impact of urban agriculture on household food security in Kisumu City, Kenya. African Journal of Agricultural Research, 13(36), 1800–1811.

Orsini, F., Kahane, R., Nono-Womdim, R., & Gianquinto, G. (2013). Urban agriculture in the developing world: A review. Agronomy for Sustainable Development, 33(4), 695–720. https://doi.org/10.1007/s13593-013-0143-z

Owusu Asante, F., Al-Hassan, R., & Kuwornu, J. K. M. (2024). Agricultural service delivery and household welfare in rural Ghana: Evidence from MESR modeling. Development Studies Research, 11(1), 77–93. https://doi.org/10.1080/21665095.2024.2298771

Rahut, D. B. (2017). Urban agriculture and its effects on household welfare: Evidence from urban areas. *Journal of Urban Economics, 23*(4), 345–367. https://doi.org/10.1016/j.jue.2017.01.004

Simatele, D., & Binns, T. (2008). Sustainability and development in urban agriculture: Evaluating urban livelihood strategies in Lusaka, Zambia. Urban Forum, 19(1), 1–21. https://doi.org/10.1007/s12132-008-9025-8

Teklewold, H., Kassie, M., Shiferaw, B., & Köhlin, G. (2013). Cropping system diversification, conservation tillage and modern seed adoption in Ethiopia: Impacts on household income, agrochemical use and demand for labor. *Ecological Economics, 93*, 85–93.

Tesfay, G. (2020). Fertilizer adoption and market participation among smallholders in Northern Ethiopia: An ESR approach. Agriculture & Food Security, 9(1), 56. https://doi.org/10.1186/s40066-020-00256-y

Tessema, A. (2020). Urban agriculture and household welfare: Evidence from Hossana Town, Ethiopia. Journal of Economics and Sustainable Development, 11(5), 1–13. https://doi.org/10.7176/JESD/11-5-06

Van Niekerk, J. A., Swanepoel, J. W., & Tirivangasi, H. M. (2021). Analysing the contribution of urban agriculture towards urban household food security in informal settlement areas. Development Southern Africa, 38(5), 785–798. https://doi.org/10.1080/0376835X.2021.1920888

Wolday, A., et al. (2018). Urban agriculture and food security in Ethiopia. *Food Security Journal, 10*(2), 307–319.

World Bank. (2020). *Poverty and shared prosperity 2020: Reversals of fortune*. Washington, DC: World Bank.
Yitbarek, E., & Tesfaye, K. (2022). Climate-smart agriculture and non-farm employment: A multinomial endogenous switching regression analysis in Ethiopia. Agriculture, 12(2), 284. https://doi.org/10.3390/agriculture12020284
Zezza, A., & Tasciotti, L. (2010). Urban agriculture, poverty, and food security: Empirical evidence from a sample of developing countries. Food Policy, 35(4), 265–273. https://doi.org/10.1016/j.foodpol.2010.04.007

Appendixes

Appendix 1. Summary of studies conducted on impact of urban agriculture on households' welfare

Author & years of publication	Methodology (models)	Determinant variables	Dependent & Outcome variables
Abraham Tessema (2020)	Binary logit model Propensity score matching	Age, sex, education level of household head, household size, land size, income from other sources, access to credit, access to water, access to extension services, access to improved inputs	Participation in Urban Agriculture, Consumption Expenditure per Adult Equivalent
Lemi Jeneral Guta, Takele Wogari Irge, 2022	Multinomial logit model Propensity score matching model	Risk preference, Households Income, Extension service , Access to credit, Access to irrigation, Age of household head, Sex of household head, Educational level of household head, Dependency ratios of household, Land size, Market distance, Family size, Membership in cooperative, Livestock , Marital status	Determinants of urban agricultural practices Household's food security
Nigus *et al.* (2024)	Multivariate Probit (MVP) model	Sex, age, education level, land size, extension contact, credit access, community group participation, training, and household nonfarm income, perception, farming experience & market distance	Determinants of adoption of urban agricultural practices
Van Niekerk *et al*. (2021)	Probit model Propensity score matching	Human resources, time, investments, access to land area (space for urban agriculture) and practical knowledge of urban agriculture, access to finance, time, access to land and farming resources, and knowledge of farming.	Decision to participate in urban agriculture Household welfare
Mamush Masha *et al.*, (2024)	Logistic regression Propensity score matching	Gender, access to credit, age, available land for farming, educational level, family size in number, job status, location of the residence, market demand, ownership of living home, perception toward urban agriculture, total monthly income, training	Determinants of adoption of urban agriculture Food security
Naomi Appiah (2016)	Logistic regression model Propensity score matching	Age, household size, education level, employment status, income, accessibility to land, marital status, household poverty status, participation in non-farm activities	Determinants of participating in urban agricultural practices Household Welfare

Appendix 2. Mean estimation result of households' consumption expenditure in Ethiopian Birr

	Mean	Std. Err.
Mean of household welfare measured by consumption expenditure	6733.333	346.1307