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The various face(t)s of urban agriculture: evidence from secondary towns in Ethiopia

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ABSTRACT

Urban agriculture (UA) is often proposed as a solution to feed cities sustainably and nutritiously. Yet, research on secondary towns is limited, despite their central role in Africa's urbanization, and studies on the entire supply chain are scarce. This study uses a qualitative approach to explore the technical, institutional and commercial aspects of UA in two Ethiopian secondary towns, Dessie and Kombolcha, focusing on leafy vegetables due to their nutritional importance. Using purposive sampling, we conducted 68 key informant interviews and 11 focus group discussions with farmers, traders and officials. Through a thematic analysis, we identified three UA typologies: peri-urban commercial farms, home gardens and agriculture under the Urban Productive Safety Net Program (UPSNP). Nearly 90% of leafy vegetables consumed locally are sourced through UA, underscoring its importance. However, insecure land rights, limited policy support and informal trading systems hinder its impact. Each UA type plays a distinct role: peri-urban farms are most productive, home gardens enhance household nutrition, and UPSNP supports the poorest. Informal markets also cause post-harvest losses, especially affecting women, who face disproportionate barriers. To fully realize UA's potential, inclusive and gender-sensitive policies that address the diverse needs across production systems and the supply chain are essential.

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Urban food system; short food supply chains; alternative food network; gender; Africa

1. Introduction

By 2050, it is predicted that over 70% of the global population will live in urban areas, with African and Asian cities accounting for 90% of this growth (UNDESA, 2023). Feeding the growing urban population in a sustainable, inclusive and nutritious way is a global priority. While urbanization can boost local economies by increasing food demand, creating opportunities for farmers and promoting commercial agricultural clusters near cities (Minten et al., 2020; Moustier et al., 2023), it can also harm food system sustainability if poorly managed. Inadequate planning and the expansion of informal settlements may increase food insecurity by raising demand and prices, shifting consumption patterns and reducing agricultural land (Ayambire et al., 2019).

Urban agriculture (UA), defined as all farming practices in and around cities to meet local food demand, is proposed as a lever to improve urban food systems in low-income countries (Moustier et al., 2023; Zezza & Tasciotti, 2010). Since the early 2000s, UA has received increasing attention from policy makers and researchers, acknowledging both its opportunities and challenges (Yan et al., 2022). On the one hand, UA has been praised for its multifunctionality, providing food, livelihoods, health benefits and green infrastructure while promoting biodiversity and ecosystem services, including improving air and water quality, and repurposing urban waste for fertilizer and irrigation (Clinton et al., 2018; Pradhan et al., 2023). UA is especially promising in case of perishable produce like fresh fruits and vegetables. The shortening of food supply chains allows to avoid long transportation from (remote) rural areas to urban areas, which can be damaging if no proper storage and cooling facilities can be used (Enthoven & Van den Broeck, 2023). UA also plays key cultural and social roles, preserving indigenous food practices, empowering women and

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youth and fostering social cohesion (Olivier & Heinecken, 2017). On the other hand, if not well managed, UA can cause environmental challenges, such as air, water and soil pollution, and conflicts over land and water use (Badami & Ramankutty, 2015; Davies et al., 2021; Follmann et al., 2021). Misuse of agrochemicals and improper waste disposal also increase health risks (Antisari et al., 2015; Goldstein et al., 2016).

Despite a growing number of studies, empirical evidence still has shortcomings. Research on UA is largely based on megacities and less on secondary towns (Battersby, 2013; Graefe et al., 2019). In Sub-Saharan Africa (SSA), urbanization will rather occur through secondary towns of 100,000 to 500,000 people (Githira et al., 2020). Secondary towns face other challenges than megacities, like limited public investments, unstable land policies and restricted access to services, though these issues may vary by region (Christiaensen et al., 2013). As a consequence, secondary towns have different food accessing strategies and engagement in UA than megacities. Case studies from South African cities corroborate that an unequal focus on megacities has resulted in a fragmented understanding of UA in the country (Kanosvamhira, 2024). Given these differences and the growing importance of secondary towns in SSA, empirical evidence is highly needed. In addition, much of the available evidence on UA relies on quantitative data, which typically focuses solely on either the production or consumption side of UA. While quantitative studies may offer more generalizable and representative insights, they may lead to a fragmented view that excludes marketing and distribution. More in-depth results from case studies that cover the entire food supply chain, encompassing farmers, traders, consumers and other actors in UA, can give valuable, more detailed insights.

We address both shortcomings in our paper. We apply a food supply chain perspective to provide evidence on the role of urban agriculture in two secondary towns in north-central Ethiopia, Kombolcha and Dessie. We aim to understand the production and marketing practices of leafy vegetables, and locate possible opportunities and constraints of the urban vegetable supply chain. We focus on leafy vegetables (e.g. lettuce, kale, green cabbage and chard), because these produces are fresh, nutrient-dense and primarily produced and consumed within city boundaries. They have the potential to contribute to sustainable, inclusive and healthy urban food systems, if they are well integrated into urban food supply chains. Using primary data from purposively selected 68 semi-structured interviews and 11 focus group discussions, we conduct a thematic analysis to assess the technical, institutional and commercial possibilities and constraints of UA along the entire supply chain. We apply the global framework by FAO, Rikolto and RUAF to distinguish between three different UA typologies: peri-urban commercial farming, agriculture in the framework of the Urban Productive Safety Net Programme (UPSNP), and home gardens (FAO et al., 2022). Each typology comes with its own opportunities and challenges, involving different types of production and marketing practices. This makes our findings relevant for policy makers and practitioners who develop strategies for safe and nutritious food production, trade and consumption in similar secondary towns in the region.

Our focus on two secondary towns in Ethiopia is appropriate for various reasons. Ethiopia is the second most populous country in Africa, with an estimated population of 126.5 million in 2022. The urban population accounts for 23.2%, with an annual urbanization rate of 4.6%, which is higher than the African average of 3.5% (UNDESA, 2023). Rapid urbanization has led to chronic food insecurity in Ethiopian cities, and rural production alone cannot meet the growing demand. Therefore, the Ethiopian government has promoted UA, aiming to create 1.5 million jobs in UA by 2030. This would correspond to nearly a three-fold increase in 12 years, as UA employment amounted to 542,000 people in 2018 (Yalew, 2020). To achieve this ambitious target, the government has launched various initiatives, such as a new partnership between the Ministry of Urban Planning and Development and Farm Africa, and the UPSNP that supports UA as part of its food security efforts (Derso et al., 2021). Despite the growing recognition of UA as a formal sector, challenges remain due to the lack of policy frameworks on land use, advisory services, water scarcity and the neglect of secondary towns. Urban sprawl has reduced croplands as fertile areas are converted for housing. Additionally, political unrest and conflict have further disrupted agricultural activities and investment in UA.

2. Data and methods

2.1. Research area

The study focuses on two secondary towns in north-central Ethiopia, in the region of Amhara: Dessie and Kombolcha. While they are closely located to each other (27 km distance), their socio-demographic and

agroecological characteristics are quite different. The estimated population in 2021 was 257,126 for Dessie and 125,654 for Kombolcha (Assefa, 2024). Both towns experienced rapid growth with respective increases of 70.1% and 47.2% since 2007. While Kombolcha is more of an industrial zone, Dessie is mainly a residential town. Self-employment in small businesses and wage employment for the government are the main livelihood activities in both cities. Poverty rates and food insecurity are high and similar to other drought-prone regions in Ethiopia. The altitude of Dessie is 2550 masl, while Kombolcha's is at 1842 masl. Both cities experience a bimodal rainfall pattern, with the main rainy season concentrated in June–September and a relatively dry season from October to January, during which serious water shortages can occur. The two towns are connected through a highway and a river (Borkena).

Figure 1 shows the location and the land use in Dessie and Kombolcha. There is a relatively large availability of cropland area, including vegetables, in the peripheries of the two towns, with 30.6% of total land use in Dessie and 37.9% in Kombolcha. However, urban sprawl and informal settlement practices have changed land use to non-agricultural practices, like residential, industrial and other infrastructures.

2.2. Typologies of urban agriculture

In both towns, three typologies of UA are observed: 1) peri-urban commercial farming, 2) agriculture under UPSNP and 3) home gardens. These typologies are in line with the framework by FAO, Rikolto and RUAF, which distinguishes between commercial, socio-cultural and subsistence types of UA. Home gardens and UPSNP are more subsistence-oriented, while peri-urban farmers are more commercially oriented. Peri-urban farming is found near the borders of the city, where it can use water from the nearby Borkena, Melkawedaja and Gerado rivers for irrigation. UPSNP is found in the vacant areas and institutional lands in the city centre, whereas home gardens can be located either in the centre of the city, close to the household compound, or in the urban peripheries on land owned by citizens, within walking distance from home. While peri-urban farming and home gardens have a longer history, the UPSNP is more recent as it started in 2017 in Dessie

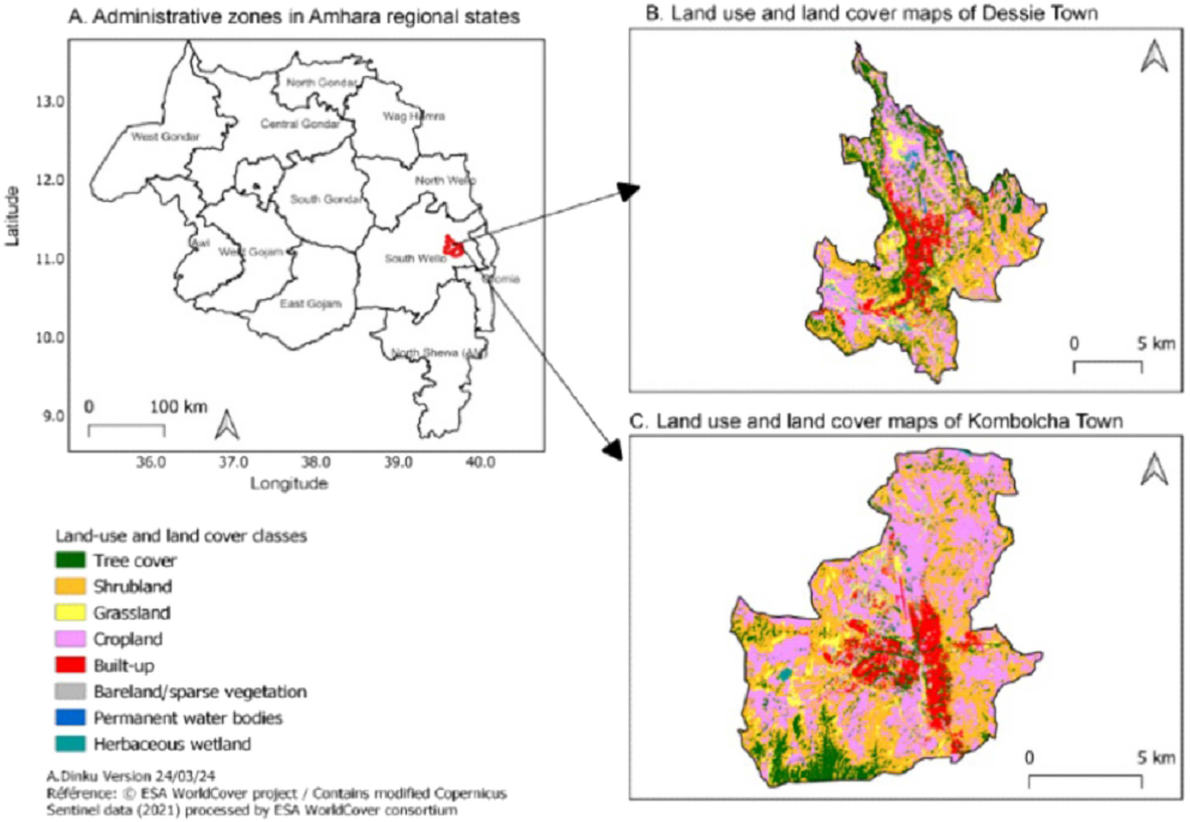


Figure 1. Land use and land cover map of Dessie and Kombolcha towns in 2023, located in north-central Ethiopia.

and in 2020 in Kombolcha. Initiated by the World Bank and the Ethiopian government, the UPSNP is a social protection programme aiming at supporting 604,000 people in 11 cities in Ethiopia (Assefa, 2024). The programme focuses on three main pillars (safety net, livelihood support and capacity building) through public works and direct support. Public works cover 84% of programme participants (e.g. 1220 in Dessie and 1227 in Kombolcha), who receive a monthly wage while engaging in labour-intensive activities, such as UA. Those who are unable to participate in public works, such as elderly individuals, receive direct support from the government.

2.3. Data collection

Our research approach relies on qualitative methods, as we aim to explore and understand the various production systems, functions and actors associated with UA. We employ a descriptive case study design to explore context-specific and complex insights, barriers and perceptions of urban vegetable farmers, traders and institutional actors, which are often overlooked through a purely quantitative approach. We collected primary data among various actors involved in the three UA typologies, including farmers, traders and city level sectoral representatives, leading to a total of 68 semi-structured interviews and 11 focus group discussions (FGDs) (Table 1). First, our data collection began with field observations during May–June 2023, visiting farms and vegetable markets, and conducting informal interviews with various people involved in vegetable production and marketing. We then contacted the relevant offices of UA in both cities to gather information on collaborative institutions, production methods and the status of vegetable production and supply. We conducted in-depth interviews with 14 local institutional representatives, 8 from Kombolcha and 6 from Dessie, with 5 women respondents in total. We selected institutions based on their involvement in urban vegetable production and marketing, using snowball sampling after initially interviewing UA and UPSNP offices.

Second, during July–September 2023, we conducted semi-structured interviews with farmers from peri-urban, UPSNP and home garden production. The discussed topics included production practices, land and water use, labour, governance, marketing and distribution. The questions were based on the literature, our field observations and additional insights obtained from the interviews with the office representatives. A total of 35 farmers (18 in Kombolcha and 17 in Dessie) were interviewed, with 54.3% being women. Each UA typology was represented with 11 respondents for peri-urban farming, 13 for UPSNP and 11 for home gardens. Snowball sampling was used until saturation of information was achieved.

Third, we conducted semi-structured interviews with vegetable traders at various wholesale and retail markets, including central markets, peri-urban markets, Sunday markets, markets with shaded stalls and small-scale roadside (Gulit) markets. To ensure a diverse range of traders, we visited these markets on different days. We interviewed 19 traders, of which 73.7% were women, with 12 in Kombolcha and 7 in Dessie.

Fourth, to gain a deeper understanding of the challenges faced by urban farmers, we conducted 11 FGDs. These discussions were focused around six main themes: the role of UA, production issues, technology adoption, marketing strategies, challenges and the link between UA and sustainable food supply. We held six FGDs in Dessie and five in Kombolcha. Each FGD included four to eight participants. To ensure balanced representation and avoid male dominance, we organized separate FGDs for men and women within each UA typology. Two FGDs were conducted for each production modality (except for home gardens, where only one FGD was held). Additionally, a mixed-gender FGD was included to involve both male and female members of UPSNP farms in Kombolcha.

Table 1. Distribution of target respondents by cities and data collection methods.

		Kombolcha		Dessie	
Participant type	Sub-group	Interviews	FGDs	Interviews	FGDs
Farmers	UPSNP	7	3	6	3
	Peri-urban	5	2	6	2
	Home garden	6		5	1
Traders		12		7	
Office representatives		8		6	
Total		**38**	**5**	**30**	**6**

FGDs means focus group discussions; UPSNP means Urban Productive Safety Net Programme.

2.4. Ethical approval

Ethical review and approval were obtained from Wollo University Research and Community Service Ethical Board with approval number (WU/COA/RDAE/104/2023). Participants were presented with informed consent forms and given the option to provide either written consent, in the form of a signature or thumbprint, or verbal consent. Verbal informed consent was given by some participants to promote open communication and reduce potential pressure associated with written consent. All involvement was entirely voluntary based. Participants were fully informed about the objectives of the study, duration of the interview time and their right to withdraw the interview at any point. They were approached respectfully and cordially. To enhance trust, formal letters of support were also secured from Wollo University and the local administrative offices of the two towns.

2.5. Data analysis

We applied thematic analysis using interview transcripts, field observations and own notes. We chose thematic analysis for its flexibility in understanding diverse contexts and its ability to easily manage and analyze large volumes of qualitative data. Unlike content analysis, which quantifies data, thematic analysis focuses on identifying key themes and meanings (Strang et al., 2022). First, we transcribed and organized the data based on its source. Then, we coded the data manually, aligning the themes with the framework by FAO, Rikolto and RUAF (FAO et al., 2022). To ensure validity and reliability, we used data triangulation from our field observations, semi-structured interviews and FGDs. In addition, we applied a supply chain approach to understand vegetable marketing strategies and characterize different marketing channels, linkages, networking and relationships among supply chain actors. Throughout our analysis, we paid specific attention to the differences experienced in the three UA typologies.

3. Results

This section consists of three parts. First, we assess the role of local government stakeholders in supporting or hindering UA in Dessie and Kombolcha. Second, we describe the various characteristics and challenges linked to the urban production of leafy vegetables. Third, we map the supply chain of leafy vegetables and assess marketing and distribution characteristics.

3.1. The role of local government stakeholders

UA is a cross-sectoral issue in the urban development policy agenda. Because of its multifunctionality, different offices and lines of authorities are involved. We identified eight key government stakeholders who have direct and indirect responsibilities in UA in Dessie and Kombolcha: 1) urban agriculture office, 2) UPSNP office, 3) women, children and social affairs office, 4) city industry and investment office, 5) sanitation and urban greening office, 6) trade and market development office, 7) work and skills department and 8) city urban planning and housing design office (Table 2).

The roles of local government stakeholders vary from providing different forms of support to coordinating land use policies, with not all UA typologies receiving the same level of support. Policy support and coordination for UPSNP is strongest, as all local government stakeholders participate in a city-level steering committee led by the mayor. As reported by an UPSNP office representative in Kombolcha, this committee assists poor urban farmers with access to land and water, employment and advisory services and stakeholder institutions – such as schools, hospitals and the Urban Greening Office – primarily facilitate access to land, water and security. The office of UPSNP also initiated an open demonstration centre in both towns in order to show urban farmers how they can best design their gardens and use locally available technologies to produce vegetables. In contrast, the UA office coordinator in Dessie noted that the office's loose organizational structure clearly indicates poor coordination in both peri-urban and home-garden production models. For peri-urban farming, only the UA office is responsible for facilitating support and providing services like training, seed supply and fertilizer distribution. Home gardeners receive no formal government support.

Table 2. The role of local government stakeholders in urban agriculture in Dessie and Kombolcha.

Local government stakeholders	Roles in UA
1. Urban agriculture office	• Provide technical and institutional support to urban farmers • Lead and coordinate UA initiatives in the city
2. UPSNP office	• Identify, train, support and monitor poor urban residents to engage in UA for their livelihoods
3. Women, children and social affairs office	• Integrate gender considerations into UA jobs • Support women's and children's engagement in nutrition, employment and labour rights
4. City industry, and investment office	• Encourage public and private sector participation in UA • Provide services like licences, credit, machinery and market access, especially for large-scale producers
5. Sanitation and urban greening office	• Promote urban greening, sanitation and waste recycling in UA • Enhance the city's environmental performance through integrating UA with 'cleaning and greening' initiatives
6. Trade and market development office	• Facilitate access to market for farmers, traders and consumers • Support input supply (e.g. credit for fuel and motor pumps) • Record and share regular market prices • Supervise marketplace operations and enforce shade tax regulations
7. Work and skills department	• Enhance the skill of unemployed youth and women • Promote entrepreneurship using UA as one source of employment • Coordinate youth in cooperatives to practice UA
8. City urban planning and housing design office	• Integrate UA into city planning • Zone urban land for different uses

Source: researchers' formulation from qualitative data 2023.

3.2. Vegetable production

Table 3 gives an overview of the key characteristics and challenges linked to vegetable production for the three different UA typologies: 1) primary purposes and functions, 2) production practices, 3) land use and management, 4) water use and management, 5) labour resources and 6) financial resources.

3.2.1. Primary purposes and functions

The three UA typologies fulfil different purposes and functions. The primary purpose of home gardens is securing food self-sufficiency. Most home gardeners report that they completely satisfy their own vegetable needs, especially during the rainy season. For instance, a young adult woman from Kombolcha stated, '*We don't buy any leafy vegetables for own consumption; we harvest fresh produce from our gardens*'. Beyond food self-sufficiency, home gardeners report that it enhances their family engagement during leisure time. All family members, including children, are involved in vegetable production. Additionally, elderly people appreciate the physical exercise, sometimes even more than the food supply itself. Aspects of cultural preservation, thereby educating young people, are also mentioned as important purposes. Some home gardeners also produce vegetables for waste management. For example, a man from Dessie told that he started vegetable production during the COVID-19 pandemic to manage urban waste and contribute to neighbourhood greening.

In the words of UPSNP office representatives, UPSNP producers are driven by two main objectives: nutrition and income support, as well as urban greening and rehabilitation. On the one hand, the UPSNP significantly contributes to food and nutrition security. For instance, one group team leader among UPSNP producers in Kombolcha noted: '*This year, we farm on two small, fragmented plots and have saved 15,000 Ethiopian Birr (about 240 USD using that time official exchange rate) from three harvests of leafy vegetables*'. UPSNP farmers are motivated by the slogan 'feeding myself in my garden', highlighting that the primary aim of UA is to produce food in public spaces to first supply group members, and then to sell any surplus. On the other hand, the UPSNP is also used for rehabilitation and urban greening to restore degraded lands and aid with waste management. A key difference between UPSNP and the other two typologies is the collaborative approach. This is witnessed during a women's FGD in Kombolcha: '*UPSNP creates shared ideas and better social cooperation among people who work together*'.

Peri-urban farmers focus on market-oriented production, which comprises a main part of their total income generation. As reported by participants in the peri-urban FGD in Kombolcha, farmers primarily grow vegetables that are in high market demand, such as head cabbage, potatoes and hot peppers. These farmers prioritize leafy vegetables over other crops due to their profitability, short maturity and multiple harvests per season. Women farmers benefit especially, as it provides a regular source of cash income. The

Table 3. Overview of urban agriculture typologies and key characteristics, and challenges linked to production.

Traits	Primary purposes and functions	Production practices	Land use and management	Water use and management	Labour resources	Financial resources	Main challenges
Home gardens	• Fresh food supply • Recreation • Education • Cultural preservation • Waste management	• More extensive production system • Partly organic production • Container farming	• Own home gardens • Unfinished built-up areas • Communal spaces • Use of low-tech containers	• Mostly rainfed system • Use fresh pipeline water • Apply kitchen wastewater • Watering manually	• Mostly use family labour • Women invest more hours • Elders and unemployed participate	• Informal credits • Indirect funds • Own investment	• Shortage of water • Lack of time for producer • Food safety • Destruction by wild animals (dogs, cats and hyenas) • Pests and diseases
UPSNP-supported	• Food supplement • Income generation • Urban greening • Social integration • Collaborative approach	• Conventional to fully organic production	• Institutional lands • Public spaces • River, road and hillsides • Undeveloped and degraded spaces	• Mostly rainfed system • Irrigation from river, pipelines, underground pounds and rainwater reserves	• Members of the production group • Equal participation of members • Small support from UPSNP programme	• Facilitated by-UPSNP office • Use own group savings	• Shortage of land • Land insecurity • Food safety • Water scarcity • Theft and animal attack • Low financial capital
Peri-urban	• Commercial production • Major means of livelihood • Empower women through regular cash income	• More intensive production system • Higher use of external inputs • Staggered planting	• Larger landholdings with different tenure arrangements • Majority has formal land ownership certificate	• Mostly irrigated system (traditional and motor pump) • Mostly use water from river	• Hired labour for peak season • Women share more time for smaller plots • Low labour productivity due to khat	• Rural-oriented • Cross collateral system • Use own sources (sale of assets)	• Natural disasters, including drought, flood and pests • Rise in the price of agricultural inputs • Poor agricultural extension • Lack of clarity for rural to urban land use transition

other vegetables and herbs that are often intercropped with leafy vegetables (e.g. mint, bell pepper, garlic, rosemary and lavender) are mainly used for home consumption.

3.2.2. Production practices

Based on field observations and data drawn from interview participants, production intensity and use of external inputs is lower for home gardens and UPSNP than for peri-urban farming. There are also differences across the two towns, with a higher use of agrochemicals in Kombolcha and more organic input use in Dessie. In general, land productivity is rather low. For example, based on reports from key informant farmers and our own calculations across production models, the average lettuce yield is approximately 7.5 tonnes per hectare for peri-urban farms, 4.5 tonnes per hectare for home gardens and 3 tonnes per hectare for UPSNP farms.

Regarding fertilizer use, farmers rely heavily on organic waste or manure, coming from their own waste or at a reduced price from other livestock owners. To illustrate, a peri-urban female farmer from Dessie stated: '*I own 800 m^2 of land integrated with dairy cows. I produce organic vegetables using animal manure*'. As explained by the respondent, the further the plot is located away from home, the more fertilizer is applied. When peri-urban farms are larger (e.g. bigger than 0.25 ha), requirements for large amounts of compost are often not feasible. For example, a woman farmer from Kombolcha reported that '*I had to stop composting because it was too labour intensive and took more space to compost*'. This finding indicates that organic agriculture might be more difficult for larger peri-urban farms. Peri-urban farmers also practice intercropping to maintain soil fertility, and UPSNP farmers maintain the soil by growing other spices, such as basil and black cumin, before they use the land for vegetable production. A UPSNP farmer from Kombolcha explained, '*Before planting vegetables, we clean the land, remove plastic and metal waste and add external soil to improve fertility*'.

Regarding pesticide use, different approaches are followed. In general, most farmers frequently reported that pests and diseases are among the core problems in leafy vegetable production, especially due to the cabbage looper (Trichoplusia ni), locally known as 'Atako', whiteflies (Bemisia tabaci) and powdery mildew, called 'Ameday'. Peri-urban and UPSNP farmers mostly use *Tilt 250 EC*, a systemic fungicide with relatively low toxicity, as pest control. In addition, they apply crop rotation and switch to crops like maize, beans and chickpeas at least once a year. Home gardeners mostly do not apply chemicals, they rather use homemade pesticide solutions to protect against pests and diseases. For example, a woman home gardener from Kombolcha said: '*I use Omo and ash juice to spray my vegetables every morning. It's effective and prevents pest attacks*'.

Regarding seed use, farmers use both improved and local seeds to grow lettuce, green cabbage and chard and a propagation method to replicate kale. Many farmers state concerns about limited access to seeds because of high prices. As noted by home garden growers in Dessie, vegetable seeds are often sold in large quantities, making them too expensive for small-scale farms. To address this, some farmers produce and share local seeds, especially for lettuce and chard. However, producers in Kombolcha note that, even though local varieties are preferred in the market, they are less productive and mature too early.

The use of technology and innovation in production practices is observed as well, especially in the case of peri-urban farming and home gardens. In Dessie, peri-urban farmers utilize staggered planting techniques (i.e. planting different crops at different times or in different sequences) to optimize land use, ensure a steady income by extending the harvest season, and reduce post-harvest losses. For example, a woman from Dessie stated: '*I have 100-square metres of land, and I divide it into four portions for successive planting to produce lettuce. This allows me to produce all year round and support my livelihood, including paying tuition fees for my children*'. Staggered planting is particularly effective for vegetables that have a short growing season (about 45 days for lettuce and chard), especially when land availability is highly limited. To illustrate, some productive peri-urban farmers produce lettuce up to 10 times in a year. We also observe that staggered planting not only enhances agricultural productivity but allowing farmer to respond the changing market and environmental conditions. Innovations applied by home gardeners include practices of container farming, but then replicated at small scale, using materials like plastic bags, old car tires and sacks.

3.2.3. Land use and management

According to our field observations and semi-structured interviews, access to land, farm size, and tenure security vary greatly across the three UA typologies. Home gardeners typically use very small areas to grow vegetables, ranging from 0.001 to 0.002 ha, including space used in containers, backyards and balconies. They face several challenges related to land, such as limited space-saving technologies, high land costs, poor public support and regulatory restrictions. While the lack of available land is often cited as the main challenge for UA, we observe that many open spaces in home gardens remain underutilized. Home garden producers largely reported that damage from animals like dogs, cats and hyenas is a common problem. Those located on open or communal lands do not put fencing due to concerns of land insecurity.

Land tenure insecurity poses a significant challenge for UPSNP farmers as well. For instance, the absence of formal agreements between land-owning institutions and UPSNP farmers discourages long-term investments. Although farmers are expected to provide maintenance services, such as 'cleaning and greening' for these institutions, they lack assurance of long-term land use. As one UPSNP farmer in Dessie noted: '*We could be forced to leave the land at any time if the office needed it for other purposes*'. According to our field observation, farm sizes in UPSNP range from 0.08 ha to 0.25 ha, depending on the plot managed. For example, plots in school sites are larger than those in other institutional sites. As they complained, theft and animal attacks are an important challenge for UPSNP farmers, especially in river-adjacent areas in Kombolcha. They lack the resources to invest in fencing to protect their fields. Another example relates to farmers who stopped growing vegetables in school gardens out of fear for student theft (UPSNP Women's FGDs in Kombolcha).

For peri-urban farms, plot sizes are about 0.28 ha on average, either through cultivation on own land or through share-cropping arrangements. Tenure security is also a main challenge, with a particularly severe competition for land use with other industrial sectors in Kombolcha. Along the Borkena river, peri-urban farmers compete with sand-mining associations that hold legal rights to utilize the riverbanks within a 50-metre radius, while farmers operate informally in the same space. In FGDs, peri-urban farmers in both towns expressed concerns about land insecurity following the introduction of a new urban plan in 2021. They explained that the shift from rural to urban land administration has increased uncertainty about their land rights. Under the rural system, they hold long-term certificates that secure their land use rights, but the new urban system is more complex and time-consuming. Peri-urban farmers in Kombolcha report that much of their land has been taken for other use since the airport project began in 2010. They are frustrated by low compensation and payments in small instalments that are often delayed. This leads to growing mistrust between the government and landowners. Peri-urban farmers also report that the movement of people around their farm causes damage to their vegetable fields. This includes theft and destruction from foot traffic.

3.2.4. Water use and management

Access to water, especially during the dry season, is another major challenge. Home gardeners depend heavily on rainfall, with many reporting that during periods of water scarcity, their crops often go without watering for several weeks. This highly reduces home gardens' productivity and potential to remain food self-sufficient during the dry season. When possible, gardens are irrigated at night. One apartment-based gardener in Dessie stated: '*During the day, I can't irrigate my vegetables because the pipeline is busy for household use. I prefer to water them at night, once a week, if water is available*'. This highlights the prevailing water use competition for gardening and home use, which might cause conflicts among neighbours. For example, a 43-year-old home garden owner from Dessie stated: '*There is a water scarcity, especially during the dry winters, when water is scarce, the competition between home use and vegetable irrigation increases, leading to conflicts among neighbours*'. In addition to the lack of water, there is also an important issue linked to the quality of water. Some gardeners resort to using untreated wastewater for irrigation and washing, raising food contamination and public health concerns. For example, in Kombolcha, it was reported that untreated wastewater from industries is used for irrigation, and direct disposal of faecal waste for fertilizing in Dessie.

Unlike home gardeners, peri-urban farmers, and UPSNP farmers use multiple water sources for irrigation in addition to rainwater. UPSNP farmers often rely on water coming from pipelines, underground and rivers. In some institutional compounds, such as schools, they tap into groundwater reserves or use direct

pipelines from the organization's water supply, covering the water costs themselves. An FGD participants from Dessie confirmed that: '*We use groundwater, we dug three pits, each three metres deep and two metres wide. We don't face water shortages, even during dry times*'. In the hillsides of Dessie, UPSNP farmers use pipeline water for irrigation, with access to a water tanker provided by the UPSNP office. Whereas in Kombolcha, they utilize water from the Borkena river, by purifying it through a distillation system facilitated by the office. This is further explained by the UPSNP programme coordinator in Kombolcha: '*The river isn't clean. We help farmers by pulling the water through pipelines and collecting it in one area where it can be distilled and purified…… Additionally, there are plans to further purify the water using chemical processes*'.

Peri-urban farmers use mostly river water for surface irrigation and ponds for water storage. In Kombolcha, irrigation is driven by motor pumps, while in Dessie, farmers use more traditional irrigation methods through canals connected to the river. From June to August (i.e. rain-fed production system**)**, they primarily grow maize, wheat and beans, while from September to June (i.e. irrigated production system), they switch to the production of leafy vegetables, besides root and fruit vegetables.

3.2.5. Labour resources

Leafy vegetable production is labour intensive, mostly relying on family labour and displaying clear gender roles. Based on our field observations, semi-structured interviews and focus group discussions, women in home gardens typically contribute more labour, especially to tasks related to weeding, watering and harvesting. In UPSNP, both men and women equally contribute to farming. Yet, division of labour is determined by social norms, with laborious practices done more by (younger) men and (older) women more involved in harvesting, washing and selling. Peri-urban farmers are the only UA typology that might hire in labour, depending on farm size and production stage. Hired labour is especially prominent during peak activities, like planting and harvesting. Women in peri-urban vegetable production are responsible for irrigation, secondary tillage, weeding, pest control, harvesting, grading, washing, delivering and selling of vegetables.

In some cases, lower labour productivity is observed among men. Most men, particularly in peri-urban areas, have a cultural habit of chewing khat, a native plant that contains the stimulant cathinone and that hampers their motivation to work. For example, a female FGD participant in Kombolcha explained that: '*Our spouses are usually inactive in the afternoon farming activities. They hold up their khat and hide somewhere in the city. In the afternoon, we are always working alone*'.

3.2.6. Financial resources

Access to formal credit is typically low, with a varied interest in credit across the three UA typologies. Home gardens do not use any form of credit, as their production is mostly subsistence-oriented and highly extensive. In contrast, the UPSNP office facilitates credit access for their members. This is confirmed by a female key informant, who stated that: '*If we get sufficient land, having enough cash is not a challenge for production, because we have own small monthly savings and the UPSNP office facilitates credit if required. Though not sufficient, farm tools are supplied from UPSNP office as well*'.

Unlike UPSNP producers, credit access is a challenge for peri-urban farmers. They struggle with the rising prices of agricultural inputs and need finance to facilitate innovation. For example, in Kombolcha, peri-urban farmers require credit to purchase motor pumps for irrigating their vegetables. However, they cannot apply for credit as they cannot use their land as collateral if they do not have a land certificate. There is also a limited availability of agricultural credit providers. The former Amhara Credit and Savings Institute (ACSI), currently known as the Tseday bank, is the only credit provider for small-scale farmers. However, complaints about corruption are mentioned, especially with respect to the targeting rules of those who can benefit. In addition, urban farmers are still served by the rural agricultural credit scheme, which does not consider the challenges of urban farming, such as limited space for production. Another difficulty is that individual credit schemes are not promoted, and that credit is instead arranged for groups of people using a cross-collateral system. However, peri-urban farmers are hesitant to use this system, as they fear the risk of serving as collateral for one another, and because not all members of the borrowing group are equally committed to taking responsibility for the credit. As a consequence, most farmers rely on other forms of credit, such as funds allocated for other purposes, or on informal credit provided by friends and family.

3.3. Vegetable marketing and distribution

3.3.1. Supply chain of leafy vegetables

Figure 2 shows a schematic overview of the supply chain of leafy vegetables in the towns of Dessie and Kombolcha. After triangulating our data from multiple actors and accounting for both rainy and dry seasons, we find that about 90% of the leafy vegetables consumed in the cities are supplied from farmers located within the city limits. About 80% of this supply is commercially traded and originates from peri-urban farmers.

The length of the supply chain and the number of intermediaries depend on the UA typology. Most home gardeners primarily grow vegetables for their own consumption. If there are surpluses, they are often shared with neighbours. Only a small number of home gardeners sell their produce, and they usually do so at lower prices compared to other suppliers. This is because they have only small volumes of produce, limiting their bargaining power, and marketing is not their main focus. They typically sell to nearby roadside markets when there is a surplus. Like home gardeners, UPSNP farmers primarily grow vegetables for their own consumption, but the harvest distribution and marketing is communally arranged through the programme. Members can buy vegetables at reduced prices, while any surplus is usually sold directly to local consumers or employees of nearby institutions. These profits are then used to pay out the dividends of the group members, which are based on their period of participation. In contrast, only a small share of peri-urban farming is destined for own consumption (about 10%–15%) while the rest is sold. Both direct marketing channels, selling directly to institutional (e.g. hotels, restaurants, bars) and individual consumers and indirect channels, selling to collectors and retailers, are used. Most of their produce is sold at peri-urban markets, especially if they cannot sell large quantities and transaction costs to go to the central market are too high. They could receive a higher price at the central market, but this often does not compensate for the additional costs, especially those linked to significant transportation challenges.

3.3.2. Markets and traders

In Dessie and Kombolcha, leafy vegetables are typically traded in traditional, informal markets, including wholesale and retail. Based on our field observations and interviews with traders, there are two types of wholesale markets: central markets, located in town centres and peri-urban markets, located closer to peri-urban farms. Peri-urban markets function as collection points for traders, enabling farmers with small quantities or limited market access to sell their produce effectively. Central markets serve as primary venues for farmers and intermediaries who sell directly to other traders and owners of shops, restaurants, bars and hotels, with vegetable sales typically concluding by mid-morning during high demand. Next, three types of retail markets can be distinguished: 1) Sunday markets, 2) daily markets with shaded stalls and 3) small-

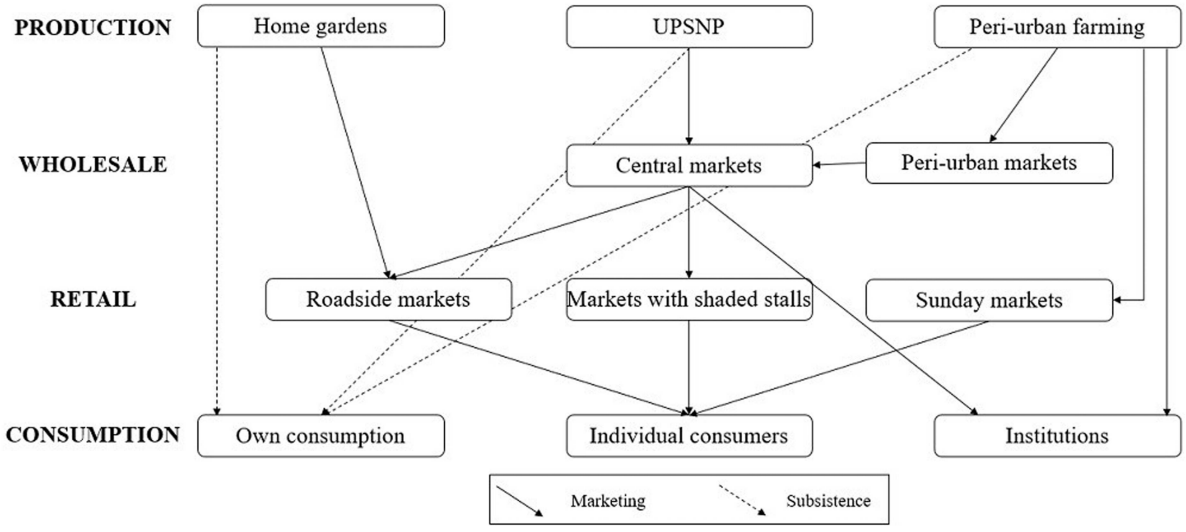


Figure 2. Schematic overview of supply chain of leafy vegetables in Dessie and Kombolcha towns.

scale roadside ('Gulit') markets without any permanent infrastructure. While the first market is only open on Sunday, the others are open on a daily base while stocks last. Daily markets source their vegetables from central or peri-urban markets, serving nearby neighbourhoods, while roadside markets cater to customers needing smaller produce quantities. Sunday markets allow farmers to sell leftover vegetables to church-goers. As most of the markets are rather traditional, there is no designated area for displaying vegetables, making it difficult to organize sales effectively. In addition, inadequate road infrastructure may make trade even more challenging. For example, weekly central markets in Kombolcha have dirt pathways, which can turn very muddy and impractical during rainy season.

Data from interviews with traders and market officials indicate that traders can be distinguished based on their formality, indicating whether they have a license for vegetable marketing, and whether they have guaranteed access to a shaded selling point by paying a formal 'shade' tax. More formal traders act on the bigger markets, trading large volumes of fresh produce. About 30% of them are women. Besides leafy vegetables, they offer a variety of other vegetables as well, including roots, tubers and fruits. They typically sell to individual and institutional consumers (hotels and juice-houses), mini shops and intermediaries.

More informal traders, who comprise the large majority of vegetable traders in Dessie and Kombolcha, do not have licences from the marketing and trade office and do not have a guaranteed shaded stall in the marketplace. To secure a spot, they must arrive early, sometimes even a day in advance, as space is allocated on a first-come, first-served basis. They typically conduct their business on a weekly market day, purchasing and retailing on the same day. They mainly source their produce directly from farmers. This can even be through their own farm production, when they have the dual role of farmer-trader, supplemented with produce gathered through farm-to-farm collection. If they can get to the market early enough, they can also buy vegetables from other farmers. Farmers usually finish their produce early in the morning, between 6:00 and 10:30 am, with the quality of vegetables largely diminishing over time. Otherwise, they buy from other retailers at a higher price. They primarily sell to individual consumers. About 90% of informal traders are women, which is much higher than for formal traders.

When asking traders whether they aspire to continue with their job, most traders, particularly in the informal sector, express their desire to switch jobs if a better opportunity arises. Only few of them aspire to expand their business. However, they do acknowledge that it is a fair starting point. The primary reason for becoming a trader is its ease of entry into the sector, especially for women. Other advantages include the convenience of collecting vegetables from nearby locations to ensure freshness, minimal initial capital that is required and decent profit margins when market conditions are favourable. As costs and revenues are typically not recorded, an exact estimate of profit margins cannot be uncovered. The biggest challenges that traders face relate to insufficient shade, leading to high losses of vegetables that cannot be sold anymore. To deal with this and attract more customers, traders often engage in promotional activities and better handling of vegetables. For example, by spraying water over the leafy vegetables, the shelf life can be somewhat extended.

3.3.3. Coordination and information in the supply chain

Vertical coordination between farmers, traders and consumers is largely based on spot market interactions, and formal contractual agreements are rare. However, farmers do often have a long relationship with their buyers, largely based on trust from both sides. For peri-urban farmers, this is especially the case when they sell to institutions, as explained by a woman in Dessie: '*I supply my vegetables to the same hotels and restaurants in Dessie for the last 8 years*'. Sometimes institutional consumers also visit the farmers' fields to check quality of production and enhance trust. The quality of vegetables in direct marketing channels is relatively high, focusing on freshness, colour and cleanness. Vegetables sold at peri-urban markets and Sunday markets are of somewhat lower quality.

Trust is also key for the relationships between traders and individual consumers. Traders note that trust can be built through good customer service, such as offering fresh vegetables, giving small gifts and having friendly interactions with customers. They also sometimes work together by setting similar prices, especially if they work in the same spot of shade. When they buy vegetables, they negotiate with farmers in group and bargain collectively. Some traders mentioned that they share knowledge, money, and even produce with each other. For example, if one trader finishes a particular product, they start selling from another colleague.

Disseminating correct information about the quality and safety of leafy vegetables is a major challenge. Spreading of false information is relatively common, damaging the reputation of certain farmers and traders. For example, a female farmer from Dessie explained: '*Other vegetable producer neighbourhoods report to the public that their competitors practice unsafe production practices, like use of toilet waste and overuse of chemicals*'. In some cases, unsafe practices have been applied by farmers, but there is no way to verify this, which may further feed into the rumours. Traders indicated that consumers start to question about the source of vegetables and production practices, including which water has been used for irrigation and washing. Ongoing conflicts in northern Ethiopia have also disrupted market connections between local towns, affecting trade relationships between farmers, traders and consumers. However, these disruptions are larger for produce that is sourced from outside the towns, and the urban production of vegetables is less affected.

4. Discussion

Various points of discussion emerge from our analysis. First, based on our data triangulation from key informants of institutional representatives, we estimate that urban production of leafy vegetables contributes up to 90% of total consumption in Dessie and Kombolcha, implying that urban agriculture can support food security and nutrition in these towns. This contribution is notably higher than in larger cities, where urban agriculture typically provides 60%–80% of the leafy vegetable supply (Akaeze & Nandwani, 2020; Kalanda Joshua et al., 2020; Tuffour et al., 2024). This finding shows that UA might be more promising in secondary towns than in megacities, as they can benefit more from shorter supply chains. However, UA encompasses various production systems, with peri-urban farming accounting for the large bulk of production. Home gardens and UPSNP farms are much less productive, especially during the dry season. Nevertheless, home gardens can supplement diets with fresh, nutritious produce, as has been shown for other African cities (e.g. Blakstad et al., 2022; Hirvonen & Headey, 2018). UPSNP farms, on the other hand, have the important purpose of promoting social cohesion and creating decent work. Such social protection programmes have been recently highlighted as levers for more inclusive food systems (Schneider et al., 2024), and evidence is emerging on its potential to improve food security among urban residents (Assefa, 2024).

Nevertheless, UA in Dessie and Kombolcha faces numerous challenges. Access to land and tenure security is not guaranteed, as policy support for UA is very thin and spread out over multiple offices. Focus groups form peri-urban farmers in both cities pinpointed that urban expansion and land use changes create conflicts over land rights and water access, hampering long-term investments. Yet, those farmers show inventiveness by creating small-scale innovations that are tailored to their production systems, such as staggered planting and the use of container farming. Marketing is characterized by poor infrastructure, resulting in substantial postharvest losses for both farmers and traders. Lack of knowledge and expensive inputs lead farmers to use home-made fertilizers and pesticides, which are often less safe. This can have damaging effects on the reputation of the farmers and traders, leading to a lack of trust among consumers. These challenges are in line with other studies on megacities (e.g. Abdulkadir et al., 2012; Ayambire et al., 2019; Yalew, 2020), but also highlight differences. While land pressure is higher in megacities, challenges linked to weak infrastructure and access to inputs are bigger for secondary towns.

Our findings highlight the different roles of men and women in UA, both for production and marketing. Our observations and interviews with farmers and traders show that men are more active in commercially oriented UA, such as peri-urban farming, while women are more active in subsistence oriented, such as home gardens. Employment by UPSNP is more equitable, again highlighting its potential to stimulate more inclusive food systems (Schneider et al., 2024). Vegetable trading is predominantly done by women, as this is deeply rooted in cultural norms, but also because of lack of economic opportunities for women. However, women are more likely to be informal traders. They trade smaller quantities at smaller margins and have less access to market stalls with shade, resulting in more vegetable losses. As a consequence, they need to spend relatively more labour to be able to earn a minimum income. While gender inequalities in Ethiopia and other African countries have been documented by numerous studies before (e.g. Aguilar et al., 2015; Van den Broeck & Kilic, 2019; Van den Broeck et al., 2023), our study suggests that this may hold for UA as well.

Of course, we need to be careful with the interpretation of our results to a wider setting. Our insights are based on a detailed case study of two secondary towns in Ethiopia. We find many similarities but also some contrasts between the two towns, highlighting the need to acknowledge the context specificity of UA. In addition, we rely on qualitative research methods that yield a better understanding of the various production systems, the supply chain and all the different actors associated with UA. However, the generalizability and validity of the findings may be limited due to the study's limited representativeness of more cities and potential biases that may have arisen during data collection, analysis and interpretation. Moreover, qualitative research does not allow us to draw causal conclusions on the effectiveness of UA to contribute to, e.g. food security and gender equity. These are promising avenues for further research using quantitative evidence based on impact evaluations.

5. Conclusion

This study investigates the technical, institutional and commercial aspects of UA in two secondary towns in north-central Ethiopia. Nearly 90% of urban consumption of leafy vegetables originates from UA, highlighting its potential to contribute to more nutritious diets. However, this potential remains largely untapped due to persistent challenges related to land tenure insecurity and weak policy support. Addressing these barriers, through coherent urban planning, is essential to unlocking UA's full benefits. Recognizing the diversity in production systems, including peri-urban farms, home gardens and UPSNP, is crucial, as each group faces distinct challenges. While peri-urban farms are the most productive, home gardens contribute to household nutrition, and UPSNP plays a vital role for the poorest citizens. This diversity also matters for the entire supply chain, where the predominance of informal trading often contributes to substantial post-harvest losses. For women, these challenges can be even more pronounced, requiring gender-sensitive policies to promote UA.

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Author contributions

AMD contributed to the conception and design, and analyzed and interpreted the data and drafted the paper, while GVB supervised the research and revised the paper. Both authors approved the final version for publication and take full accountability for all aspects of the work.

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Data availability statement

Data will be available upon request to the authors. We disclose the interview transcript and audio records from public access to protect personal privacy of respondents.

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