



ADDIS ABABA UNIVERSITY

COLLEGE OF DEVELOPMENT STUDIES, DEPARTMENT OF ENVIRONMENT
AND SUSTAINABLE DEVELOPMENT

URBAN VEGETABLE FARMERS' AWARENESS ON THE HEALTH IMPACTS OF
THE UTILIZATION OF RIVER WATER FOR VEGETABLE PRODUCTION AND
ENVIRONMENTAL PROTECTION PRACTICES IN NEFAS SILK LAFTO SUB-
CITY, ADDIS ABABA

By: SOLOMON ABEBAW MEKONNEN

October, 2024

Addis Ababa, Ethiopia

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This is to certify that this thesis is prepared by Solomon Abebaw Mekonnen, entitled: **Urban vegetable farmers’ awareness on the health impacts of the utilization of river water for vegetable production and environmental protection practices in Nefas Silk Lafto sub-city, Addis Ababa**. Submitted to center for environment and Sustainable Development in partial fulfillment of the requirements for the degree of master of arts in Environment and Sustainable Development complies with the regulations of the university and meets the accepted Standards with respect to originality and quality.

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STATEMENT OF DECLARATION

I, Solomon Abebaw, do hereby declare that the thesis entitled “**Urban vegetable farmers’ awareness on the health impacts of the utilization of river water for vegetable production and environmental protection practices in Nefas Silk Lafto sub-city, Addis Ababa**” submitted in partial fulfillment of the requirements for the award of the degree of Master of Arts in Environment and Sustainable Development to College of Development studies, Addis Ababa University in the Department of Environment and Sustainable Development, is my original work and that it has not been submitted partially or fully by any other person for an award of a degree in any other college or university. Where assistance was pursued, it has been accordingly acknowledged.

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DEDICATION

*I dedicate this thesis for my late Mother **W/ro Sefinesh Gelaw** who had great intension to see my academic achievements since my childhood. I am deeply saddened because she was not able to see all this. “Enate” you were my everything, I will engrave your love and your advice. With all my heart I dedicate this research for you.*

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Solomon Abebaw Mekonnen

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Abbreviations

AACA	Addis Ababa City Administration
ESS	Ethiopian Statistics Service
FAL	Farm-Africa-Limited
FDRE	Federal Democratic Republic of Ethiopia
GDP	Gross Domestic Product
GHG	Green House Gas
NGS	National Geographic Society
UA	Urban Agriculture
UN DESA	United Nations Department of Economic and Social Affairs
UN-HABITAT	United Nations Human Settlement Programme
USDA	U.S Department of Agriculture
WHO	World Health Organization

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Abstract

The exponential growth of urban population size worldwide created a demand for sustainable solutions to address urban challenges such as food security, environmental pollution, and resource management. Urban river pollution poses significant health risks to vegetable farming. The contamination of rivers with pollutants from various sources negatively affects the quality and safety of vegetables leading to potential health hazards for both farmers and consumers. This particular study investigates the awareness level of urban vegetable farmers in Nefas Silk Lafto sub-city, Addis Ababa, regarding the health impacts of using polluted river water for irrigation and their implementation of environmental protection strategies. The study employed a survey research design. For data collection, structured questionnaires, interviews and field observations were used. In addition, secondary data sources such as books, articles, and legal documents were also reviewed. The data was analyzed using descriptive statistics. The study found critical gaps in urban vegetable farmers' awareness and mitigation of health risks from polluted river water irrigation. While 62% acknowledged the water was polluted, only 13.1% knew the specific risks. Most farmers (86.9%) had not noticed negative impacts on production, and none were employing risk mitigation measures, due to lack of access to alternative water and financial constraints. Though 77.4% knew of relevant regulations, only 60.6% believed there were sufficient government policies to address urban river pollution impacts. Paradoxically, the farmers expressed belief in existing policy guidelines, yet failed to implement sustainable environmental protection strategies. The researcher observed the river was highly polluted, but farmers continued to use it without treatment. The study found a significant knowledge gap among urban vegetable farmers regarding the health risks of using polluted water for irrigation, with the majority lacking awareness of these potential hazards. Farmers did not implement any mitigation measures, despite most not observing negative impacts on crop quality or yields. While many farmers were aware of environmental regulations, they did not effectively adopt sustainable practices due to barriers like limited access to alternative water sources and financial constraints. The recommendations call for improving farmer training and awareness, facilitating stakeholder collaboration, and providing support to enable the adoption of environmentally-friendly irrigation and water management approaches.

Keywords: *farmer's awareness, river pollution, mitigation strategies, environmental protection*

CHAPTER ONE: INTRODUCTION

1.1. Background of the study

Globally the urban population has shown an exponential increment since the 1950's from an estimated total urban population of 751 million, raised to 4.2 billion in 2018. In 2022, the total urban population of the developed region of the world counted more than 1 billion and 4.4 billion in the developing countries (UNCTAD, 2023). According to the United Nations Department of Economic and Social Affairs (UN DESA), 55% of the world's population lives in urban areas, this percentage share is estimated to increase by 68% in the year 2050. This prediction also indicates that urban centers will be the most preferable place of residence for 2.5 billion people by 2050 and close to 90% of this increase will take place in Asia and Africa (UNDESA, 2019).

Migration from rural to urban areas also contributed to aggravating concerns for population growth in urban areas. As a result of this, urbanization is becoming a global concern that causes greater pressure on resources, impoverishment, food insecurity, and environmental pollution that induces versatile problems for its residents. Even in such uncertainty, people continue to move from rural areas into urban centers looking for better socio-economic opportunities and better living conditions. Indeed, in most developed nations technological advancement has decreased the need for a manual agricultural labor force partly because cities are seen as offering greater economic opportunities (NGS, 2024).

As urbanization is growing around the world, the greatest challenge for countries is becoming addressing the needs of the urban dwellers which includes housing, transportation, and food supply. To fulfill the needs of the urban residents, countries are adopting policies to overcome pertinent contemporary issues. In addition, urban areas mainly in the developing world are also causing irreversible land-use challenges, climate change, loss of biodiversity, and high levels of pollution [water, air, soil, and the like] (UN-HABITAT, 2020).

More recently, urban agriculture (hereafter UA) has been assumed to hold environmental and economic sustainability in a way that brings low impacts but with numerous benefits both for the urban centers and their residents. Specifically, UA often provides resource-efficient forms of

sustainable agriculture within cities and towns that benefit to mitigate climate change-induced problems, food insecurity, food distribution chain, and reusing urban waste by creating integrated reuse of waste heat and rainwater runoff, among others (Dorr et al., 2021). This in turn improves nutrition for urban dwellers and the income of the stakeholders in UA (FAL, 2024).

UA encompasses the production, processing, and distribution of horticulture, animal products, and aquaculture in urban and peri-urban settings (FAL, 2024) UA often involves diversified food products including vegetables and animal products for the urban dwellers. Indeed, serving as one of the solutions to serve some of the challenges of urban areas. UA is not limited to the production of vegetables; it also includes the production of livestock, apiculture, aquaponics, the production of non-food products such as seeds, and growing flowers. UA promotes food security mainly by providing a fresh food supply for the urban poor and other urban dwellers, helping maintain the urban ecosystems, and opening employment opportunities. By its nature, urban agriculture is highly influenced by policies related to urban planning and uses urban residents as the source of labor.

UA covers a variety of production systems that can be located either inside or on the outskirts of cities. There are all kinds of these systems from small-scale production and processing for household consumption to full commercialization. UA can also be intra-urban or take place on the periphery of cities (peri-urban). These activities can be conducted on the residential land itself (on-site) or outside, on other pieces of real estate off-site. It can be either privately owned or leased land or publicly available public lands like parks and conservation areas; roadsides, streams or railway corridors. UA can be held on public property such as schoolyards or hospital grounds. This characteristic of urban agriculture is usually its proximity to consumers and markets, affording direct distribution. At the same time, closer proximity to land resources creates high-pressure competition for space within cities. Therefore, urban agriculture is frequently constricted for space. However, UA also has the advantage of using urban organic solid wastes and wastewater as feedstocks. This encourages sustainable methods to deal with organics in our waste heaps while recycling resources (Mekuria & Messay, 2018).

This particular research was intended to assess the level of awareness of vegetable farmers regarding the health impacts of vegetable production using water from polluted rivers within

Nefas Silk Lafto Sub-City in Addis Ababa. This research was envisaged to provide an informative conceptual framework on the understanding and practice of local UA stakeholders in relation to pertinent environmental protection concerns.

1.2. Statement of the problem

Statement of the problem

Addis Ababa, the capital city of Ethiopia since 1886, has been a political, economic, and cultural hub. However, like other cities in the developing world, it faces challenges such as food security, rapid population growth, youth unemployment, environmental degradation, pollution, and climate variability. Urban sprawl and associated environmental pollution are significant problems, exacerbating poverty among vulnerable residents. With a population of over four million, 22% are poor, and 23.5% are unemployed (FAL, 2024).

Urban and peri-urban agriculture (UA) in Addis Ababa includes vegetable and animal production, providing essential food supplies to urban residents. However, the growing demand for agricultural products, driven by population growth, increases pressure on low-income households, particularly female-headed households, worsening food and nutritional security. Nearly 79.9% of Addis Ababa's population faces food insecurity due to inflated food prices, supply-demand imbalances, and land-use changes (Birhane et al., 2014).

Urban river pollution poses significant health risks to vegetable farming in Addis Ababa. Pollutants from various sources contaminate rivers, affecting vegetable quality and safety, and posing health hazards for farmers and consumers. The lack of awareness and effective mitigation strategies hinders sustainable agriculture practices and community health protection (Agegnehu et al., 2019).

Recent studies highlight the urgent need to address urban river pollution and its impact on vegetable farming. According to Woldetsadik et al. (2018), the rivers in Addis Ababa face contamination from various sources such as industrial effluents, solid waste disposal, and agricultural runoff, resulting in high levels of heavy metals, pathogens, and chemical pollutants.

These pollutants can accumulate in vegetables, leading to adverse health effects when consumed by humans.

Urban river pollution affects the health of farmers and consumers, undermines the long-term viability of vegetable farming, disrupts ecological balance, degrades soil quality, and compromises sustainable agriculture practices (Woldetsadik et al., 2018).

Heavy metals, pathogens, pesticides, herbicides, organic pollutants, and nutrient runoff in polluted rivers pose significant health risks. Heavy metals like lead, mercury, cadmium, and arsenic accumulate in vegetables, leading to neurological disorders, kidney damage, cardiovascular diseases, and cancers (Toxicological Profile for Lead, 2020). Pathogens from sewage and organic waste cause gastrointestinal illnesses (Havelaar et al., 2012; Kesari et al., 2021; Woldetsadik et al., 2018; Toxicological Profile for Lead, 2020). Pesticides and herbicides contribute to chemical contamination in rivers, leading to hormonal disruptions, developmental issues, and cancers. Organic pollutants from industrial chemicals, petroleum products, and pharmaceuticals cause endocrine disruption, reproductive issues, and developmental disorders (Baweja et al., 2020). Nutrient runoff causes eutrophication, resulting in algal blooms, oxygen depletion, and harmful toxins, posing gastrointestinal and liver damage risks (Yang & Toor, 2018).

Health implications vary with concentration and duration of exposure to pollutants. Consuming vegetables grown in polluted urban river areas increases health risks. Mitigation strategies like proper wastewater treatment, improved agricultural practices, and regular irrigation water testing are crucial to minimize health risks and ensure food supply safety (Gashaye et al., 2020).

In developing African nations like Ethiopia, rapid urbanization, industrial activities, inadequate waste management, and limited pollution control resources exacerbate river pollution. Issues such as improper land use, lack of training, insufficient support, excessive use of fertilizers and pesticides, improper solid waste management, deforestation, and soil erosion contribute to river pollution (Berhanu & Akola, 2014; Adegoke et al., 2018; Ferronato & Torretta, 2019; Zahoor & Mushtaq, 2023). These pollutants cause health risks when used for irrigation, including microplastics accumulation, waterborne diseases, skin infections, gastrointestinal ailments, and reduced crop yields.

Limited awareness among farmers about polluted irrigation water risks and inadequate resources for water treatment worsen the problem. Despite the challenges, comprehensive mitigation strategies are lacking. Current efforts focus on household-level water treatment, failing to address the root causes of pollution and the need for collective action (Woldetsadik et al., 2018).

Therefore, there is an urgent need to investigate the awareness of urban farmers over the use of polluted rivers for vegetable production and its impact on health and environmental protection practices and identify effective mitigation strategies within Nefas Silk Lafto sub-city. By filling this knowledge gap and proposing feasible and sustainable solutions, this study aimed to promote community health, sustainable environmental protection, sustainable agriculture practices, and informed decision-making among UA stakeholders.

This research aimed to assess the awareness of urban farmers regarding the health risks of utilization of polluted river water for irrigation and environmental protection strategies in Nefas Silk Lafto sub-city, Addis Ababa. By investigating the current level of awareness and environmental protection practices among vegetable farmers and identifying effective mitigation strategies in action, this study seeks to promote environmental protection practices, community health, sustainable agriculture practices, and informed decision-making amongst stakeholders.

Ultimately, the outcomes of this research can contribute to the development of policies and plans that prioritize awareness of urban farmers regarding the health impacts of utilizing polluted rivers and environmental protection practices, sustainable agriculture, and the well-being of the community.

1.3. Objective of the study

General objective

The general objective of this study was to assess the awareness among urban vegetable farmers over the utilization of polluted rivers for irrigation and identify their implementation of environmental protection strategies in the city of Addis Ababa, particularly in Nefas Silk Lafto sub-city.

Specifically, the research project sought to attain the following specific objectives:

1. Assess the awareness of vegetable farmers in Nefas Silk Lafto sub-city regarding the health impacts of vegetable production using water from polluted rivers.
2. Explore the existing mitigation strategies employed by vegetable farmers to minimize the health risks associated with urban river pollution.
3. Explore vegetable producers' strategies for environmental protection.

1.4. Research questions

1. What is the awareness of vegetable farmers in Nefas Silk Lafto sub-city regarding the potential health risks associated with using water from a polluted river for vegetable production?
2. What measures do vegetable farmers currently employ to minimize the health risks associated with utilizing water from a polluted river for vegetable production?
3. What are the key strategies employed by vegetable farmers in Nefas Silk Lafto sub-city to protect the environment?

1.5. Significance of the study

From a methodological perspective, this study on urban river pollution and its impact on urban agriculture in Addis Ababa is significant as it addresses a pressing global issue of river pollution, which is exacerbated by rapid urban expansion and industrialization. The study also aims to evaluate the ground level of awareness among urban vegetable farmers regarding the use of polluted river water for irrigation. By identifying the sources and contributors to urban river pollution, the study can propose targeted mitigation strategies to promote sustainable agriculture practices and safeguard the health of farmers, consumers, and the environment. The findings of this study can provide valuable recommendations for policymakers and local actors to develop effective policies and tailor-made intervention plans to address urban river pollution, guiding regulatory measures and resource allocation to protect the health of communities and promote sustainable urban development.

1.6. Scope of the study

The scope of the study was delimited within Addis Ababa city particularly within Nefas Silk Lafto sub-city with a special focus on urban vegetable farmers' awareness of the health impacts of utilizing polluted rivers and their implementation of environmental protection strategies. Hence, the intention of the study was to assess the level of awareness of urban vegetable farmers regarding the health impacts of irrigating polluted river water for vegetable production and environmental protection practices in the study area, the target population were the urban farmers.

1.7. Limitations of the study

Urban farming along riversides in Addis Ababa is widely practiced in many parts of the city. This particular research solely focused on Nefas Silk Lafto Sub City among ten other sub-cities and the Akaki River. This makes the researcher reflect on the area-limited issue of river pollution, awareness among urban vegetable farmers, and mitigation strategies to promote sustainable agriculture and environmental practices.

During the research undertakings, the researcher was challenged by getting genuine responses from urban farmers because of their fear of being spayed or inspected by local authorities, some of them also showed their concern about being a target uprooted from their farmland if the sources of irrigation were found to be highly polluted. In addition to this, time and financial constraints were the biggest challenges in which the researcher was not able to address more areas in Addis Ababa as a study focus.

1.8. Organization of the study

This study is structured in five chapters. Chapter one deals with introduction, which incorporates background, statement of the problem, research objectives, research questions, significance, scope and limitation of the study. Chapter two focuses on review of related literature which covers, literature related to urban farming and empirical reviews and conceptual framework. The third chapter describes the research methods i.e., description of the study area, research design, data sources, data collection techniques and sampling methods, data analysis methods and ethical considerations. Chapter four deals with results and discussion of the collected data. The last

chapter, chapter five emphasizes on conclusion and recommendation bases from the findings of the study.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction to urban agriculture

Urban agriculture is progressively vital in urban food systems, especially in developing cities. It includes growing, processing, and distributing food within urban areas, offering numerous socio-economic and environmental benefits (Mougeot, 2018). As cities expand, integrating agriculture into urban planning enhances food security, urban resilience, and sustainable urban development (FAO, 2017).

A key benefit of urban agriculture is its contribution to food security. Urban populations in developing countries often struggle with food access and affordability. Urban farming helps address these challenges by providing locally grown, fresh produce at lower costs, thus improving urban residents' nutritional status (Zezza & Tasciotti, 2010). Additionally, it reduces reliance on imported food items, which can be prone to price volatility and supply chain issues.

Urban agriculture also offers significant economic benefits by creating job opportunity, especially for marginalized groups like women, youth, and the urban poor, enhancing their livelihoods (Hovorka, 2006). Small-scale urban farmers can capitalize on the rising demand for organic and locally produced foods, which fetch higher prices in urban markets.

Environmentally, urban agriculture improves urban areas by enhancing biodiversity, mitigating the urban heat island effect, and improving air quality. It also supports sustainable waste management through composting organic waste and reducing the city's waste burden (Dubbeling et al., 2011).

Despite its benefits, urban agriculture faces challenges, particularly the use of non-conventional water sources for irrigation. Many urban farmers use river water, often contaminated with pollutants from industrial discharges, sewages, and runoffs (Angelakis et al., 2018). This poses health risks, as pathogens, heavy metals, and chemicals can accumulate in crops, causing foodborne illnesses and long-term health issues on both the producers and consumers (Woldetsadik et al., 2018).

Addis Ababa, Ethiopia, exemplifies these challenges. The city has a rapid population growth and the urbanization make food security and pollution management difficult. Urban farmers often use the polluted rivers (like Kebena and Akaki River for irrigation); raising concerns about the health impacts of producing and consuming such crops (Alemu et al., 2024).

Understanding urban farmers' awareness and perceptions of the health risks using contaminated water is crucial for crafting effective interventions both on the production and supply channels. Farmers' knowledge, attitudes, and practices often influence their decision-making and adoption of safer farming methods (Serbessa et al., 2023). In addition, examining urban farmers environmental protection practices can reveal contextual challenges and opportunities for promoting sustainable urban agriculture in Addis Ababa city.

2.2. Review of empirical studies

2.2.1. Utilization of river water in urban farming

The utilization of river water for irrigation in urban farming is a pervasive practice driven by its accessibility, cost-effectiveness, and the imperative to meet urban food demands. In cities like Addis Ababa, where rapid urbanization outpaces infrastructure development, river water serves as a vital resource for sustaining agricultural production close to urban centers (Farm Africa, 2023).

Sources and availability of river water

Urban agriculture heavily relies on nearby rivers and streams as primary sources of irrigation water. In Addis Ababa, the Akaki River plays a critical role, supplying water to a substantial portion of the city's vegetable cultivation areas. This reliance on river water is due to limited access to alternative sources such as treated municipal water, which may be either unavailable or prohibitively expensive for small-scale urban farmers (Farm Africa, 2023).

Quality of river water

Despite its accessibility, river water used in urban farming is often compromised by various pollutants. Urban runoff, industrial discharge, and inadequate waste management systems contribute to contaminating river water with heavy metals, pathogens, and organic pollutants

(Ketema et al., 2023). Studies in Addis Ababa have documented elevated levels of pollutants such as fecal coliforms, nitrates, and heavy metals in river water used for irrigation, posing significant risks to both crop production and public health (Mekuria et al., 2021).

Implications for urban farming practices

The availability and quality of river water significantly influence the irrigation practices adopted by urban farmers. Surface irrigation methods, such as furrow and flood irrigation, are commonly employed due to their simplicity and low-cost nature, making them suitable for utilizing untreated river water (Farm Africa, 2023). However, these methods also contribute to water loss through evaporation and runoff, exacerbating water scarcity issues in urban environments.

In recent years, there has been a growing awareness of the need for more sustainable irrigation practices that reduce water consumption and minimize environmental impacts. Techniques such as drip irrigation and sprinkler systems, which apply water directly to the root zone of plants, have gained traction for their efficiency in water use and ability to reduce contamination risks associated with surface water (Angelakis et al., 2018). Despite their benefits, the adoption of these technologies in urban farming is often hindered by high initial costs and technical expertise requirements, limiting their widespread implementation among smallholder farmers.

Challenges and mitigation strategies

The use of river water in urban farming presents challenges that must be addressed for sustainable practices and public health. Pollution and health risks from contaminated water, which often contains pathogens and heavy metals, can lead to diseases and long-term health impacts. Additionally, urbanization increases water demand, exacerbating scarcity and competition for this vital resource. Efficient water management is crucial to ensure urban agriculture thrives without compromising other urban water needs (Woldetsadik et al., 2018).

Moreover, weak regulatory frameworks and inadequate enforcement of water quality regulations exacerbate these issues. Many urban areas lack robust monitoring systems to ensure water quality, leading to ongoing pollution of urban water sources. The lack of strict enforcement of existing regulations allows industrial discharge, sewage, and urban runoff to contaminate rivers, further compromising the safety and sustainability of using river water for urban farming

(Mekuria et al., 2021). Addressing these regulatory and enforcement gaps is essential to protect public health and promote sustainable urban agricultural practices. To mitigate these challenges, there is a growing need for integrated water management approaches that combine water treatment technologies, sustainable irrigation practices, and community engagement. Policies aimed at promoting safe water use in agriculture, coupled with investments in water infrastructure and farmer education, are essential for enhancing the resilience of urban farming systems.

2.2.2. Health impacts of using contaminated river water

Using contaminated river water for irrigation in urban agriculture poses significant health risks to both farmers and consumers. This section explores the various health impacts associated with the utilization of polluted river water and provides insights into recent studies conducted in similar contexts.

Pathogen transmission

Pathogens in contaminated river water pose serious health risks when used to irrigate vegetables. Studies have found pathogenic bacteria, viruses, and parasites in urban rivers. Research in Addis Ababa, for example, identified fecal coliforms and *E. coli* in the Akaki River, indicating crop contamination (Mekuria et al., 2021). Pathogens can adhere to vegetable surfaces during irrigation, particularly on leafy greens, and survive until consumed by humans, causing gastrointestinal illnesses such as diarrhea, typhoid, and cholera (Awoke et al., 2016).

Chemical contaminants

In addition to pathogens, contaminated river water may contain chemical pollutants that can accumulate in vegetables and pose long-term health risks. Heavy metals such as lead, cadmium, and mercury are frequently found in urban water bodies due to industrial discharges and runoff from urban areas. These metals can enter the food chain through irrigation water and bioaccumulate in vegetables over time (Woldetsadik et al., 2018).

Exposure to heavy metals through contaminated vegetables has been associated with serious health consequences, including neurological disorders, kidney damage, and increased cancer

risks (Ketema et al., 2023). Studies have shown elevated levels of heavy metals in vegetables grown with wastewater irrigation compared to those irrigated with clean water, underscoring the direct link between irrigation water quality and food safety (Mekuria et al., 2021).

Health studies and evidence

Recent health studies show that using contaminated river water for irrigation leads to significant health impacts. For instance, an Ethiopian study found higher gastrointestinal illness rates among those consuming vegetables grown with contaminated water (Mekuria et al., 2021). Similar outbreaks of waterborne diseases have been reported globally (Awoke et al., 2016). Beyond immediate illnesses, chronic exposure to chemical contaminants in vegetables can cause long-term health effects, particularly in vulnerable populations like children and pregnant women (Woldetsadik et al., 2018). Efforts to mitigate these risks must address both immediate and long-term health impacts.

Mitigation strategies

Addressing the health impacts of using contaminated river water in urban agriculture requires integrated strategies that encompass water quality management, agricultural practices, and public health interventions. Regular monitoring of water quality is essential to identify contamination sources and mitigate risks. Promoting safe irrigation methods like drip and soil-based irrigation reduces direct pathogen contact with crops. Educating farmers and consumers about these risks and safe food handling practices is crucial. Strengthening regulatory frameworks to enforce water quality standards and promoting sustainable agricultural practices can also contribute to safer urban farming environments (FAO, 2017).

2.2.3. Farmers' awareness and perception

Awareness and perception of health risks among urban vegetable farmers regarding the use of contaminated river water for irrigation are critical factors influencing their practices and decision-making processes. Understanding these factors is essential for developing effective interventions to mitigate health risks and promote sustainable farming practices in urban settings like Nefas Silk Lafto sub-city, Addis Ababa.

Knowledge levels and sources of information

Research indicates that urban farmers often lack knowledge about the specific health risks of using contaminated river water for irrigation. In Addis Ababa, while farmers are aware of general water pollution issues, their understanding of specific contaminants and health implications is often inadequate (Amsalu, 2020). This can lead to suboptimal practices and increased risk of exposing consumers to contaminated produce. Farmers primarily rely on informal sources like fellow farmers, local markets, and personal experience, which may not provide accurate information on water quality and health risks (USDA, 2024). Formal sources, such as government agencies or agricultural extension services, are underutilized due to limited outreach or accessibility issues (Amsalu, 2020). Strengthening the dissemination of accurate information through these formal channels could significantly improve farmers' awareness and decision-making regarding water use in agriculture.

Attitudes and beliefs

Farmers' reliance on contaminated river water for irrigation is driven by several factors, primarily economic constraints and the lack of alternative water sources. In regions where access to clean water is limited, especially in urban areas, the necessity of economic survival often outweighs concerns about health risks. Despite the known dangers associated with using polluted water, the affordability and ease of access make it a viable option for many farmers, particularly in developing regions where untreated wastewater and polluted water sources are commonly used for irrigation (Malakar et al., 2019).

Moreover, cultural and social norms influence farmers' perceptions of risk and their willingness to adopt safer practices. In many cases, traditional farming practices passed down through generations may not account for modern health and environmental concerns (Jiménez et al., 2008). Farmers who have been using river water for generations may perceive it as a reliable and acceptable practice, reinforcing its continued use even in the face of emerging health risks.

Challenges and barriers to behavior change

Farmers face significant barriers in adopting safer irrigation practices, primarily due to financial limitations. These economic constraints often prevent them from investing in alternative water sources or water treatment technologies that could reduce health risks. The lack of access to adequate resources, such as improved seeds, fertilizers, and water-saving technologies, further exacerbates the challenge, making it difficult for farmers to transition to safer and more sustainable irrigation methods (Gebremedhin et al., 2023).

The rapid urbanization and land use changes in cities like Addis Ababa have significantly contributed to environmental degradation and water pollution. These challenges make it increasingly difficult for urban farmers to access clean water sources for irrigation. Moreover, the regulatory frameworks in place are often inadequate or poorly enforced, failing to provide the necessary incentives or penalties that would encourage compliance with safer and more sustainable farming practices (Gebremedhin et al., 2023).

The role of education and community engagement

Addressing farmers' awareness and perception requires targeted educational interventions and community engagement strategies. Education programs should focus on increasing farmers' knowledge of water quality issues, the specific contaminants found in urban rivers, and their health implications. These programs should be accessible, culturally sensitive, and tailored to the needs of urban farmers, emphasizing practical solutions and alternative farming techniques that reduce reliance on contaminated water sources (Assefa, 2016).

Community engagement plays a crucial role in promoting behavior change among farmers. By fostering peer-to-peer learning networks and partnerships with local organizations, farmers can access the support, information, and resources needed to adopt sustainable farming practices (FAO, 2017). Engaging community leaders and local stakeholders in advocacy efforts can also raise awareness about the importance of water quality and environmental protection in urban agriculture.

2.2.4. Environmental protection practices in urban farming

Effective environmental protection practices are critical for sustainable urban agriculture, especially in mitigating the impacts of using contaminated river water for irrigation. In Addis Ababa, urban farmers have adopted various strategies to enhance environmental sustainability and reduce health risks. These include composting to improve soil fertility and recycle organic waste (Gebremedhin et al., 2023), crop rotation to maintain soil health and reduce pest pressure, and integrated pest management (IPM) techniques to minimize pesticide use and control pests effectively. Water conservation methods, such as mulching and drip irrigation, are also employed to address water scarcity by reducing evaporation and minimizing wastage. Additionally, the use of organic inputs like compost, bio-fertilizers, and organic pesticides helps improve soil fertility and reduce environmental pollution (Amsalu, 2020).

Challenges and barriers

Despite efforts to improve environmental protection in urban farming, farmers in Addis Ababa face significant challenges. A major issue is limited access to clean water, with reliance on contaminated river water compromising crop quality and posing health risks (Serbessa et al., 2023). Financial constraints also hinder the adoption of sustainable practices, as many small-scale farmers cannot afford the necessary infrastructure and technology (FAO, 2017). Additionally, there is a critical need for capacity building and technical support. Many farmers lack access to training programs on composting, integrated pest management (IPM), and water management, which are essential for implementing effective sustainable practices (Amsalu, 2020).

Policy and regulation

Effective policies and regulations are crucial for supporting sustainable urban agriculture. Strengthening enforcement of environmental standards, such as water quality and agricultural input regulations, is essential to reduce pollution and protect public health (FAO, 2017). Governments should also offer incentives and subsidies to encourage farmers to adopt sustainable practices, such as financial support for equipment, clean water sources, and marketing organic produce (Amsalu., 2020). Increasing investment in research and innovation is essential for advancing technologies and practices tailored to urban agriculture in Addis Ababa.

This should encompass studies on drought-tolerant crop varieties, efficient urban waste management for agricultural use, and the development of advanced irrigation techniques. Such efforts would enhance productivity while mitigating the environmental challenges associated with urban farming (Serbessa et al., 2023).

2.2.5. Environmental policies related to river pollution and protection of riverside areas

Addis Ababa has implemented several policies and regulations aimed at addressing river pollution and protecting riverside areas, especially in the context of urban agriculture. This policy review will focus on the national and local frameworks that govern environmental protection in Addis Ababa.

National environmental policy

The Federal Democratic Republic of Ethiopia (FDRE) established its Environmental Policy in 1995, with the primary goal of the policy intended to promote sustainable social and economic development through the sound management and use of natural resources. The policy emphasizes the protection of water resources from pollution and degradation, which is crucial for maintaining the health of urban rivers (FDRE, 1995).

Environmental impact assessment proclamation

The Environmental Impact Assessment (EIA) Proclamation No. 299/2002 requires that any project likely to have a significant impact on the environment must undergo an environmental impact assessment. This includes urban agricultural projects that use river water for irrigation. The EIA process ensures that potential environmental impacts are identified and mitigated before project implementation (FDRE, 2002).

Challenges and implementation gaps

Despite the presence of these policies and regulations, there are significant challenges in their implementation some key challenges and implementation gaps were noted. There is often a lack of financial and technical resources to enforce environmental regulations effectively. This results in insufficient monitoring and control of pollution sources. In addition to the gap in fully

applying the basic policies protecting the environment, there is a need for other policies such as urban agriculture policy in the city of Addis Ababa as well as in Ethiopia at large.

2.3. Conceptual Framework

Based on the literature review, a conceptual framework was proposed to guide the investigation of environmental protection and mitigation strategies for urban river pollution in Nefas Silk Lafto sub-city (see Figure 1).

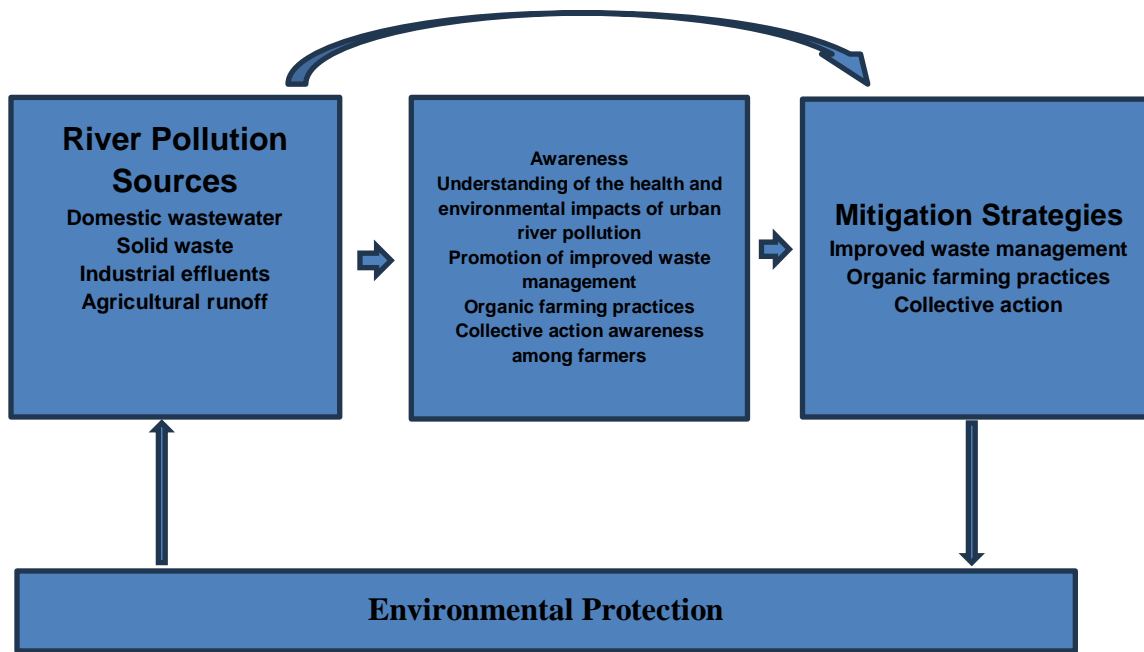


Figure 1: Conceptual framework

The above conceptual framework illustrates the interplay between environmental protection practices, river water pollution sources, and mitigation strategies. As we can see from the diagram river pollution can be induced by different sources of pollutants like domestic wastewater, solid waste, industrial effluents, and agricultural runoffs.

Contextual awareness and initiative about contamination and contaminant sources including the health impact of using polluted water on producers and the final consumer can create foundational footage to promote and understand the health impacts of urban river pollution. Farmers who are aware of the potential risks are more likely to adopt and even craft a mitigation strategy.

The mitigation strategies, such as improved waste management, organic farming practices, and the establishment of collective action, aim to protect the environment and minimize health risks. The whole interrelated scenario will bring holistic environmental protection. Mitigation strategies, like policy initiatives and guidelines, will have an impact on changing and crafting the interventions for river water pollution and their usage including irrigation. Holistically the practice will bring a protected sustainable environment, a healthy community (both the producers and end customers), and pro-environment urban agriculture practice.

UNIT THREE: DESCRIPTION OF THE STUDY AREA AND RESEARCH METHODOLOGY

3.1. Introduction

In this section, the research identifies the procedures and techniques that were used in the collection, processing and analysis of data. Specifically, the following subsections were included; research design, research approach, data source, and data collection instruments, method of data analysis and finally validity and reliability.

3.2. Description of the study area

As estimated by the Ethiopian Statistics Service (ESS) in 2024, Addis Ababa hosts more than 3.9 million people, accounting for 17% of Ethiopia's total urban population (ESS, 2024). The city is one of the fastest-growing in Africa, with a 3.8% annual population growth rate, and according to UN-HABITAT approximations, this number is projected to reach 12 million by 2024. Addis Ababa's strategic geographic location, combined with its political and socio-economic significance, has made it a melting pot for hundreds of thousands of people from all corners of the country seeking job opportunities and services (UN-Habitat, 2020). The city encompasses eleven sub-cities and 118 woredas, covering a total area of about 540 km². Its economy is expanding at an annual rate of 14%, and Addis Ababa alone contributes approximately 50% of Ethiopia's national GDP, underlining its vital role in the country's overall economic development (World Bank Group, 2015). Additionally, Addis Ababa serves as the diplomatic capital of Africa, housing more than 92 embassies and consular representatives, as well as the headquarters of the Organization of African Unity and the UN Economic Commission for Africa.

Nefas Silk Lafto, a sub-city in the southwestern part of Addis Ababa, is bordered by Kolfe Keranio, Lideta, Kirkos, Bole, and Akaki Kaliti. It sits at an elevation between 2,239 and 2,318 meters, blending urban and peri-urban environments with residential, commercial, and industrial areas. The climate is typical of Ethiopia's highlands, featuring moderate temperatures and seasonal rainfall. The area is diverse, with markets, small businesses, and manufacturing units, and it houses residents from various socioeconomic backgrounds, including both middle-income and lower-income households. According to the ESS projection in 2023, Nefas Silk Lafto had a

population of approximately 455,500, composed of various ethnic groups and communities, contributing to the sub-city's rich cultural diversity and dynamic community life (ESS, 2023).

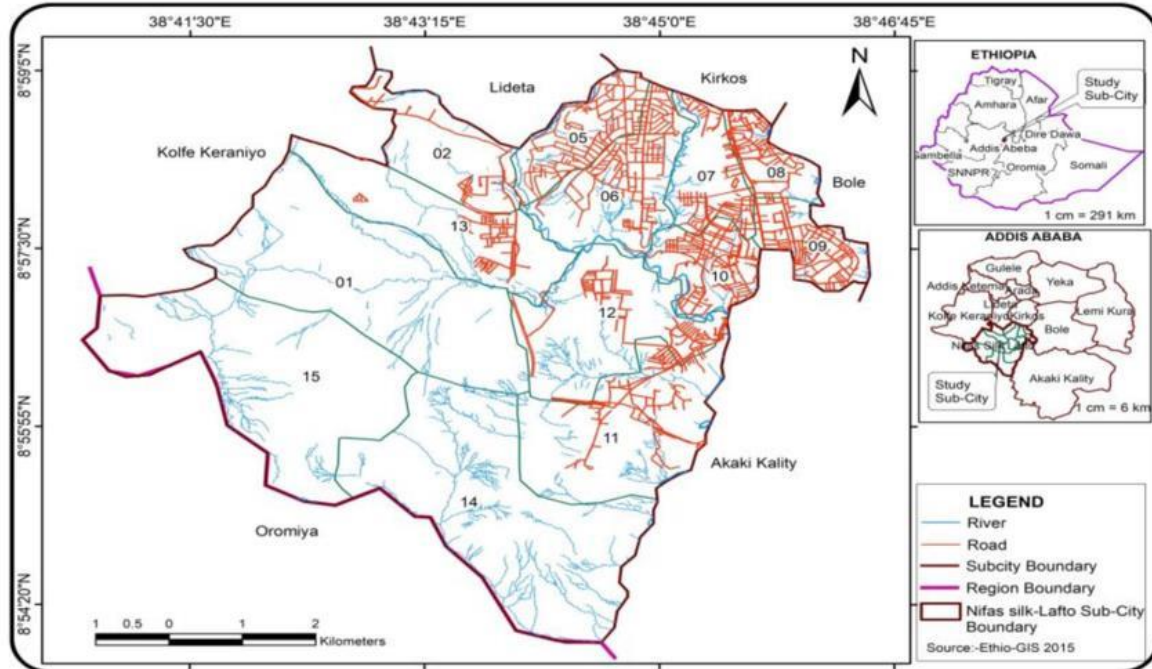


Figure 3.1. Map of Nifas Silk Lafto sub-city, Addis Ababa, Ethiopia (Adapted from Addis Ababa City Administration [ACA], 2020; Habtamu et al., 2023).

3.3. The Research Design

3.3.1. Research method

This study was a quantitative study and employed survey research design. As per Harrison et al., (2020) survey research designs are beneficial to collect quantitative data using questionnaires or interviews and statistically analyze the data to describe trends about responses to questions and to test research questions. Likewise, this study aimed at assessing the awareness of vegetable farmers concerning the health impacts of utilizing polluted rivers for vegetable production in the study area and to identify effective mitigation strategies of urban farmers to address the challenges posed by urban river pollution in Addis Ababa's Nefas Silk Lafto sub-city and its Woredas. The study further identified the environmental protection strategies implemented by urban vegetable farmers.

Along with the quantitative data, the findings were also supported by qualitative data to confirm the realities mentioned in the survey. Interviews were conducted with key stakeholders such as government officials and leaders of urban farming associations within the study area. Additionally, the researcher used field observations to verify the accuracy of the primary data.

3.3.2. Data collection instruments

Under this study, mainly primary data were used. Structured questionnaires, interviews and field observations were used to collect data. The main source of data for this study was structured questionnaire with demographic questions, and yes or no questions. The survey was held by using structured questionnaires to collect data on farmers' awareness and practices related to the health impacts of the utilization of polluted river water for vegetable farming. The questionnaire had both close and open-ended questions. The surveys were administered to the sampled vegetable farmers either through questionnaires or face-to-interviews depending on the contextual circumstances (such as the literacy of the participants). The questionnaires were translated to a local language which is Amharic.

The interviews employed key informants from governmental institutions, and relevant stakeholders involved in the environmental protection and agriculture sector in Nefas Silk Lafto sub-city. An interview guide was used and it covers topics such as sources of urban river pollution, health impacts experienced by farmers, current mitigation strategies, and suggestions for improvement.

Field observations were used in specific urban river areas in Nefas Silk Lafto sub-city where vegetable farming takes place. These areas represent different levels of pollution and farming practices. The field visits conducted within the selected sites and the environmental conditions, farming techniques, and pollution levels were documented.

In addition, secondary data sources such as books, articles, and legal documents including proclamations, regulations and guidelines from different sources were reviewed in order to understand the standards.

3.4. Sampling

Research participants' list obtained from Nefas Silk Lafto sub-city Farmers and Urban Agriculture Development office. The sample size was determined as an appropriate sample size that represents the population of vegetable farmers in the sub-city. Random sampling techniques were used to select a representative sample of vegetable farmers from the sampling frame. This ensures that the findings can be generalized to the larger population.

In identifying the sample size for this research, the researcher set the target group which was the urban vegetable farmers within Nefas Silk Lafto sub-city. According to Nefas Silk Lafto sub-city Farmers and Urban Agriculture Development office currently, there are 241 urban vegetable farmers working in two unions across 7 Woredas (local administrative unit).

Sample size determination

The sampling frame included study sites and sample respondents. The target population for this study was all urban vegetable farmers and Nefas Silk Lafto sub-city Farmers and Urban Agriculture Development office coordinators and officers. The sample size was determined from the total study population engaged in urban agriculture by using Yamane's (1967) formula.

Where **n** is the required sample size

N is the total target Population

e is the margin of error (significance level will use 5%) or level of precision (0.05)

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

The total population of the study area was 241 involved in urban agriculture in the study area.

To find the total sample size we use the above formula

$$n = 241 / (1 + 241 * (0.05)^2)$$

$$n = 241 / (1 + 241 * 0.0025)$$

$$n = 241 / (1 + 0.6025)$$

$$n = 241 / 1.6025$$

$$n \approx 150.468$$

Therefore, when $N = 241$ and $e = 0.05$, the value of n is approximately 150.468. So, the sample size for this study was 150 urban farmers in the study area. Two sub-city experts from the Farmers and Urban Agriculture Development office were selected purposely for the interview.

3.5. Validity and Reliability

To achieve validity the researcher used a questionnaire and the instrument was already valid and tested in other researches. Content validity was ensured by the consistency in administering the questionnaires. All questionnaires were distributed to participants by the researcher personally; the questions were formulated in simple language for clarity and ease of understanding. Clear instructions were given to the participants. To achieve criterion and content the researcher conducted a pilot test and took questionnaires respectively. For the validity test, the sampled questionnaires were distributed for the pilot test and some modifications undertaken accordingly. The reliability of the questionnaire was achieved by ensuring consistency and uniformity in asking questions across time. The computation of Cronbach's Alpha score was 0.73 which is considered acceptable reliability.

3.6. Data analysis

This particular research was a descriptive research. That means the research was directed at making observations and documentation on the level of awareness of urban farmers regarding the health impacts of vegetable production utilizing polluted rivers and identifies effective mitigation strategies to address the challenges posed by urban river pollution in Addis Ababa's Nefas Silk Lafto sub-city.

Structured questionnaires were used as a primary data collection tool. This helped to collect useful information for assessing the level of awareness concerning the health impacts of irrigated rivers among urban agriculture producers in Nefas Silk Lafto sub-city and explore urban agriculture producers' strategies for environmental protection.

Moreover, quantitative data obtained from structured questions was analyzed by using descriptive methods of analysis. Descriptive statistics helped the researcher to provide details of the various aspects on the level of awareness of urban farmers regarding the health impacts of vegetable production utilizing polluted rivers and identify effective mitigation strategies to address the challenges posed by urban river pollution in Addis Ababa's Nefas Silk Lafto sub-city.

Moreover, tables and percentage distribution, frequencies, means and standard deviations were used to describe research questions using Statistical Package for Social Science (SPSS) version 20 software. With regard to the interview, all the collected data were transcribed and coded to identify themes, patterns, and perspectives related to urban river pollution, health effects, and mitigation strategies.

3.7. Ethical Consideration

Before going to the study area for data collection, I ensured that a supportive letter was obtained from Addis Ababa University and the sub-city office of agriculture. Legal permission was secured from both the sub-city and the study participants. Respondents selected for providing data were briefed about the purpose and importance of the study. I also oriented these individuals to provide accurate information, assuring them that their feedback would be kept confidential. Additionally, I ensured that each participant provided their informed consent to take part in the study. To further uphold ethical considerations, I made sure not to use any personal information or data in the study.

CHAPTER FOUR: RESULTS AND ANALYSIS OF THE SURVEY DATA

This chapter entails the empirical findings and discussions of the results obtained from the study accordingly. The survey data is analyzed with the help of summary statistics. Then after, an overview of the urban farmer's awareness of the health impacts of using polluted rivers for irrigation is discussed.

4.1. Descriptive analysis

4.1.1. Demographic and socio-economic characteristics of the Urban Farmers

According to the table below, a total of 150 sampled urban farmers were selected from the study area. Out of the total sample population, 13 respondents were not willing to respond to the questionnaire. Thus, only 137 questionnaires were accepted as valid for the analysis. Of the surveyed urban farmers, 34 (24.8%) were female and 103 (75.2%) were male respondents. So, it indicates that the gender proportion was not equally distributed. This particular survey was conducted under a highly male-dominated setting.

As per Table 1, 14 (10.2%) respondents were between the ages of 18-30, 56 (40.9%) respondents were between the age of 31-45, and 67 (48.9%) respondents were between the ages of 46-60. Regarding the marital status of the respondents, 121 (88.3%) of them reported that they were married and 67 of them (11.7%) were widowed. When we see the family size, 119 (86.9%) of the respondents reported that they have a family member size between 1-5, and 18 of them (13.1%) reported that they have a family member size between 6 to 10. Of the sampled urban farmers, 33 (24.1%) didn't attend school, 20 (14.6%) of them attained primary education, and 84 (61.3%) of them reported that they had reached secondary education. Moreover, the respondents were presumed to be capable of responding to the survey instrument.

During the survey data collection, the majority of the respondents were not comfortable disclosing their respective annual income due to unknown reasons. However, the largest proportion of the respondents (50.4%) reported that they incur between 51,000 to 100,000 per annum, 10.2% of the respondents get a net average annual income between 25,000 to 50,000, and 54 (39.4%) of the respondents earn above 100,000 annually.

The table below appears to depict that 14 respondents (10.2%) have been involved in urban farming in the study area for 10 years or less. 123 respondents (89.8%) have been involved in urban farming in the study area for more than 15 years. Based on the collected data, the vast majority of urban farmers in the study area (nearly 90%) have been involved in urban farming for a significant period of time, over 15 years. This suggests that urban farming has been an established practice in this area for more than a decade, with a relatively experienced group of farmers.

According to the farmer union’s office and Farmers and Urban Agriculture Development office in the sub-city, the urban farming practices were in place during the Italian invasion (1935-1937) and have been continued during Emperor Haile Selassie’s regime by local landlords. The urban farming practice continued in an organized manner mainly after the Derg regime’s “land to the tiller” proclamation and the land ownership was transferred from the landlords to the local farmers. Since then, the urban farmers have been doing the farming practices. According to the researcher’s field observation, all urban farmers in the study area are practicing river-irrigated vegetable farming in which they support their family members for many years. In this regard, some of the farmers with a larger plot of land hire more daily laborers during preparation and weeding. When farmers were asked to repay on the size of their plots land, the average farmland the farmers possess ranged from 600 M²- 1000M².

Table 1: Respondents demographic information and involvement in urban agriculture

	Variable	Number	Percent
Gender	Male	103	75.2
	Female	34	24.8
	Total	137	100
Age	18-30	14	10.2
	31-45	56	40.9
	46-60	67	48.9
	Total	137	100

Level of education	None	33	24.1
	Primary Education	20	14.6
	Secondary Education	84	61.3
	Total	137	100
Marital status	Married	121	88.3
	Widowed	16	11.7
	Total	137	100
Number of family members	1-5	119	86.9
	6-10	18	13.1
	Total	137	100
Net annual income	25,000-50,000	14	10.2
	51,000-100,000	69	50.4
	Above 100,000	54	39.4
	Total	137	100
Years of urban farming experience	Before 10 years	14	10.2
	Above 15 years	123	89.8
	Total	137	100

Source: researcher's survey result, 2024

4.1.2. Farmers' awareness on the health impacts of polluted river water usage on vegetable production

As per Table 2, all respondents replied that they obtain irrigable water for their farming activities from the nearby river. When participants asked about their awareness about water from the river that they use for vegetable production is polluted, majority of the respondents (62%) replied that the nearby river they are using for irrigation is polluted as a result of both human-generated and environmental pollutants from industries. The pollutants that the respondents mentioned were sewage, wastewater effluents, solid waste, litter, industrial effluents mainly from

nearby industries, oil and grease as well as construction wastes. On the other hand, 38% of the respondents replied that the river which they are using for irrigation is not polluted.

According to Table 2, respondents were asked about their level of awareness about the health risks associated with the usage of water from the polluted river for irrigating vegetable farms 51.8% of them indicated that they were not aware of the specific health risks of using polluted river water for vegetable irrigation. A significant portion 35% replied that they are not sure about the health risks of using polluted river water for vegetable irrigation. Only 13.1% of them are aware of the health risks.



Figure 4.1: Polluted River across the study area

As we can see from the table below (table 2), 37.2% of the respondents are moderately confident about their understanding of the potential health hazards associated with using polluted water for irrigation. However, 26.3% are slightly confident and 36.5% of the respondents are not confident in their understanding of the potential health hazards of using polluted water for irrigation purpose.

As we see in Table 2, the majority of the respondents (86.9%) replied that they never noticed any negative effects on the quality or yield of their vegetable production as a result of using water from the polluted river. In this context, only 13.1% of the respondents have noticed a decline in the quality and production of the vegetables produced in the study area using the polluted river for irrigation. During the researcher's field observation, some farmers argued that "if the water is polluted our hands and feet will be affected as a result of the pollutants".

As per the information provided by the urban farmers, all of the respondents in the study area use fertilizers. The majority of the respondents (62%) apply fertilizers frequently and 38% of them use fertilizers sometimes. In a similar context, 66 (48.2%) of the participants replied that they are using pesticides for their farm and 51.8% of them are not applying pesticides on their vegetable farm. Of those farmers who mentioned that they are using pesticides all of them replied that they use pesticides sometimes.

Table 2: Farmers awareness of the health impacts of polluted river water health risks

Item	Variable	Number	Percent
How do you obtain water for your urban farming activities?	Nearby river	137	100
Are you aware that the water from the river that you use for vegetable production is polluted?	Yes	85	62.0
	No	52	38.0
Are you aware of the specific health risks associated with using water from polluted river for irrigating vegetable farms?	Yes	18	13.1
	No	71	51.8
	Maybe	48	35.0
How confident are you in your understanding of the potential health hazards associated with using polluted water for irrigation?	Not at all confident	50	36.5
	Slightly confident	36	26.3
	Moderately confident	51	37.2
By any chance, have you noticed any negative effects on the quality or yield of your vegetable crops as a result of using water from the polluted river?	Yes	18	13.1
	No	119	86.9
Do you use any fertilizers in your urban farming activities?	Yes	137	100.0
Do you use any pesticides in your urban farming activities?	Yes	66	48.2
	No	71	51.8

Source: researcher's survey result, 2024

4.1.3. The existing mitigation strategies employed by vegetable farmers to minimize the health risks associated with urban river pollution

Based on Table 3, it is evident that all the respondents replied that they do not employ any measure to minimize the health risks of utilizing polluted river water for urban farming activities. This data indicates that there is no physical structure that deters pollutants and mitigates health risks in their urban farming practices. During the time of the researcher's field observation, the researcher witnessed that the water canal used for irrigation purpose do not have any water filtration and treatment plants. In this regard, the sub-city's Farmers and Urban Agriculture Development office also mentioned that the office is trying to minimize the pollution of rivers in the sub city along with the offices of environment protection and code enforcement to minimize the rate of pollution of the rivers. As per Nefas Silk sub-city Farmers and Urban Agriculture Development office inform the researcher that closely working with the aforementioned offices along with the sub city's health office to assess the current level of the rivers water quality in which they are waiting for the results.

According to table 3, respondents were asked if they have ever received any information or training regarding the potential health impacts of using polluted water for vegetable production, 54 individuals (39.4%) answered Yes indicating as they have received information or training on this topic. On the other hand, 83 respondents (60.6%) answered No, suggesting they have not received any information or training regarding the potential health impacts of using polluted water for vegetable production. Those respondents who answered 'Yes' also specify that government agencies were the source of their training or information. As the sub-city's Farmers and Urban Agriculture Development office the office provided trainings about the health impacts of polluted rivers and their utilization for vegetable growth for office workers at monthly basis.



Figure 4.2: a farm in the study area

Table 3 shows that out of the total respondents, 53 individuals (38.7%) indicated that they are familiar with alternative sources of non-polluted water for vegetable irrigation. Out of the total 53 respondents indicated their familiarity with alternative water sources, 38 individuals (71.7%) mentioned groundwater, 15 respondents (28.3%) with rainwater harvesting as an alternative water source. On the other hand, 84 respondents (61.3%) stated that they are not familiar with any other alternative sources.

Table 3 indicated that all of the respondents replied that they were not currently employing any methods to reduce water pollution and improve the water quality polluted water used for irrigation. According to all urban farmer respondents, there were several factors that influenced their decision to continue using water from a polluted river for vegetable production. One key factor was the lack of alternative water sources in the study area. The farmers had limited access to clean or treated water for irrigation purposes, leaving them with no viable options but to rely on the polluted river water to sustain their production.

Explicitly, the urban farmers also reported that they have viable financial constraints to make a corrective measure to utilize other alternative irrigation water sources. Implementing alternative water sources or water treatment measures was costly and required investments that they were unable to afford. The loss of effectiveness and enforcement of government policies and guidelines were crucial factors in crafting a plausible solution to address farmers' demand for water alternative sources and treatment of rivers. The existing regulations to address water pollution were not well-enforced and monitored. The urban farmers perceived a lack of

consequences for using polluted water. This perception, coupled with a lack of viable alternatives, contributed to their decision to continue using the water despite its contamination.

The agricultural officers in Nefas Silk Lafto sub-city indicated that there are policies and regulations in place to support and regulate urban agriculture activities, including zoning, land use, and water usage guidelines. However, the current state of urban agriculture in the sub-city is diverse, with a growing number of farmers engaged in vegetable production, but also facing challenges like limited access to non-polluted water sources and a need for more awareness on sustainable practices. The officers described their multi-pronged approach to convey governmental policies and regulations to urban farmers, including workshops, training, and collaboration with extension services. They confirmed the presence of major urban river pollution within the sub-city, stemming from industrial, commercial, and waste management activities, and stated that their office has conducted field assessments and implemented measures to mitigate the pollution, such as promoting alternative water sources and sustainable farming techniques.

Table 3: Urban farmers mitigation methods to minimize health risks

Item	Variable	Number	Percent
Do you employ any measures to minimize the health risks in your urban farming activities?	No	137	100.0
	Yes	0	0
	Total	137	100
Have you ever received any information or training regarding the potential health impacts of using polluted water for vegetable production?	Yes	54	39.4
	No	83	60.6
	Total	137	100
Are you familiar with any alternative sources of water for vegetable irrigation that are not polluted?	Yes	53	38.7
	No	84	61.3
	Total	137	100
Do you currently employ any methods to reduce water pollution and improve water quality of polluted water used for irrigation?	Yes	0	0
	No	137	100.0
	Total	137	100

Source: researcher's survey result, 2024

4.1.4. Urban framers strategies for environmental protection

According to table 4, out of the total respondents, 106 individuals (77.4%) responded that they are aware of the environmental regulations or guidelines related to urban agriculture in Nefas Silk Lafto Sub-city. Conversely, 31 respondents (22.6%) answered as they are not familiar with any environmental regulations or guidelines specific to urban agriculture in Nefas Silk Lafto Sub-city. As per the sub city's Farmers and Urban Agriculture Development office the urban farmers are already informed about the environmental regulations specific to urban agriculture through their urban farmers union. Majority 60.4% of the research participants' believed that there are enough government policies and guidelines address urban river pollution and its impact on urban farming.



Figure 4.3: river diversion to the farm lands

Paradoxically the framers has a firm believe in the existence of government led policy guide lines however the framers seemed to fail to in-place a sustainable environmental protection strategies. During the researcher's field observation, the researcher noted that the river is highly polluted by variety of contaminants but the farmers still utilized the river without any treatment.

Table 4: Awareness of environmental regulations or guidelines related to urban farming

Item	Variable	Number	Percent
Are you aware of any environmental regulations or guidelines related to urban agriculture in Nefas Silk Lafto Sub-City?	Yes	106	77.4
	No	31	22.6
	Total	137	100
Do you believe that there are enough government policies and guidelines to address urban river pollution and its impact on urban farming?	Yes	83	60.6
	No	54	39.4
	Total	137	100

Source: researcher's survey result, 2024

4.2. Discussion

The study highlights a significant gender disparity in urban agriculture indicating a male-dominated environment influenced by traditional gender roles, limited resources, land tenure challenges, and cultural norms. Additionally, marital status influences farmers' access to resources and decision-making processes, highlighting the importance of collaborative approaches and health-conscious practices within households.

A significant majority of the surveyed farmers (62%) are aware that the nearby river they use for irrigation is polluted. This awareness is crucial as it indicates that farmers recognize the potential risks associated with using contaminated water sources for growing vegetables. By acknowledging the presence of pollutants such as sewage, wastewater effluents, solid waste, litter, industrial effluents, oil and grease, and construction wastes, farmers are better equipped to make informed decisions and take appropriate actions to protect their health and the safety of their crops. A similar study conducted Woldetsadik et al., (2018) in Addis Ababa indicated that despite differences in the levels of awareness of health risks, farmers appear informed about the contamination of their irrigation water. Likewise, Ghanaian urban farmers despite their different awareness levels were generally informed about the contamination of their irrigation water (Keraita et al., 2008).



Figure 4.4: one of the nearby factories to the river with direct liquid waste pollution

The majority of the respondents (86.9%) reported that they have never noticed any negative effects on the quality of yield of their vegetable production as a result of using water from the polluted river. Only a small percentage (13.1%) reported a decline in the quality and production of vegetables due to using the polluted river for irrigation.

Previous studies have shown that contaminants in water sources lead to reduced plant growth, increased susceptibility to pests and diseases, and compromised food safety. Therefore, the current results highlight the need for an understanding of the specific context and factors influencing farmers' observations and perceptions. Farmers lack the necessary knowledge or tools to accurately assess the link between water quality and crop production. They also face other challenges that outweigh the perceived risks, such as limited access to alternative water sources or economic constraints. Additionally, the effects of pollution on crop quality and yield are not immediately noticeable and require long-term monitoring or scientific analysis to detect.

The survey findings highlighted the widespread use of fertilizers among urban farmers, with a majority applying them frequently to increase their production. However, the farmers' use of pesticides is relatively lower than half of the participants reporting pesticide use. The high usage of fertilizers among urban farmers is attributed to the need for nutrient supplementation in urban environments where soil quality and fertility may be compromised. Urban farmers rely on chemical fertilizers due to their accessibility, affordability, and convenience. The relatively lower use of pesticides, along with the infrequent application among users, indicated a desire to minimize chemical inputs and mitigate potential negative impacts on the environment and human health. Studies have indicated the use of both chemical fertilizers and pesticides often leads to negative changes in the quality of water and the health of stream ecosystems. More specifically, fertilizers and pesticides contaminate soil, groundwater, and surface water on a large scale with the residue of heavy metals (Jadon et al., 2022).

The study further stipulated a lack of awareness and implementation of health risk mitigation strategies among urban farmers. The lack of action exposed farmers and consumers to potential health hazards associated with urban farming, such as exposure to contaminants, pesticide residues, or other environmental pollutants. A study by Qadir et al. (2010) illustrated that undesirable constituents in wastewater can harm human health and the environment, so this makes the usage of polluted irrigation water a public health and environmental concern. Developing countries [like Ethiopia] are still unable to implement comprehensive water treatment programs for irrigation purposes.



Figure 4.5: car wash near to the river

According to this particular survey, some respondents have received information or training, but a significant majority has not been exposed to awareness and knowledge-sharing workshops about the potential health impacts associated with the usage of polluted water for vegetable production. This aligns with the government officers' response that there is both a resources and skill set gap in reaching out to the urban farmers. The majority of the respondents are aware of the existence of environmental regulations or guidelines for urban agriculture in Nefas Silk Lafto Sub-city. This indicates that efforts have been made to establish and communicate regulations or guidelines to promote environmentally responsible practices in urban agriculture as there are no other alternative sources. The incapacity of government intervention among the least developed nations deters them from crafting comprehensive risk management and interim solutions for anticipated problems in the utilization of polluted rivers for irrigation plus creating a guiding standard (Qadir et al., 2010).

A notable portion of respondents are familiar with alternative water sources for vegetable irrigation. This indicated a potential opportunity to promote the adoption of these alternative sources and mitigate the use of polluted water in vegetable production. Groundwater often be tapped through wells or boreholes and perceived as a reliable source of non-polluted water. On the other hand, the mention of rainwater harvesting suggests that some respondents are aware of the potential for collecting and storing rainwater for irrigation purposes, which can be particularly useful in areas with seasonal rainfall patterns.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

There is a significant knowledge gap among urban vegetable farmers in Nefas Silk Lafto sub-city regarding the specific health risks associated with using polluted water for irrigation. While the majority of farmers are aware of the water pollution issue, only a small percentage possesses knowledge about the potential hazards. Furthermore, a considerable portion of farmers lack awareness and confidence in understanding these risks.

Farmers in the study area do not implement any measures to mitigate the health risks associated with using polluted river water for irrigation. Additionally, the majority of farmers have not observed any negative impacts on the quality or yield of their vegetable production resulting from the use of polluted water. The majority of farmers have not received any information or training regarding the potential health impacts of using polluted water for vegetable production. Interestingly, the farmers who have received such information cite government agencies as the source.

The study also reveals that while a significant proportion of farmers in the study area are aware of environmental regulations and guidelines, they do not effectively implement measures to reduce water pollution or improve water quality for irrigation. The lack of access to alternative water sources and financial constraints are identified as key barriers preventing farmers from adopting more environmentally sustainable practices.

5.1. Recommendations

- Provide comprehensive training programs that specifically address the potential health risks associated with using polluted water for vegetable production. These programs should be designed to improve farmers' understanding of the risks and provide them with practical knowledge of mitigation measures.
- Deliver awareness campaigns that bridge the knowledge gap among farmers. These campaigns should emphasize the specific health risks of using polluted water and highlight the importance of adopting measures to minimize these risks.

- Collaboration of stakeholders (Urban farmer unions, NGOs, Gov't actors local community through consumer associations) responsible for disseminating information and regulations related to urban agricultural practices. This partnership will ensure that accurate and up-to-date information reaches urban farmers effectively.
- Address the issue of limited access to alternative water sources by exploring innovative solutions such as rainwater harvesting, water recycling systems, or community water-sharing initiatives. This will reduce farmers' reliance on polluted river water for irrigation.
- Recognize the financial constraints faced by urban farmers and provide financial support mechanisms to enable them to adopt more environmentally sustainable practices. This could include financial grants, microfinance options, incentives, and the provision of eco-friendly pollution reduction measures.
- Furthermore, the topic required multi-disciplinary scrutinization to come up with a holistic policy and practical framework.

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Annex-1

**Addis Ababa University College of Development
Department of Environment and Development
Information Sheet**

Principal investigator- Solomon Abebaw

Aim- My research aimed at an assessment of urban vegetable farmers' awareness on the health impacts of the utilization of polluted river water for vegetable production and environmental protection practices in Addis Ababa around Nefas Silk Lafto sub-city.

Expectation of the participant- We are expecting you to respond anonymously to questions or surveys about your personal details regarding your experience and awareness of environmental protection, and urban agriculture in your vicinity which will take no more than half an hour.

Voluntary Participation- Participation in this study is completely voluntary and therefore, you have the right to terminate your participation.

Confidentiality- Your information obtained during data collection will be completely kept confidential during the process of research as well as after completion of the study. Your names will remain anonymous while reporting the results of the study, and hence we would like you to ensure that your names will not appear in any publications of research.

Benefit- the study will have a significant benefit in studying environmental protection in urban agriculture and vegetable farming in Addis Ababa, Nefas Silk Lafto sub-city lies in several key areas including environment and health impact implications, sustainable agriculture, policy and planning, community awareness, as well as an existing knowledge gap. This study will contribute to the knowledge building in the area of environmental protection practices and the mitigation strategies implemented associated with urban vegetable farming practices along rivers.

Questions about Research- If you would like to ask for any further information about this research, or questionnaire items, you may contact the principal investigator, **Solomon Abebaw** via email as well as mobile telephone. My email is solofikir23@gmail.com and my mobile telephone is (+251) 910-61-03-71. In case you need more information about this study you can also directly contact Addis Ababa University, College of with an address of office telephone (+251)111544200.

9. If you are engaged in vegetable farming, what types of vegetables do you cultivate in your urban farming activities? _____

10. How many plots of land do you utilize for urban agriculture?

_____ square metres

Part II: Farmers awareness on the health impacts of polluted river water usage on vegetable production

1. How do you obtain water for your urban farming activities?

Municipal water supply

Harvest rainwater

Nearby river

Groundwater extraction

2. Are you aware that the water from the river that you use for vegetable production is polluted?

Yes

No

Maybe

If yes, please specify the major urban river pollutants nearby

Sewage and wastewater effluents

Stormwater runoff:

Industrial effluents:

Solid waste and litter

Oil and grease

Pesticides and herbicides

Microplastics

Sediment, erosion and construction wastes

Agricultural nutrients (nitrogen, phosphorus, and fertilizers)

Heavy metals (industrial or vehicle emissions, and improper waste disposal)

If other, please specify _____

3. Are you aware of the specific health risks associated with using water from a polluted river for irrigating vegetable farms?

Yes

No

Maybe

If yes, please specify _____

4. How confident are you in your understanding of the potential health hazards associated with using polluted water for irrigation?

Not at all confident

Slightly confident

Moderately confident

Very confident

5. By any chance, have you noticed any negative effects on the quality or yield of your vegetable crops as a result of using water from the polluted river?

Yes

No

Not sure

6. Do you use any fertilizers in your urban farming activities?

Yes

No

Sometimes

If yes, how frequently do you use fertilizers for your farming activity?

Frequently

Sometimes

7. Do you use any pesticides in your urban farming activities?

Yes

No

Sometimes

If yes, how frequently do you use pesticides for your farming activity?

Frequently Sometimes

8. Do you employ any measures to minimize the health risks in your urban farming activities?

Yes No Sometimes

If yes, what measures do you currently employ to minimize the health risks posed by urban river pollution in your farming practices?

Filtration or treatment systems

Monitoring water quality regularly

Using alternative water sources when possible

Collaborating with local authorities for water testing

Other (please specify)

How frequently do you employ the specific techniques to treat polluted water used for irrigation purposes?

Frequently Sometimes

9. Have you ever received any information or training regarding the potential health impacts of using polluted water for vegetable production?

Yes No

If yes, which of the following agencies provide you with the training or the information?

Government agencies

Non-Governmental organizations

Research institutions or universities

If other (please specify)_____

10. Are you aware of any environmental regulations or guidelines related to urban agriculture in Nefas Silk Lafto Sub-City?

Yes No

If yes, please specify the regulations or guidelines you are aware of

11. Are you familiar with any alternative sources of water for vegetable irrigation that are not polluted?

Yes No

If yes, which of the following alternative sources of water are you familiar with?

Groundwater Treated municipal water

Rainwater harvesting Other (please specify)_____

12. Do you currently employ any methods to reduce water pollution and improve water quality of polluted water used for irrigation?

Yes No

If yes, what methods you are applying to reduce pollution and enhance water quality used for irrigation

If not, what are the main factors that influence your decision to continue using water from the polluted river for vegetable production?

13. What are the main challenges you face in using water treatment techniques for farming?

14. What are the main challenges you face in accessing clean water for vegetable production?

15. Do you believe that there are enough government policies and guidelines to address urban river pollution and its impact on urban farming?

Yes

Maybe

No

16. What do you see as the biggest barriers to implementing more environmentally friendly practices in urban farming along polluted rivers?

17. Please provide any additional comments or suggestions related to this topic?

Annex-2: Interview Guide for Urban Agriculture Officers

- Are there any policies or regulations in place to support or regulate urban agriculture activities at a city or sub-city level?
- Can you please describe the current state of urban agriculture in Nefas Silk Lafto sub-city?
- Tell us how your office conveys governmental policies and regulations to the people of interest including urban farmers.
- To your knowledge is there any major urban river pollution within the sub-city?
- Are there any industrial or commercial activities in Nefas Silk Lafto sub-city that might contribute to river pollution?
- Did your office conduct any field assessment to measure the intensity and source of pollution?
If yes, please tell me the major measures that your office took to mitigate or minimize the river pollution.
- Please tell me about the environmental protection practices you currently implement within the sub-city.
- Was there any major government initiative to assist local urban farmers in letting them mitigate the adverse effects of river pollution?
What are the major achievements your office has made so far in this regard?
- In your opinion, what steps should be taken to enhance the sustainability and resilience of urban agriculture while ensuring environmental protection in the sub-city?
- Is there any additional information you would like to share regarding urban river pollution in relation to urban agriculture in Nefas Silk Lafto sub-city?
- Please provide any additional comments or suggestions related to this topic?

Annex-3: Field observation check list

No.	Existing mitigation strategies for health risks associated with urban river pollution		
1	What strategies do farmers employ to		
2	Minimize the health risks associated with using polluted river water for irrigation?		
3	Do farmers use alternative water sources such as well water, treated municipal water, or rainwater harvesting? Have farmers implemented water		
4	Filtration systems or treatment technologies to reduce contamination levels in the water?		
5	Do farmers regularly monitor and test the quality of the water used for irrigation?		
6	Are farmers engaged in collaborations		
7	With local authorities or research institutions to access testing facilities or guidance?		
8	Strategies for environmental protection:		
9	Do vegetable producers employ sustainable farming practices to protect the environment?		
10	Are farmers implementing practices such as organic farming, conservation tillage, or cover cropping?		
11	Do farmers prioritize soil health and fertility management through composting, organic amendments, or soil testing?		
12	Are water management practices in place to conserve water resources and minimize pollution?		
13	Do farmers take measures to promote		
14	Biodiversity conservation on their farms?		
15	How do producers manage agricultural waste generated from vegetable farming?		