INTERNATIONAL JOURNAL OF RESEARCH AND INNOVATION IN SOCIAL SCIENCE (IJRISS)
ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue IV April 2025

The Effect of Innovative Urban and Peri-Urban Agriculture on Resource use Efficiency in Bamenda City, Cameroon

Ngetleh Ngesang[1*], Marietta Yilen[2]

[1]Department of Agribusiness Technology (ABT), College of Technology (COLTECH), University of Bamenda, Cameroon.

[2]Department of Economic Science, Faculty of Economics and Management Sciences (FEMS), University of Bamenda, Cameroon.

[*]Corresponding author

DOI: https://dx.doi.org/10.47772/IJRISS.2025.90400151

Received: 25 March 2025; Accepted: 29 March 2025; Published: 03 May 2025

ABSTRACT

Urban and peri-urban agriculture (UPA) has increasingly been recognized for its potential to affect resource use efficiency (RUE). By employing innovative practices and technologies, UPA helps reduce resource waste, improves productivity, and supports sustainability in cities. The main objective of this study was to investigate the contributions of urban and peri-urban agriculture innovations to resource use efficiency in the Bamenda City. Data was collected from 402 farmers practicing UPA in Bamenda city with the use of questionnaire. The Ordinary Least Squares-OLS method was employed and the empirical findings showed that overall; the practice of innovative UPA has a positive and significant effect on RUE. When decomposed into the use of organic and inorganic fertilizer, the effect is higher when farmers use inorganic than organic fertilizers. Access to extension services increases RUE more when inorganic, than organic fertilizers are used. These findings are consistent with empirical literature, demonstrating that innovative UPA plays a crucial role in enhancing RUE, particularly through the use of improved seeds, fertilizers, and extension services. The study recommends the advancement of policies that encourage the adoption of sustainable farm methods, such as the use of organic fertilizers, composting, water harvesting, and efficient irrigation systems, to optimize resource use. The study further recommends that extension services that provide tailored training on proper fertilizer application techniques and effective implementation of innovative UPA should be implemented by urban and peri-urban farmers to avoid misuse of resources and to ensure sustainability.

Keywords: Urban and Peri-Urban Farmers, Innovative Agriculture, Resource Use Efficiency, Ordinary Least Squares Method, Cameroon.

INTRODUCTION

Urban and peri-urban agriculture (UPA) is experiencing an unprecedented growth throughout the world, finding applications in countries with both developing and more developed economies (Orsini, 2020), it has assumed global concern and has become a topic of scientific research in recent years. Compared to rural agriculture, UPA has some distinct features (such as the limited land access, alternative growing media, unique legal environments, or the non-production-related missions) that encourage the development of new practices such as “novelties” or “innovations” (Sanyé-Mengual et al., 2019). Motivation for UPA is significantly high in developing nations with an increasing interest in the practice due to the prevailing relatively harsh economic conditions. In Dar-es-Salaam, Tanzania’s capital, urban agriculture comprises at least 60% of the informal economic sector and is the second-largest urban employer (Ruhweza, 2020). In Kenya, statistics from the University of Nairobi indicate that about 30% of households in Nairobi benefit from urban and peri-urban agriculture, such as vertical gardens and hydroponics, which provide 60% of the leafy vegetables and 70% of milk and poultry products to consumers in Nairobi (Ruhweza, 2020).

Urban and peri-urban agriculture (UPA) has increasingly been recognized for its potential to enhance resource use efficiency. The concept of resource use efficiency in UPA revolves around optimizing the use of land, water, energy, waste, and other inputs while maximizing outputs. By employing innovative practices and technologies, UPA helps reduce resource waste, improves productivity, and supports sustainability in cities. Innovative UPA practices encompass a wide range of techniques and technologies aimed at maximizing resource use efficiency while minimizing environmental impacts. Practices such as hydroponics, aquaponics, and vertical farming offer efficient water use solutions by employing recirculating systems that minimize water wastage (Hodgson and Dunkerley, 2019). Studies have shown that these systems can reduce water consumption by up to 90% compared to conventional farming (Specht et al., 2014), these systems can produce high yields using significantly less water compared to conventional agriculture, making them well-suited for urban environments with limited water resources (Godfray et al., 2010).

Water scarcity is a growing concern in many cities, and UPA has been at the forefront of adopting water-saving technologies and practices. Innovations such as drip irrigation, hydroponics, and rainwater harvesting have been empirically shown to enhance water use efficiency in UPA. Land availability is also often limited in urban and peri-urban areas, making efficient land use crucial for sustainable food production. Vertical farming, rooftop gardens, and community gardens are examples of innovative UPA practices that maximize land use efficiency by utilizing vertical space and transforming underutilized areas into productive landscapes (Lin, 2015). Innovative UPA practices contribute to better utilization of limited urban land, enabling agricultural production even in densely populated areas. Techniques such as vertical farming, rooftop gardening, and the use of vacant lots have been shown to enhance land use efficiency in cities. Similarly, techniques such as agroforestry, green roofs, and solar-powered irrigation systems prioritize energy efficiency and renewable energy sources (Sanyé-Mengual et al., 2015). Studies have shown that integrating renewable energy technologies into UPA can significantly reduce greenhouse gas emissions and energy costs (Sundberg et al., 2016).

Like elsewhere in the world, Cameroon is experiencing rapid and unplanned urbanization; the urbanization rate in Cameroon was estimated at 53.98% in 2014 with 65% of the urban population living in slums and the number of slum dwellers increasing at an annual rate of 5.5% (UN-habitat, 2016). The National Institute of Statistics of Cameroon further predicts that the population of Cameroon is expected to grow to 55.62 million by 2060, of which 77.23% will be urban (Awah and Bidogeza, 2021). UPA witnessed a significant development in Cameroon during the 1980s when the economic crisis followed by structural adjustment policies slowed down rural agriculture, reduced public sector employment, and increased urban unemployment. It served as a means of survival and an additional source of income and food for the population. Today, agriculture remains an important aspect of the lifestyle of urban Cameroonians, and there are a growing number of urban and peri-urban farmers from different age groups and sectors including young graduates and civil servants. In Bamenda, urban agriculture includes a range of activities such as growing market gardening crops, staple food crops, fruits, and herbs, as well as raising conventional (chickens, goats, pigs) and unconventional (rabbits, guinea pigs, bees) livestock, and fish (aquaculture), (Feldt et al., 2018), and innovations such as the growing of mushrooms in pots, bags, and papers, within enclosed rooms, greenhouses, hydroponics and aquaponics. The practice of agriculture in and around the city of Bamenda is an important aspect of the creation of a resilient and secure food system, and provides an important solution for resource use efficiency, and a complementary strategy to cope with the problems of rapid population growth and the socio-political crisis in the region (Ngetleh et al., 2023).

Urban agriculture is an important source of livelihood and survival for the urban poor in Bamenda city. However, it is inadequately supported by government and investors. UPA is often tolerated by governments, but rarely encouraged despite its vital contribution to employment, livelihoods and sustainability (Martin-Moreau and Ménascé, 2019). Urban planners and managers focus more on providing services like housing, transport, water, and electricity, neglecting urban agriculture which is an integral component of urban systems. Remedying this situation by establishing an organized and planned mechanism such as the provision of inputs, technical resources, capacity building and innovations, is crucial in supporting UPA. Moreover, the rising urban population of Cameroon including Bamenda city, has increased the pressure on its limited urban resources and therefore creates the need for the promotion and implementation of innovations in agriculture that ensure sustainable agricultural productivity and resource use efficiency. By training UPA farmers and equipping them to practice techniques such as zero acreage farming (vertical agriculture), aquaculture practiced in drums and barrels, greenhouse farming, hydroponics etc., urban agricultural production and productivity can be increased, which will ensure a continuous supply of food throughout the year, contribute to the fight against climate change, and to the efficient use of resources. This research therefore has as main objective to investigate the contributions of urban and peri-urban agriculture innovations to resource use efficiency and sustainability in the Bamenda City.

LITERATURE REVIEW

Sundberg et al. (2016) investigated the role of solar energy in urban agriculture through a case study approach. The study utilized quantitative data analysis techniques, including energy consumption calculations and economic feasibility assessments. Their findings suggested that solar-powered greenhouses and vertical farms contribute to energy efficiency and environmental sustainability in UPA systems. Hodgson and Dunkerley (2019) utilized a literature review approach to assess the impact of UPA on water use efficiency. They found that UPA practices such as hydroponics and aquaponics significantly reduce water consumption compared to conventional agriculture. The study synthesized findings from multiple sources, including empirical studies, case reports, and technical reports, to provide a comprehensive overview of water-saving techniques in UPA.

Similarly, Lin (2015) conducted a review of ecological and socioeconomic benefits of agroforestry management in urban and peri-urban environments. The study employed a qualitative synthesis of existing literature to examine the impact of agroforestry on land use efficiency. By analyzing case studies and empirical evidence, the author highlighted the potential of agroforestry systems to maximize land utilization and promote sustainable urban agriculture. Zezza and Tasciotti (2010) conducted empirical research to examine the impact of urban agriculture on nutrient management and food security. The study employed household surveys and field observations to collect quantitative data on nutrient recycling practices in urban farming systems. By analyzing survey responses and nutrient flow diagrams, the authors assessed the efficiency of nutrient cycling and its contribution to sustainable food production in urban areas. The study revealed that urban agriculture contributes to nutrient management by recycling organic waste and utilizing natural fertilizers. Through practices such as composting and vermiculture, urban farmers convert organic waste into nutrient-rich soil amendments, reducing the need for synthetic fertilizers. This not only improves soil fertility and crop productivity but also minimizes nutrient runoff and environmental pollution.

Additionally, Orsini et al. (2017) utilized a multidisciplinary approach to evaluate the sustainability aspects of UPA in urban environments. The study integrated quantitative assessments of water and energy use with qualitative analyses of social and environmental impacts. By combining data from field experiments, surveys, and literature reviews, the authors assessed the synergistic effects of integrated UPA systems on resource use efficiency and overall sustainability. Through quantitative analyses, the authors found that UPA practices, such as rainwater harvesting and renewable energy integration, can significantly reduce water and energy demand compared to conventional agriculture. They also found that UPA practices, such as organic farming and agroforestry, promote soil fertility, carbon sequestration, and urban biodiversity. These findings underscored the potential of UPA to optimize resource utilization and enhance sustainability in urban environments. Therefore, by employing a multidisciplinary approach and integrating quantitative and qualitative analyses, the authors highlighted the potential of UPA to enhance resource use efficiency, promote social equity, and contribute to environmental sustainability in urban landscapes. Likewise, Paoli et al. (2018) employed a mixed-methods approach, combining satellite imagery analysis, field surveys, and stakeholder interviews to assess land use efficiency in urban agriculture. They utilized Geographic Information Systems (GIS) software for spatial analysis and conducted qualitative interviews to gather insights into land management practices. The study revealed that UPA practices, such as rooftop gardens and vertical farming, effectively utilize underutilized urban spaces, optimizing land use efficiency. These findings suggest that UPA can contribute to maximizing agricultural productivity in densely populated urban areas.

Furthermore, Martínez et al. (2017) conducted a life cycle assessment (LCA) to evaluate the energy efficiency of urban agriculture systems, including rooftop gardens and urban aquaponics. They collected data on energy inputs and outputs throughout the production process and analyzed the environmental impacts using LCA software. The study found that UPA systems integrated with renewable energy technologies, such as solar panels and wind turbines, significantly reduced energy consumption and carbon emissions compared to conventional agriculture. This highlights the potential of UPA to enhance energy efficiency and sustainability in urban food production. Viljoen et al. (2015) conducted a comprehensive review of nutrient management practices in urban agriculture, synthesizing findings from empirical studies, experimental trials, and literature reviews. They employed a systematic approach to analyze nutrient cycling processes and assess the effectiveness of various nutrient management strategies. The study identified composting, vermiculture, and agroforestry as effective methods for nutrient recycling in UPA systems. These practices not only improve soil fertility and crop productivity but also reduce reliance on synthetic fertilizers, minimizing nutrient runoff and environmental pollution. Sposito et al. (2019) conducted a field study comparing water use efficiency between traditional agriculture and hydroponic systems in an urban setting. They measured water inputs and crop yields over a growing season and analyzed the data using statistical methods. The study found that hydroponic systems used significantly less water compared to traditional soil-based agriculture while achieving comparable or higher crop yields. This indicates that UPA practices such as hydroponics can greatly improve water use efficiency in urban environments.

MATERIALS AND METHOD

Description of the Study Area

The study covers the three municipalities of Bamenda (Bamenda I, II and III) in Mezam division of the Northwest Region (NWR) of Cameroon corresponding to seven communities; (Bamendakwe, Nkwen, Ndzah, Mankon, Chomba, Nsongwa and Mbatu). Bamenda municipality has an estimated population that stands at two million inhabitants (MINADER, 2015; Tambi, 2024). The Northwest Region is the third most populated region in Cameroon with Bamenda city as the regional capital, the administrative seat of Mezam Division, and the largest town in the Northwest Region. Bamenda city is located between latitude 5o56 and 5o58´´ north of the Equator and longitude 10o09´´ and 10o11´´ east of the Greenwich Meridian, situated at 1258 meters above sea level (Master Plan of Bamenda city council, 2011-2027 cited in Fombe and Acha, 2020). The area shows great ecological variations and consequently climate variations which greatly influenced settlement patterns and agricultural activities. The type of climate found here is the Guinean climate. The climate is marked by two distinct seasons: the dry and rainy seasons.

The population of Bamenda city is largely cosmopolitan made up of indigenous Mankon, Nkwen and Ndzah people, with so many migrants from other tribes` of the NWR (predominantly due to the displacements because of the ongoing Anglophone crises), West Regions, and other regions of Cameroon, as well as Nigerians. Most of the inhabitants do business for a living which is the main source of their income followed by agriculture, with many people doing farming just for family consumption (Tambi, 2024). The main industries are the production and processing of agricultural produce such as coffee, elementary food processing, handicraft, cottage industry, education (schools), tourism/hospitality, construction works and transport. The population of Bamenda is also composed of many youths and graduates from agricultural schools who propel innovative practices in UPA as a source of income and a way of applying knowledge acquired from school while training other farmers.

The choice of Bamenda City as the location for this study is justified by the fact that Bamenda I, II, and III represent the major urban spaces in the Northwest region of Cameroon where urban development and population growth is on a rise. In addition, many inhabitants of Bamenda city (Bamenda I, II and III) are now practicing urban and peri-urban agriculture to supplement their livelihoods and income.

Data Collection

The study population comprised of plant crops and livestock urban and peri-urban farmers including staple food crop farmers, market gardening farmers, greenhouse farmers, mushroom farmers, pisci-culture, and livestock farmers. These actors (a total of 402 persons) were selected from the urban and peri-urban space of Bamenda I, II and III municipalities of Bamenda city. The study employed a mixed-methods research design by combining both quantitative and qualitative research methods, through a cross-sectional survey. Data was collected with the use of questionnaires which were administered using both probability and non-probability sampling techniques. The sampling techniques used included cluster sampling and this was done by dividing the area into three clusters according to the various municipalities (Bamenda I, II and III clusters respectively). Data was

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue IV April 2025

collected based on the desired characteristics of the study population (plant crop farmers and livestock farmers) to obtain an organized data on urban and peri-urban agriculture according to the various municipalities (clusters) in Bamenda. Furthermore, the simple random sampling technique was used within the various clusters to obtain data from market gardening and livestock farmers, while the snowball sampling technique was used to identify and obtain data from mushroom farmers, greenhouse farmers and pesci-culture farmers.

The total farming population of Bamenda I, II and III in 2022 according to the quarterly (January to June 2022) reports of the Divisional Delegation of the Ministry of Agriculture and Rural Development (MINADER) of the Northwest Region of Cameroon, stood at 200,859 persons/farmers. This number constitutes the sample frame (target population) of the study from which a sample size was determined. The sample size was determined using the formula for determination of sample size proposed by Yamane (1967) and as used by Obienusi et al., (2014). At 95% confidence level the minimum sample size required as derived from Yamane's formula was 399, but 402 households were sampled for this study due to the availability and easy reachability of an additional number of farmers.

Model Specification and Estimation Technique

From literature and by intuition, innovative practices in UPA can affect RUE. The dependent variable of this model is therefore Resource Use Efficiency (RUE). This variable was captured as a continuous variable in the form of an index. Specifically, the Multiple Correspondence Analysis (MCA) was used to build the index since all the indicators were binary in nature, as applied by Tambi (2024). The hypothetical link between Innovative UPA and RUE can be depicted in an econometrical model as in equation 1:

$$RUE = \varphi_0 + \varphi_1 IUPA + \omega_3 X + \mu \quad \text{……………………………………………………….. (1)}$$

Where μ is the error term of the model, φ denotes the coefficients of the independent variables to be estimated in the model while ω is the coefficient for the other variables used in the model that jointly affects RUE. The dependent variable is linear and this appeals to any linear model.

The Ordinary Least Squares (OLS) method of analysis was chosen to measure the contributions of UPA innovations on RUE and Sustainability in Bamenda city. In doing this, it was ensured that results are Best Linear Unbiased Estimates (BLUE) so that the findings from the study are reliable. This approach is suitable for this study because the model presentation is free from other econometrical issues of endogeneity and sample bias.

RESULTS AND DISCUSSIONS

Descriptive Statistics

This section displays a summary of the nature and type of variables used in the study.

Table 1: Summary of Descriptive Statistics of Variables in the Model

Variables	Observations	Mean	Std. Dev.	Min	Max
RUE	402	-0.98805	1.94241	-6.31951	0.97437
Innovative UPA	402	0.65920	0.47456	0	1
Female	402	0.46268	0.49922	0	1
Age (18_25)	402	0.30099	0.45926	0	1
Tertiary Education	402	0.01741	0.13096	0	1
Single	402	0.41791	0.49383	0	1
Household Size	402	0.57711	0.49463	0	1
Employment Status	402	0.36815	0.48290	0	1

Professional / Technical Training	402	0.33582	0.47286	0	1
Access to Extension Services	402	0.35323	0.47857	0	1
Access to Credit	402	0.22139	0.41570	0	1
Household Location	402	0.39054	0.48848	0	1
Farm Size	374	0.21925	0.41429	0	1
Use of Improved Seeds/ Hybrids	402	0.77114	0.42061	0	1
Use of Fertilizer	402	0.75621	0.42989	0	1
Access to land	402	0.98258	0.13096	0	1

Source: Field Survey Data (2024)

Table 1 is a summary of the descriptive statistics of the variables used in the model linking resource use efficiency and UPA innovations. The mean of RUE is -98 percent implying that on average RUE is on a negative side in Bamenda city. UPA innovations stands at 62 percent, indicating that majority of farmers in Bamenda city practice innovations in farming. Tertiary education has the lowest mean value among the variables that determine the practice of UPA innovations, implying that it is not a very essential component for farmers in Bamenda city for the practice of UPA innovations. Access to land has the highest mean value, implying that it is essential in the practice of UPA innovations.

Empirical Results

Table 3 presents the estimates for the effect of UPA on RUE in Bamenda city. Column 1 shows the global effect while columns 2 and 3 are the results decomposed according to type of fertilizer used on the farm.

Table 3: Effect of Innovative UPA on RUE.

Variable	**RUE (1)**	**RUE by organic fertilizer (2)**	**RUE by inorganic fertilizer (3)**
Innovative UPA	0.902*** (0.145)	0.771*** (0.166)	0.993*** (0.185)
Female	-0.201* (0.114)	-0.110 (0.140)	-0.300** (0.146)
Age	0.306* (0.162)	-0.0192 (0.178)	0.0366 (0.233)
Tertiary Education	-0.335 (0.421)	-0.187 (0.510)	0.180 (0.582)
Single	-0.0421 (0.155)	0.240 (0.181)	0.0418 (0.210)
Household Size	-0.252** (0.117)	0.167 (0.145)	-0.0088 (0.166)
Fulltime Employment	0.337*** (0.121)	0.0035 (0.146)	0.130 (0.183)

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue IV April 2025

Professional/technical Training	-0.129 (0.128)	0.0908 (0.155)	0.0251 (0.178)
Access to Extension Services	-0.0043 (0.147)	0.385** (0.171)	0.537** (0.232)
Access to Credit	0.222 (0.161)	-0.390* (0.202)	-0.237 (0.230)
Urban Residency	-0.0245 (0.117)	-0.0364 (0.134)	0.0809 (0.177)
Medium Farm Size	0.631*** (0.141)	0.503*** (0.177)	0.587*** (0.191)
Use of Improved Seeds	-2.840*** (0.159)	-1.531*** (0.194)	-2.503*** (0.197)
Land Access	-0.396 (0.424)	-0.248 (0.339)	1.308 (0.820)
Constant	-0.621 (0.446)	-1.057*** (0.367)	-2.117** (0.857)
Observations	402	115	130
R-squared	0.700	0.680	0.809

Source: Author from field survey (2024). **Where; *, **, ***, represent 10, 5 and 1 percent level of significance respectively.**

The results in column 1 reveal that the practice of innovations in UPA has a positive and significant effect on RUE. A one-point increase in UPA innovations increases RUE by 90.2 percent at 1 per cent level of significance. This implies that when UPA farmers adopt innovative methods in farming, it increases the efficient use of resources. Results also reveal that an increase in the age of a farmer significantly increases RUE by 30.6 percent. Also, a farmer who is practicing innovative UPA fulltime is likely to increase RUE by 33.7 percent than their counterparts who are practicing part time. This implies that there is a tendency for resources to be efficiently used in agricultural innovations and production, when a farmer engages full time in the activity. In addition, results in column 1 reveal that when farmers carry out agricultural innovations on medium sized farms, RUE increases by 63.1 percent at a 1 percent level of significance. This implies that farm size has a crucial role in determining the efficient use of resources in UPA.

Furthermore, the non-use of improved seeds or hybrids is revealed to be negatively affecting RUE. When improved seeds are not used by a farmer, RUE reduces by 2.84 percent at a 1 percent level of significance. This implies that the use of improved seeds or hybrids as an agricultural innovation can contribute positively to RUE. On the other hand, being a female reduces by RUE by 20.1 percent at 10 percent level of significance than being a male farmer. This implies that female farmers may need more training on innovative methods in agricultural production. An increase in the household size also reduces RUE by 25.2 percent at 5 percent significance level.

Empirical Results by Type of Fertilizer used.

To further investigate the contribution or impact of urban and peri-urban agricultural innovations on resource use efficiency and sustainability, results were further split in terms of the type of fertilizer used by the farmer, as depicted in columns 2 and 3 of Table 4. Results demonstrate that innovative practices in UPA have a higher impact on RUE when farmers use inorganic than organic fertilizers (99.3 percent > 77,1 percent). However, both have a positive effect on RUE and are all significant at 1 per cent level of significance. A possible explanation for these differences in impact could be associated with the accessibility and cost of fertilizer type. Inorganic fertilizers are less costly and more accessible to farmers compared to organic fertilizers which are more costly and limited in supply. Therefore, there is a tendency for farmers to use more inorganic fertilizers in farming compared to organic fertilizers which leads to different positive contributions to RUE.

DISCUSSION OF FINDINGS

The findings provide several insights into how innovative practices influence sustainable and efficient use of agricultural resources among urban and peri-urban farmers. The analysis shows that UPA innovations contribute positively to RUE, thereby aligning with the work of authors like (Zhang et al., 2016), who emphasized that technological advancements in agriculture improve productivity and the efficiency of resource allocation. The finding is also in line with the Agricultural Innovation System (AIS) theory, which posits that the interplay between different actors such as farmers, research institutions, and extension services fosters innovation that can improve agricultural productivity and efficiency.

The study also reveals interesting gender dynamics, showing that male farmers are more likely to benefit from innovations in agriculture compared to female farmers. The application of innovative methods by female farmers resulted in a decrease in RUE, indicating the need for targeted training and capacity building for women in agriculture. This aligns with findings by Meinzen-Dick et al. (2014), who argue that women farmers often face constraints in accessing resources and information that limit their ability to benefit from agricultural innovations. Results further reveal that medium-sized farms contribute significantly to RUE, thereby supporting the argument that farm size plays a critical role in resource optimization, as medium-sized farms may have better economies of scale than smaller ones. This is in line with the Theory of Optimal Farm Size, which posits that there is an optimal farm size that maximizes efficiency in resource use. This theory suggests that medium-sized farms have the potential to balance the benefits of scale like better access to technology and resources while still being nimble enough to adapt to market changes.

Moreover, the results reveal that the use of inorganic fertilizers contributes more to RUE compared to organic fertilizers, which can be attributed to the accessibility and cost differences between the two. The positive impact of inorganic fertilizers on RUE compared to organic fertilizers in Bamenda aligns with recent research that highlights the widespread use and efficiency of inorganic fertilizers in urban and peri-urban settings. This observation is in line with Khonje et al. (2015) who found that the use of inorganic fertilizers significantly boosts productivity and resource efficiency, especially in smallholder agricultural systems where soil fertility is often poor. However, there has been a growing emphasis on promoting organic fertilizers to enhance sustainability. According to a study by Altieri and Nicholls (2020), while organic fertilizers contribute to long-term soil health and sustainability, they may not provide the immediate efficiency gains seen with inorganic fertilizers. This presents a trade-off between short-term efficiency and long-term sustainability, which policymakers must consider when promoting resource-efficient practices in urban agriculture.

Access to extension services was found to positively affect RUE, more so when organic than inorganic fertilizers are used. This underscores the critical role that agricultural extension services play in disseminating information about innovations and ensuring efficient resource use, as supported by studies of Davis et al., (2012), and Davis and Nkonya (2019) who emphasized the role of extension services in disseminating information about innovations and providing technical support to farmers. They found that farmers who receive extension services are more likely to adopt resource-efficient practices, resulting in better outcomes in terms of productivity and resource optimization. On the contrary, access to credit in Bamenda was found to negatively affect RUE, which aligns with a study by Simtowe and Zeller (2016), who suggest that access to credit may sometimes lead to misallocation of resources, particularly when loans are not used for productive investments. This underscores the need for policies that ensure credit is directed towards enhancing productivity and resource use efficiency.

CONCLUSION AND RECOMMENDATIONS

Innovative urban and peri-urban agricultural practices have demonstrated significant potential in enhancing resource use efficiency and promoting sustainable urban development. By adopting water-saving technologies, optimizing land use, integrating renewable energy sources, and implementing nutrient cycling systems, UPA contributes to resource use efficiency, environmental conservation, and community resilience in urban areas. This study underscores the importance of the effective use of inputs and agricultural innovations like the use of fertilizers and improved seeds / hybrids in enhancing agricultural productivity. While many studies in this area have focused primarily on exploring the effect of innovations in UPA on productivity, this study brings in a novelty by investigating how such practices can affect the efficient use of resources which can influence productivity positively. Hence, the results emphasize the crucial role of extension services in skill acquisition of farmers which enables them to adopt innovative techniques in production that enhance resource use efficiency and agricultural productivity. However, gender disparities, challenges related to farm size, and inefficient use of credit highlight the need for targeted interventions.

The study recommends the advancement of policies that encourage the adoption of sustainable methods, such as the use of organic fertilizers, composting, water harvesting, hydroponics and efficient irrigation systems to optimize resource use. The study further recommends that extension services that provide tailored training on proper fertilizer application techniques and effective implementation of UPA innovations to avoid misuse, and ensure resource use efficiency, and sustainability should be provided. Similarly, government should create policy frameworks that encourage private-sector investment and public-private partnerships in the development of technologies aimed at improving resource use efficiency in UPA. Further research into the effectiveness of UPA techniques and their scalability for widespread implementation in rapidly urbanizing regions would enforce understanding and insight into the contributions of innovative UPA to RUE, which will guide policy and decisions on the subject.

REFERENCES

1. Ajon H. L. (2015, March). A study of prevalence and risk factors of diabetic retinopathy in patients with non-arteritic anterior ischemic optic neuropathy (NA-AION). In Seminars in Ophthalmology. 30(2) 101-104.
2. Altieri, M. A., & Nicholls, C. I. (2020). Agroecology: Scaling up the regenerative agriculture movement. Sustainability, 12(14), 5787.
3. Asselin L and Tuan A (2005): Multidimensional poverty in Vietnam 1993 – 1998, According to CBMS indicators; Vietnam Socio-Economic Development Review, No 41.
4. Awah, A., & Bidogeza, J.-C. (2021). Dynamics and sustainability of urban and peri-urban vegetable farming in Yaoundé City, Cameroon. African Journal of Agricultural Research, 17(12), 1343-1359.
5. Davis, K. et al. (2012). "Impact of Agricultural Extension Services on Smallholder Farmers' Productivity: Evidence from the Northern Regions of Ghana." Journal of Agricultural Extension and Rural Development, 4(1), 13-21.
6. Davis, K., & Nkonya, E. (2019). "The Role of Agricultural Extension in the Dissemination of Innovation and Technology in Developing Countries." Agricultural Economics, 50(1), 101-113.
7. Feldt, T., Dittrich, N., & Karg, H. (2018). Urban and peri-urban agriculture in Bamenda: A policy narrative. Sustainable Development and Humanitarian Services Foundation.
8. Fombe, L. F., & Acha, M. E. (2020). Land use dynamics and variations in sprawl across municipalities in the Bamenda urban-scape from 1996 to 2018. Journal of Sustainable Development, 13(4), 224-240.
9. Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., Pretty, J., Robinson, S., Thomas, S. M., & Toulmin, C. (2010). Food Security: The Challenge of Feeding 9 Billion People. Science, 327(5967), 812–818.
10. Hodgson, K. T., & Dunkerley, D. (2019). Urban Agriculture: A Global Review of the Impacts of Reusing Water, Waste, and Energy Resources. Sustainability, 11(14), 3954.
11. Khonje, M. G., Mwiya, K., & Mbewe, S. (2015). "The impact of inorganic fertilizers on the productivity and resource efficiency of smallholder farmers in Zambia." African Journal of Agricultural Research, 10(5), 498-504.
12. Lin, B. B. (2015). Agroforestry Management in Urban and Peri-Urban Environments: A Review of Ecological and Socioeconomic Benefits. Agroforestry Systems, 89(3), 521–556.
13. Martin-Moreau, M., & Ménascé, D. (2019). Field Actions Science Reports Urban Agriculture: Another Way to Feed Cities Creative Commons Attribution 3.0 License.

14. Meinzen-Dick, R., et al. (2014). "Gender and sustainability in agriculture." Sustainability, 6(4), 1119-1131.
15. MINADER (2015). Department of Statistics, Ministry of Agriculture and Rural Development. Report from field survey in collaboration with Bamenda City Council, Cameroon. Working Document, No: 416, 2015
16. Ngetleh, N., Bime-Egwu, M. and Tambi, M. (2023) Drivers of Innovative Urban and Peri-Urban Agriculture in Bamenda City, Cameroon. Agricultural Sciences, 14, 1133-1152. doi: 10.4236/as.2023.149076.
17. Obienusi, C., Ogwueleka, T., & Ijeoma, E. (2014). Urban agriculture as a viable solution for food security in Nigeria. Journal of Agriculture and Sustainability, 5(1), 20-28.
18. Orsini, F. (2020). Innovation and sustainability in urban agriculture: the path forward. Journal fur Verbraucherschutz und Lebensmittelsicherheit 15(3). pp. 203–204.
19. Ruhweza, A. (2020, October 27). How can innovations in urban agriculture strengthen Africa's food systems and deliver benefits for nature and the environment? Commission on Sustainable Agriculture Intensification CoSAI. Retrieved from https://wle.cgiar.org/how-can-innovations-urban-agriculture-strengthen-africa-food-systems-and-deliver-benefits-nature-and-the-environment?
20. Sanyé-Mengual, E., Orsini, F., Oliver-Solà, J., Rieradevall, J., Montero, J. I., & Gianquinto, G. (2015). Techniques and Crops for Efficient Green Roofs in Dry and Mediterranean Climates. Ecological Engineering, 82, 275–285.
21. Sanyé-Mengual, E., Specht, K., Grapsa, E., Orsini, F., & Gianquinto, G. (2019). How can innovation in urban agriculture contribute to sustainability? A characterization and evaluation study from five Western European cities. Sustainability (Switzerland), 11(15).
22. Simtowe, F., & Zeller, M. (2016). "The Impact of Credit on Resource Allocation in Smallholder Agriculture: Evidence from Malawi." Agricultural Economics, 47(1), 37-48.
23. Specht, K., Siebert, R., Hartmann, I., Freisinger, U.B., Sawicka, M., Werner, A., Thomaier, S., Henckel, D., Walk, H. and Dierich, A. (2014) Urban Agriculture of the Future: An Overview of Sustainability Aspects of Food Production in and on Buildings. Agriculture and Human Values, 31, 33-51.
24. Sundberg, C., Parajuli, R., & Jansen, J. (2016). Solar Energy in Urban Agriculture: A Case Study of Solar Greenhouses and Vertical Farms. Renewable Energy, 89, 169-177.
25. Tambi, M. D. (2024). Women financial inclusion and household economic welfare in Bamenda, Cameroon. Journal of Quantitative Finance and Economics, 6(1), 109-138.
26. UN-Habitat. (2016). Slum Almanac 2015-2016: Tracking improvements in the lives of slum dwellers. Nairobi, Kenya: UN-Habitat. Retrieved October 12, 2024, from https://unhabitat.org
27. Yamane, T. (1967). Statistics: An introductory analysis (2nd ed.). New York: Harper & Row.
28. Zhang, J., Xu, Z., & Zhu, L. (2016). Factors affecting the adoption of agricultural technology in rural China: A systematic review. Sustainability, 8(10), 1026.