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Drivers of Innovative Urban and Peri-Urban Agriculture in Bamenda City, Cameroon

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Abstract

Urban and peri-urban agriculture (UPA) is gaining increasing importance in developing countries, due to rapid urbanization and rising rural-to-urban migration which has led to an increase in the population of the urban poor in Cameroon. It has been estimated that at least 70% of the total population of Cameroon will be living in urban areas by 2060. Urban and peri-urban agriculture (UPA) has become an important source of livelihood and survival, especially amongst the urban poor but is not adequately recognized and supported by the government of Cameroon and organizations. Recent innovations in UPA have created new opportunities for social, economic, and environmental sustainability of urban areas, hence possible policy formulation in UPA. Therefore, this study was conducted with the main objective of determining the drivers of innovative urban and peri-urban agriculture in Bamenda City, Cameroon. Methodologically, the study employed probit model, using primary data collected from a sample of 402 UPA farmers through the cluster, simple random, and snowball sampling techniques. The results revealed that access to extension services is a major driver of innovative UPA in Bamenda City and is statistically significant at 1%. Other factors such as employment status (full time), age group (26 to 50 years), and gender, were also seen to have a significant positive influence on innovative UPA while the level of education (secondary) had a negative influence on innovative UPA and was statistically significant at 5%. Limited capital, limited knowledge, and financial constraints were identified as the major challenges hindering the practice of innovative urban and peri-urban agriculture in Bamenda City. The study recommends that the government and non-governmental organizations should increase the quality and quantity of extension service delivery to urban and peri-urban farmers, and more recognition and support should be offered to them to help overcome the challenges faced.

Keywords

Drivers, Innovation, Urban and Peri-Urban Agriculture, Bamenda City

1. Introduction

Urban and Peri-urban Agriculture is a phenomenon that can be observed worldwide; it is a widely practiced industry that has existed for a long time. While featuring a range of different forms, it commonly encompasses all activities of plant cultivation and animal rearing within cities and towns and in their immediate surroundings [1]. 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" [2]. According to the Director of Foresight of the Veolia Institute, Nicolas Renard, "What is so striking about this agriculture is the extreme diversity of the forms it takes; it can be open air or indoor, in carefully sealed, protected, and controlled environments. It can be horizontal, like the community gardens of São Paulo, or vertical like in New York. It can be at ground level or in cellars or basements. Manual, like in Addis Ababa or robotized and automated like the farming factories of Japan. It can be on standalone plots or incorporated into existing buildings. It may be designed to reduce food bills for poor families, like in Quito or, conversely, to supply premium produce sold at high prices, like in Brussels. Its objective may be leisure, education, or production. It can use simple ancestral models or the latest technologies to maximize yields and minimize inputs. Its inspiration may come from conventional agriculture, hydroponics, aeroponics, permaculture, and more" [3].

Urban and peri-urban agriculture is experiencing 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 because the increasing growth of hunger in most parts of the world, especially in developing nations, has presented a huge challenge to governments. 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 [4]. Approximately 30% of the population in Nairobi is engaged in urban farming, and urban and peri-urban farmers control an estimated 75% of the vegetable value chain in urban Kenya [4]. Several African countries have witnessed economic crisis, civil strife and, in some cases, state failure, which has pushed many Africans into the practice of UPA. The primary driving force for continuous increase in urban and peri-urban farming in developing countries is a lethal combination of factors that

includes, worsening poverty, market failures, economic recession and political upheavals that cause food crisis throughout developing countries including Cameroon [5]. Urban farms, are generally managed by young entrepreneurs raised in the city, have a limited rural background, and are often highly open to technological innovations and smart agricultural techniques. This primarily enables the exploration of creativity in project design. There are, however, potential disadvantages to this increasing drive for urban and peri-urban agriculture including associated urban health risks and implications for the environment. The usage of wastewater, for example, may contaminate produced food and intensive irrigation might lead to the spread of malaria and water borne diseases, as well as threatening already limited water supplies.

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% [6]. 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 [7]. 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 City, 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) [8], and recent innovations such as the growing of mushrooms in pots, bags, and papers, within enclosed rooms. 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 recent socio-political crisis in the region. Urban agriculture reduces urban unemployment, poverty, and food insecurity in Bamenda City; it is an important source of livelihood and survival for the urban poor.

Most of the urban poor in Cameroon rely on the informal sector and unstable intermittent jobs for their survival whereas their livelihoods can be improved if the socio-economic potential and profitability of UPA is properly exploited, recognized, and promoted by government and all stakeholders. UPA is often tolerated by governments, but rarely encouraged despite its vital contribution to employment and livelihoods [3]. Many governments and non-governmental organizations funded agricultural projects in Cameroon are usually focused on

promoting smallholder agriculture and agricultural productivity in the rural areas. Usually, agricultural services are exclusively provided to rural farmers, while urban farming activities are left unattended. As a result, there is limited assistance to UPA in the provision of inputs like seeds, fertilizers, chemicals, and technical advice-resources that every farmer needs but are inadequate in the UPA contexts. Urban planners and managers focus more on providing services like housing, transport, water, and electricity, neglecting urban agriculture which is an integral component of the 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. According to the reports of the divisional delegation of the Ministry of Agriculture and Rural Development (MINADER) of the Northwest region of Cameroon, the total population of Bamenda City rose from 205,257 persons in 2016 to 467,726 persons in 2018 and it stands at 456,235 persons in 2022. The farming population of Bamenda City also rose from 78,606 farmers in 2016 to 124,701 farmers in 2018, and it currently stands at 200,859 farmers in 2022. This rapid urbanization of Bamenda City includes the migration of inhabitants of the rural areas (who are predominantly smallholder farmers) from the rural areas to the urban areas especially due to the sociopolitical crisis that has plagued the region since 2016. It therefore implies that there is a massive decrease in the population of farmers in the rural areas and there is a rising number of urban and peri-urban farmers.

The decrease in the population of rural farmers in the Northwest Region of Cameroon, has greatly affected agricultural production in the rural areas and food supply in Bamenda City. The Inadequate supply of food to Bamenda City has affected the livelihood and food security status of urban dwellers. Also, the migration of smallholder farmers (who depend predominantly on agriculture for survival) from the rural areas to the urban areas poses a problem, for there is need for new sources of income generation, accommodation, and survival of these migrant smallholder farmers. Moreover, the increase in the population of 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 agricultural productivity with limited resources. Providing technical, financial, and material support to UPA farmers will improve productivity and limit the negative impacts of urban agriculture on food safety and environment. For instance, 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. Moreover, by bringing close together urban farmers, their activity will be easily monitored, and that will facilitate food quality control. The government of Cameroon supports the practice

of UPA through the provision seeds, materials and extension services to both urban and rural farmers, but it however focuses on the growth and expansion of rural agriculture which is her primary agricultural policy focus [9]. It is true that urban agriculture alone cannot meet the food needs of a country and contribute entirely to its food security. However, its benefits and contributions especially to food security in the urban area should not be underestimated.

Drivers of innovative UPA refer to those factors, aspects, opportunities, benefits, and constraints that push people to engage in the activity of urban and peri-urban farming. Factors such as financial rewards, unemployment, poverty, resource availability, business opportunity/job creation, availability of donors and investors, government recognition and support, and the pursuit of good health and nutrition, are some examples of drivers of innovative UPA or factors that increase the practice of UPA. [10] identified several drivers of innovations in peri-urban agriculture in Kenya amongst which included, gender, household size, education level, household income, market integration, access to farmer's group, farm location, and environmental constraints. They found out that male-headed households with fewer members were more likely to adopt improved irrigation systems, and the education level of the household head was an important factor in determining the adoption of organic manure. Also, access to farmers' groups and information on new agricultural technologies and innovations significantly determined adoption of organic manure and integrated soil fertility management amongst peri-urban farmers in Kenya. Furthermore, in a study carried out by [11] on the factors affecting urban dwellers to practice urban agriculture, age, gender, education level and household size together with four latent factors (positive attitude towards urban agriculture concept, confidence in practicing urban agriculture, societal environment, and role model influences) were identified as the likely factors that would influence urban dwellers to practice urban agriculture. Today with the massive advancement of technology, the internet and social media are also a power media through which the recognition of, drive for and increase adoption of innovative UPA is advocated for and encouraged, especially amongst young people.

2. Methodology

The study covers the three municipalities of Bamenda (Bamenda I, II and III) in Mezam division of the Northwest Region of Cameroon corresponding to seven communities; (Bamendakwe, Nkwen, Ndzah, Mankon, Chomba, Nsongwa and Mbatu). Bamenda is located between latitude 5˚56" and 5˚58" north of the Equator and longitude 10˚09" and 10˚11" east of the Greenwich Meridian, situated at 1258 meters above sea level (Master Plan of Bamenda City council, 2011-2027 cited in [12]. The town is bounded to the west by the Momo division, to the southwest by Bali sub-division, to the northwest by Bafut sub-division, and to the northeast by Tubah sub-division, Ngoketunjia division to the east and to the south by Santa sub-division. 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 rainy season usually begins around March to mid-October. The rainfall ranges from 2000 to 3000 mm per annum. The dry season is usually from mid-October to February. The nights are generally very cold while the days are hot.

The research focused on people and groups in urban and peri-urban contexts in Bamenda City (Bamenda I, II and III, Municipalities), who were engaged in the practice of urban and peri-urban agriculture. This category included farmers, households practicing agriculture within and around the homestead, as well as agricultural organizations. These groups of people to whom a questionnaire was administered, are an appropriate representative for the research objectives of this study since they are involved in one or several forms of urban and peri-urban agriculture in Bamenda City and are at the forefront of innovations in urban and peri-urban agriculture in Bamenda City. The study population comprised of market gardening farmers (including greenhouse farmers), mushroom farmers, pisci-culture, and livestock farmers. These actors (a total of 402 persons) were selected from the urban space (Bamenda I, II and III) of the seven communities which make up Bamenda. The sampled areas included the urban spaces of; Bamendakwe, Nkwen, Ndzah, Mankon, Chomba, Nsongwa and Mbatu.

The Sampling techniques that were used in the study were obtained from both the probability and non-probability sampling methods. The sampling techniques used included the cluster sampling, simple random sampling, and snowball sampling techniques. This was done by dividing the area into three clusters according to the various municipalities (Bamenda I, II and III clusters respectively), and collecting data 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 pisci-culture farmers. This was because the population of market gardening and livestock farmers was easily identifiable and reachable, and could therefore be randomly selected, whereas the population of mushroom farmers, greenhouse farmers, and pisci-culture farmers was not easily identifiable and reachable. Through the snowball sampling technique, existing subjects were used to recruit future subjects from among their acquaintances. Therefore, farmers who were interviewed were asked to identify others in the population. Data obtained was manually treated and analyzed using the Statistical Package for the Social Sciences (SPSS) version 22, STATA 15, and Microsoft Excel 2021.

Model Specification

Modeling econometrically the drivers of innovative urban and peri-urban agriculture in Bamenda City, the economic model of the family developed by

[13] and as applied by [14] was used. It forms the conceptual basis for the analysis of the drivers of innovative urban and peri-urban agriculture. Based on these authors, the relationship between drivers of innovative UPA and innovative UPA can be described within the framework of a simple household production model. Thus, the generic model of the drivers of innovative UPA for farmer *i*, is assumed to be:

$$IUPA_i = \lambda_1 \mathcal{X}_i + \delta_i DRV_i + \varepsilon_{1i} \quad (1)$$

where $IUPA_i$ is a binary variable representing farmer i's innovations in urban and peri-urban agriculture, $\mathcal{X}_i$ is a vector of Household characteristics such as: gender of farmers, education and training, household location, access to credit, access to extension services, average monthly expenditure, employment status of farmer, household size etc. These are factors that can influence innovative UPA apart from drivers of innovative UPA. DRV represents drivers of urban and peri-urban agriculture, λ_1 is a coefficient representing a set of parameters of exogenous explanatory variables that correlate with innovative UPA generating functions to be estimated, δ_i is the parameter of primary interest and represents the impact that Drivers of UPA have on innovations in urban and peri-urban agriculture in Bamenda City, ε_{1i} is a random error term.

However, this single-equation estimate (1) may be upward or downward biased depending upon the effect that drivers of innovative UPA have on innovative UPA and on the correlation between omitted variables and innovative UPA. For example, as noted by [14], if drivers of innovative UPA have a positive impact on innovative UPA, then we would expect the probit estimate δ_1 to be biased upward. In empirical estimation, the prime difficulty of the two-way causality that comes in the effect that drivers of innovative UPA have on innovative UPA may cause the classical endogeneity problem. To avoid the strong likelihood of this endogeneity bias, confounded by the problem of variables that are missing in empirical data, there has been a careful selection of variables to be used in the equation. This means that the model is the best fit. Thus, drivers of innovative urban and peri-urban characteristics include: forms of innovations in UPA (outcome variable), the exogenous characteristics are: gender, age of respondent, level of education, marital status, nature of agricultural training, average monthly household expenditure and average household food expenditure (to serve as a proxy for income), household size, household location, employment status, access to credit and access and land ownership, access to extension services and technical assistance, government policy and donor support, subsistence and livelihood purposes, nutritional and health purposes, as well as financial rewards.

3. Empirical Results

3.1. Summary of Descriptive Statistics

The results of the summary statistics in **Table 1** below indicate that 65.9% of

Table 1. Summary of descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max	Cronbach's Alpha
Innovative UPA (1 = yes, 0 = otherwise)	402	0.659204	0.4745675	0	1	0.4270
Gender (1 = male, 0 = otherwise)	402	0.5373134	0.4992271	0	1	0.5042
Age group (26 to 50 years)	402	0.4900498	0.5005239	0	1	0.4754
Educational level (1 = Secondary, 0 = otherwise)	402	0.1716418	0.3775387	0	1	0.5197
Marital Status (1 = Single, 0 = otherwise)	402	0.4179104	0.4938299	0	1	0.5205
Household Size (1 = Small < 5 persons , 0 = otherwise)	402	0.2810945	0.4500937	0	1	0.5309
Employment Status (1 = Full time, 0 = otherwise)	402	0.3681592	0.4829059	0	1	0.4785
Nature of Training (1 = Professional or Technical training, 0 = otherwise)	402	0.3358209	0.4728651	0	1	0.5328
Access to Extension Services (1 = yes, 0 = otherwise)	402	0.3532338	0.4785702	0	1	0.3819
Access to Credit (1 = yes, 0 = otherwise)	402	0.221393	0.4157019	0	1	0.4383
Household Location (1 = urban, 0 = otherwise)	402	0.3905473	0.488481	0	1	0.5248

Source: Author from field survey (2022).

farmers included in the sample were applying a given form of innovation in their practice of urban and peri-urban agriculture. The Cronbach's Alpha coefficient of all variables is between 0.3819 and 0.5328 showing adequate consistency reliability between variables. The closer Cronbach's Alpha coefficient is to "1" the stronger is the correlation among items.

Male farmers constituted 53.7% of the population of farmers applying innovations in their practice of UPA. The difference between the male (53.7%) and the female (46.2%) farmers adopting an innovation in UPA is not very large (approximately 7 persons), implying that there is a considerable rate of adoption of agricultural innovations amongst farmers in Bamenda City, with male farmers having a higher rate of adoption of innovations compared to female farmers. [10] recorded similar results in a study on the drivers of sustainable intensification in Kenyan rural and peri-urban vegetable production, where it was found that male-headed households with fewer members were more likely to adopt improved irrigation systems. [7] also found out that most (57%) of vegetable producers in Yaoundé (the capital city of Cameroon) were male. In addition, the mean number of single farmers (41.8%) shows that the number of single farmers practicing innovative UPA in Bamenda City is lower than the number of married farmers. This finding relates with the results [15] in Zambia which indicate that urban agriculture participants are more likely to be married (75.73%) and have a higher population than the single participants. [16] also recorded similar results amongst urban farmers in Ibadan Nigeria where about 66% of the male and 56% of the female were married. This can be explained by the fact that the household size of single farmers is usually very small compared to the household

size of married farmers, and married farmers therefore consider several options including innovative UPA, to meet up with the food needs of their large households.

Furthermore, the mean number of farmers in the age group of 26 to 50 years is 49% indicating that a majority of urban and peri-urban agricultural farmers fall under the active age group of 26 to 50 years. This result is line with the results of [17], and [16] who recorded similar average age ranges for UPA male and female gardeners. As for the level of education, only 17.2% of farmers who have completed secondary education are practicing innovative UPA, this figure shows that urban farmers with secondary education in Bamenda City share a common characteristic with rural farmers which is that of limited application of innovative methods in agricultural production. Furthermore, the average number of farmers engaged in the full-time activity of UPA is 36.8%, implying that a greater majority of farmers practicing urban and peri-urban agriculture in Bamenda City are part-time farmers. This is so because Bamenda City is an urban area which has several activities and offers varied opportunities for income generation unlike the rural areas where agriculture is the major activity and major source of income for the household. Therefore, it is common to find people engaged in agriculture as part-time farmers, and usually for subsistence, health and nutritional purposes, and leisure. The descriptive statistics also show that 33.6% of farmers in Bamenda City who have undergone a professional or technical training in agriculture are practicing innovative UPA which is comparatively higher than the results of the formal education level (secondary education, 17.2%). It can be deduced from these results that farmers practicing UPA prefer to pursue a technical (practical) form of training compared to a formal (less practical) form of training such as secondary education.

As concerns access to extension services, only 35.3% of sampled farmers had access to extension services. This figure confirms the ongoing agricultural policy of the government of Cameroon which tends to focus more on enhancing agricultural production of smallholder rural farmers, with inadequate attention to urban farmers. In addition, 22.1% of farmers had access to credit for agricultural population. Several financial institutions in Bamenda City are yet to have a credit policy for farmers which does not require a collateral, this explains the low rate of access to credit amongst farmers since majority of urban and peri-urban farms are usually leased by single farmers or are owned by their families. Moreover, since most farmers practicing UPA are part-time farmers, there is little need for massive investments in the activity which usually require access to credit. Also, only 39.1% of farmers engaged in the activity of urban and peri-urban agriculture live in the urban area, indicating that majority of these farmers live in the peri-urban area of Bamenda City.

3.2. Estimates of the Drivers of Innovative UPA in Bamenda City

It can be observed from the results in Table 2 below, that the variable male with

Table 2. Estimates of the drivers of innovative UPA.

Practice of Innovative UPA	Coef.	Std. Err.	Z	P > |z|
Male	0.41333***	0.14709	2.81	0.005
Age group (26 to 50 years)	0.52784***	0.15793	3.34	0.001
Secondary Education	−0.26351	0.20081	−1.31	0.189
Single	0.19902	0.17331	1.15	0.251
Household Size (Small < 5 persons)	−0.25176	0.17030	−1.48	0.139
Employment Status (Full time)	0.46967***	0.16728	2.81	0.005
Professional/Technical training	−0.27735	0.18731	−1.48	0.139
Access to extension	0.81813***	0.20635	3.96	0.000
Access to credit	0.26701	0.23882	1.12	0.264
Household location	0.22745	0.15645	1.45	0.146
Constant	−0.32231*	0.17466	−1.85	0.065
Number of observations		**402**		
LR Chi^2 (11)	101.91	n/a	n/a	n/a
Prob > Chi^2	0.0000	n/a	n/a	n/a
Log likelihood = −206.95438	Pseudo R^2 = 0.1976	n/a	n/a	n/a

Source: Author from field survey (2022). *, **, ***, represent 10%, 5% and 1% percent level of significance respectively.

coefficient 0.41333 has a positive influence on innovative urban and peri-urban agriculture and is significant at a 1% level of significance. This can be explained by the fact that male farmers are usually the breadwinners of their families and are therefore always seeking new ways to generate more income, one of such ways is innovative UPA. The results corroborate the findings of [17] in Buea, Cameroon who found out that male gardeners engage in the practice of UPA mainly for income.

The age group of (26 to 50 years), and the employment status of the farmer in agriculture (full time) with coefficients 0.52784 and 0.46967 respectively, also influence positively and significantly the practice of innovative UPA at 1%. This is understandable because the age group of 26 to 50 years is made up of the youths and active working population who are usually innovative and active, while those who engage full time in the practice of innovative UPA tend to focus deeply on the activity and learn more about innovations and put them into practice unlike their counterparts who engage only part time in the activity. [15] recorded similar results with the age group of household heads practicing urban agriculture in Zambia, having a coefficient of 0.0453 and highly statistically significant at 1%. In addition, access to extension with a coefficient of 0.81813 influences innovative UPA positively and is statistically highly significant at a 1%.

This means that when one extra farmer gains access to extension services, the probability of an increase in the practice of innovative UPA is 81.8%.

The results also show the coefficients of access to credit (0.26701) and household location (0.22745) which are positive and have a positive effect on innovative UPA but are however insignificant. The insignificance could be because of the low percentage of urban farmers (36.8%) employed full time in the activity of UPA, as observed in Table 1 above. Moreover, majority of farmers usually engage in the practice of UPA mainly for subsistence and health purposes and therefore find no reason to seek for loans, which are usually sought by farmers who intend to increase their agricultural productivity and make a profit from the sale of agricultural products. The marital status (single) of the farmer with coefficient 0.19902 also influences innovative UPA positively with no significance. Other variables such as secondary education, household size and nature of training in agriculture (professional or technical training), have negative coefficients (−0.26351, −0.25176, and −0.27735 respectively) indicating a negative effect, and are statistically insignificant. This implies that an increase in secondary education by one farmer will lead to a 26.3% decrease in innovative urban and peri-urban agriculture, while an increase in professional training by one farmer will lead to a 27.7% decrease in innovative UPA. However, these results are insignificant, and it would be necessary to examine them further by increasing the sample size which will increase the degree of confidence of the result.

3.3. Estimates of Drivers of Innovative UPA by Farmers' Educational Level

This study categorized four different education levels that farmers practicing innovative UPA are likely to have attained. They include the Tertiary, Secondary Primary and No formal education levels.

Correlates of Tertiary education

Tertiary education according to this study refers to higher levels of education such as a university degree or diploma. The total number of farmers who had obtained tertiary education, and were actively engaged in the practice of innovative UPA was only 7 persons out of the sample of 402 farmers, representing only 1.7% of the sampled population of UPA farmers. This result brings out an unexpected finding because the expectation is that farmers located in the urban and peri-urban areas should have more access to tertiary education and would be actively engaged in the practice of innovative UPA. This result is contrary to the findings of [11] who revealed that respondents with higher education level are 2.023 times likely to practice urban agriculture than respondents with lower education level.

It can be observed from the table above that only four variables are statistically significant when looking at the drivers of innovative UPA by tertiary education. The variables age group (26 to 50 years) with coefficient 0.653 and access to extension with coefficient 0.697 influence innovative UPA positively and are statis-

tically significant at 5%. This means that when one farmer between the age group of 26 to 50 years obtains tertiary education, the probability that the practice of innovative UPA would increase is 65.2%. This is according to priori expectation because this age group is made of the youths who tend to be more innovative when they are trained and empowered. Also, when a farmer who has attains tertiary education gains access to extension services, there is a likelihood that the practice of innovative UPA would increase by 69.7%. This is expected because access to extension empowers farmers to be more innovative and productive. Employment status (full time) is also seen to have a positive influence on innovative urban and peri-urban agriculture when the farmer has obtained tertiary education, with a coefficient of 0.5011148 and a 10% level of significance. Therefore, when one farmer with tertiary education engages full time in the activity of UPA there would be a 50.1% increase in the practice of innovative UPA.

Secondary education (with coefficient −0.811) on the other hand influences the practice of innovative UPA negatively, even when the farmer has obtained tertiary education and this result is statistically significant at 5%. From this result it can be inferred that when a farmer who has secondary education obtains tertiary education, there is an 81.1% decrease in the probability of practice of innovative UPA. This could be because many of these farmers who obtain tertiary education tend to use their certificates to seek for other jobs or opportunities that offer more benefits compared to the benefits obtained from the practice of innovative UPA. This result corroborates the findings of [18] mentioned in [10] who found out that better educated farmers may be less willing to invest in labour intensive technologies and would rather opt for off farm jobs offering better returns on labour. All the other variables included in the table above are statistically insignificant, with household size and nature of training (professional / technical training), having a negative influence on innovative UPA when tertiary education is considered.

Correlates of Secondary education

In this study, secondary education refers to both secondary and high school grades according to the Cameroonian context. The table below shows that the total number of farmers from the sampled population (402) of UPA farmers in Bamenda City who have obtained secondary education and are engaged in the activity of innovative UPA is 69. From this result, it can be deduced that only 17.1% of sampled UPA farmers who have attained the level of secondary education are practicing innovative UPA.

Furthermore, it can be observed from the correlates of secondary education that several variables are statistically insignificant when the drivers of innovative UPA are estimated by secondary education. Only three variables, employment status, access to extension, and household location are significant when secondary education is considered. Household location with coefficient 1.793 has a positive influence on innovative UPA and is statistically highly significant at 1%

when drivers of innovative UPA are considered in terms of secondary education. This implies that there is a 179.3% probability of increase in innovative UPA when the household location of a farmer with secondary education changes. This is possible because farmers tend to be more innovative when there is limited space for agriculture, which is a common characteristic of urban areas with large populations and built-up areas. Furthermore, the employment status (full time) of the farmer with coefficient 0.951 has a positive effect on innovative UPA when the farmer has secondary education, and it is significant at 5%. Also, access to extension with coefficient 1.520 influences innovative UPA positively at a significance level of 10% implying that when one farmer who has access to extension services attains secondary education, there is a 152% chance that innovative UPA would increase. This result re-emphasizes the importance of extension services to farmers, and in the promotion of agriculture.

Other variables which have a positive effect but however no significance as seen in the table above are household size (51.1%) and access to credit (39.3%). The variables including gender (male), age group (26 to 50 years), marital status (single), and nature of training (professional/technical training) tend to influence the practice of innovative UPA negatively one farmer attains secondary education. For example, when one male farmer obtains secondary education, innovative UPA is expected to decrease by 1.2%, and when one farmer who is single obtains secondary education, innovative UPA is expected to decrease by 20.5%. This negative effect could be because many farmers prefer to seek other opportunities after their secondary education. These results are however statistically insignificant as seen in the table above.

Correlates of Primary education

Primary education in this study refers to the elementary and basic level of education according to the Cameroonian educational system. As can be seen in the table below, 112 farmers out of the sampled population of UPA farmers (402) who had attained the level of primary education were applying innovative UPA, representing 27.8% of the total sampled population. This figure is higher than that of tertiary education and secondary education discussed in Table 1 and Table 2 above. This implies that farmers with primary education are more likely to adopt innovations and engage in the activity of innovative UPA than farmers with secondary and tertiary education in Bamenda City.

Also, employment status (full time) with coefficient 0.858 and access to extension services with coefficient 0.978 influence innovative UPA positively when the farmer has primary education, at a significance level of 5%. According to these results, when one farmer who has attained primary education engages full time in innovative UPA, there is a probability that innovative UPA is going to increase by 85.8%. This could be explained by the fact that people tend to be more innovative and efficient when they engage full time in an activity in which they pay full attention to it. Therefore, a farmer who engages full time in urban

and peri-urban agriculture is likely to be innovative irrespective of his level of education. Furthermore, when one farmer who has primary education obtains access to extension services, there is a probability that innovative UPA would increase by 97.8%. This result buttresses the expectation that extension services play a key role in the advancement of agriculture.

Professional/Technical training (−0.722) on the other hand influences innovative UPA negatively when the farmer has primary education, and it is statistically significant at 10%. Thus, when one farmer who has primary education obtains professional/technical training in agriculture, there is 72.2% chance of decrease in the practice of innovative UPA. This finding is contrary to prior expectation since professional/technical training in agriculture is expected to enable farmers to adopt innovations and be more innovative in their practice of UPA. There is therefore a possibility that the type of professional/technical training offered to UPA farmers in Bamenda City is obsolete or does not adequately cover recent innovations such as roof top gardening, vertical farms, greenhouse farming etc. This can be attributed to limited resources to invest in such innovations in a developing country like Cameroon, consequently the nature of training is limited and hence the negative relationship between the nature of training and innovative UPA.

Other variables including gender (male), age group (26 to 50 years), access to credit and household location have a positive effect on the practice of innovative UPA when the farmer has primary education but are however statistically insignificant. Marital status (single) and household size have a negative influence on innovative UPA when the farmer has attained the level of primary education, however this relationship is statistically insignificant.

Correlates of No formal education

A great number of farmers in Africa have no formal education, many of them are smallholder farmers who engage in the activity as a source of livelihood and survival, and usually have inadequate resources or interest to pursue goals such as education. It can be observed from the results in Table 3 that the number of farmers from the sample (402) who have no education and are practicing innovative UPA are 214 persons, representing 53.2% of the total sampled population of farmers practicing UPA in Bamenda City. The results show that farmers (urban or rural) generally do not consider formal education as important or a necessity for them in carrying out their agricultural activities. This is true because no formal education or qualification is required before a person becomes a farmer, anyone can engage in the activity even with unskilled labour. Farmers learn innovative methods while practicing the farming activity, and as can be seen in Table 3, extension services are a major key to bridging the gap of lack of formal education and enabling farmers to be innovative in their practice of UPA. Access to extension services has a coefficient of 0.855 and it is statistically highly significant at 1%. This means that when one farmer with no education gains access to extension services, innovative UPA is likely to increase by 85.5%.

Table 3. Estimates of drivers of innovative UPA by farmers' educational level.

Variables	Tertiary	Secondary	Primary	No Education
	Innovative UPA			
Male	0.318 (1.38)	−0.012 (−0.03)	0.447 (1.42)	0.411* (1.99)
Age group (26 to 50 years)	0.653** (2.47)	−0.020 (−0.05)	0.254 (0.73)	0.928*** (3.78)
Secondary Education	−0.811* (−1.98)	0 (n/a)	0 (n/a)	0 (n/a)
Single	0 (n/a)	−0.206 (−0.40)	−0.289 (−0.79)	0.528** (2.04)
Household Size (Small < 5 persons)	−0.218 (−0.95)	0.511 (0.76)	0.170 (−0.51)	−0.211 (−0.91)
Employment Status (Full time)	0.501* (1.85)	0.952** (2.12)	0.858** (2.51)	−0.031 (−0.11)
Professional/Technical training	−0.345 (−1.01)	−0.816 (−1.29)	−0.722* (−1.75)	−0.166 (−0.58)
Access to extension	0.697** (2.19)	1.520* (1.72)	0.978** (2.14)	0.855*** (3.05)
Access to credit	0.076 (0.18)	0.393 (0.45)	0.312 (0.59)	0.151 (0.48)
Household location	0.104 (0.44)	1.793*** (2.75)	0.000 (0.00)	0.189 (0.86)
Constant	0.208 (0.54)	0.208 (0.54)	0.208 (0.54)	−0.411* (−1.71)
Number of Observations	**07**	**69**	**112**	**214**
LR Chi^2 (10)	40.85	34.84	38.27	64.30
Prob > Chi^2	0.0000	0.0001	0.000	0.000
Log likelihood	−90.193	−29.174	−52.609	−101.634
Pseudo R^2	0.185	0.374	0.267	0.240

Source: Author from field survey (2022). *, **, ***, represent 10%, 5% and 1% percent level of significance respectively.

Moreover, from Table 3 above, age group (26 to 50 years) with coefficient 0.928 has a positive influence on innovative UPA when the farmer has no education, and it is statistically highly significant at 1%. This means that one farmer with no education within the age group of 26 to 50 years has the probability of increasing innovative UPA by 92.8%. This can be attributed to the innovative characteristics of the youthful population found within this age group. Also, the marital status of the farmer (single) with coefficient 0.528 is seen to have a positive influence on innovative UPA when the farmer has no education with a level

of significance of 5%. The positive relationship between single farmers with no education and innovative UPA could be because these farmers are overwhelmed by the social responsibility that usually accompanies marriage, so they can invest their resources in innovations such as greenhouses, aquaponics, hydroponics etc. Moreover, male farmers with no education (0.411) also have a positive effect on innovative UPA with a statistical significance of 10% implying that when one male farmer with no education engages in urban and peri-urban agriculture, there is a 41.1% chance of increase in innovative UPA. This could be because male farmers tend to engage in the practice of UPA for profit unlike their female counterparts who usually engage in the practice for subsistence. They are therefore likely to invest their resources in innovative methods that are profitable.

According to the results in **Table 3** above, access to credit and household size have a positive effect on innovative UPA when the farmer has no education, however this result is statistically insignificant. Variables such as household size, employment status and professional training influence innovative UPA negatively when the farmer has no education and are statistically insignificant.

3.4. Challenges Faced in the Application of Innovative UPA

Several challenges were identified in the study as hindrances to the practice of innovative UPA in Bamenda City. Some of the challenges identified included, financial constraints, limited capital, limited knowledge, limited market access, limited space, poor government policies, and the socio-political crisis plaguing the region. **Table 4** below ranks these challenges providing a picture of challenges which are most common to farmers in Bamenda City.

Challenges such as limited capital, limited knowledge and financial constraints were identified by the farmers in the sampled population as the major challenges limiting their application of innovative UPA. Limited capital was identified by 113 out of 402 farmers as a major constraint, with a percentage of 28.11%, this challenge had the highest frequency and could be attributed to the high cost of implementing and maintaining certain innovations such as greenhouses. The finding is consistent with [19] in a study on the Challenges of Women in Urban Agriculture in Kwara State Nigeria, in which 46.4% of sampled women farmers ranked lack of credit facilities as the most pressing problem they faced in carrying out urban agriculture. [16] also reported that unavailability of land and lack of access to credit were some of the factors identified by both male and female respondents as these ranked 1st and 2nd. Furthermore, 85 persons out of 402 attributed the challenge of adoption of innovations in UPA to limited knowledge with a percentage rate of 21.4%. This is true because without adequate knowledge and understanding of how a given form of innovation works, it would be difficult to adopt it. In addition, 79 farmers identified financial constraints with a percentage rate of 19.65%, as the third major challenge faced by farmers in the application of innovative UPA. Financial constraints in the same way as limited capital also pose as a major challenge to farmers because

Table 4. Challenges faced by UPA Farmers in the Application of Innovative UPA.

Variable	C	NC	CF	Rank	%
Finances	79	323	0.197	3	19.65
Capital	113	289	0.281	1	28.11
Knowledge	85	317	0.211	2	21.14
Market access	10	392	0.025	7	2.49
Space	6	396	0.015	9	1.49
All the above	3	399	0.007	11	0.75
Capital, limited technical knowledge, and market access	1	401	0.002	13	0.25
Capital and technical knowledge	37	365	0.092	4	9.20
Socio-political crisis	5	397	0.012	10	1.24
Capital and socio-political crisis	2	400	0.005	12	0.50
Finances and capital	32	370	0.079	5	7.96
Finances and technical knowledge	9	393	0.022	8	2.24
Capital and space	2	400	0.005	12	0.50
Government policies	13	389	0.032	6	3.23
Capital and market access	5	397	0.012	10	1.24
Total	**402**	**n/a**	**1**	**n/a**	**100.00**

Source: Author field survey (2022). **NB: C** is challenge, **NC** is no challenge, **CF** is challenge frequency, **%** is percentage.

of the high cost of some forms of innovations and it is usually difficult for farmers to adopt such innovations without support from the government, non-governmental organizations, partners, and investors. These three challenges constitute the major challenges faced by farmers in Bamenda City, with some of them experiencing all or both (for example limited capital and limited knowledge 9.2%, financial constraints and limited capital 7.96% etc.) as a challenge.

Other challenges such as poor government policies were identified by 13 persons as a challenge representing 3.23% of the sampled population. 10 farmers complained of limited market access representing 2.49% of the sampled population, 1.49% (6 farmers) complained of limited space as a challenge to innovative UPA and 1.24% (5 farmers) identified the on-going socio-political crisis plaguing Bamenda City as a challenge to the application of innovative UPA.

4. Conclusions

The objective of the study was to determine the drivers of innovative urban and peri-urban agriculture in Bamenda City. The source of information was primary data collected from a sample of 402 UPA farmers in Bamenda City using the

cluster, simple random, and snowball sampling techniques. From the primary surveyed data, a probit model was used to analyze the results.

The results revealed that, gender (male), age group (26 to 50 years), employment status (full time), and access to extension services have a positive and significant effect on innovative urban and peri-urban agriculture. This implies that the more a farmer gains access to extension services, the more likely is going to be an increase in the rate of innovative UPA. Also, when a farmer engages full time in the activity of urban and peri-urban agriculture, there is going to be a rise in innovative urban and peri-urban agriculture in Bamenda City.

Furthermore, when looking at the drivers of innovative UPA in Bamenda City in terms of education level, access to extension services, employment status, and age group had a positive influence on innovative UPA and were statistically highly significant. In addition, it was found that only a very limited percentage (1.7%) of sampled farmers who had attained tertiary education level was engaged in the practice of innovative UPA. The greatest proportion of farmers practicing innovative UPA (53.2%) had no formal education, implying that farmers generally do not consider formal education as important or a necessity for them in carrying out innovations in their agricultural activities. In addition, the major challenges identified by farmers as hindrances to the adoption of innovative urban and peri-urban agriculture were limited capital, limited knowledge, and financial constraints.

It can be deduced from the findings of this study that access to extension services is a major driver of innovative UPA in Bamenda City. Based on the findings from the results, the study recommends that the government of Cameroon and agricultural NGOs should increase their outreach to urban and peri-urban farmers through extension services. More urban and peri-urban farmers should be granted access to extension services through which they will gain the necessary knowledge that will enable them to adopt innovations, thereby fostering the practice of innovative UPA in Bamenda City. In addition, more recognition and support should be offered to UPA farmers which will help them overcome the major challenges identified in this study and increase their practice of innovative UPA.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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