1 **THE EXTENT OF PARTICIPATION IN URBAN AGRICULTURE AND ITS EFFECT**
2 **ON FOOD SECURITY IN AFRICA AND ASIA: EVIDENCE FROM GHANA AND**
3 **INDIA**

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THE EXTENT OF PARTICIPATION IN URBAN AGRICULTURE AND ITS EFFECT ON FOOD SECURITY IN AFRICA AND ASIA: EVIDENCE FROM GHANA AND INDIA

Abstract

This study examined the factors that influence the extent of urban agriculture participation and its effect on food security in Ghana and India. A total of six hundred and fifty urban agriculture farmers were interviewed for this study in Ghana and India. Food security status of urban households was assessed by the use of the Household Food Insecurity Access Scale whereas the determinants of the extent of urban agriculture and its effect on food security were analysed by the use of the heteroskedastic linear regression and the Seemingly Unrelated Regression models, respectively. From the study on average, households in Ghana were mildly food insecure, but that of India was moderately food insecure. The results further revealed that, various demographic, economic, institutional and health and nutrition factors differently influenced urban food security and urban agriculture. Also, the extent of urban agriculture participation positively influenced food security. It is recommended that, Governments and NGOs interested in the reduction of urban food insecurity should aggressively advocate for urban agriculture in urban households through extension education. Interests could be stimulated by gleaning on health benefits of urban agriculture such as producing safe and nutritious food, the opportunity to consume chemical-free food and pursue urban agriculture as a business. The implication for research is that similar studies can be conducted in other emerging urban cities in Africa and Asia for the advocacy for specific urban food security policies and programmes.

Keywords: urban agriculture, food security, Seemingly Unrelated Regression, HFIAS, per capita food expenditure

1.0 INTRODUCTION

Asia and Africa are anticipated to have the most considerable urban population growth by approximately 2.8 billion and 824 million, respectively, by 2030 (FAOSTAT, 2019). Likewise, the urban population in most developing countries (including Ghana and India) are growing at an increasing frequency, whereas the reverse is exact of the rural population (Crush and Frayne, 2011). Currently, about 56.1 % of the total population in Ghana are in urban areas (FAOSTAT, 2019). India, on the one hand, has rapidly grown in urban population from 31% since 2011 and is expected to increase by 34 % in 2030 (FAOSTAT, 2019; Singh and Singh, 2020). Specifically, the second-highest growth rate of population is expected to be in Bihar (55.4%) in India (Singh and Singh, 2020). In parallel, Ghana has witnessed a rapid growth in the urban population of almost all its regions (Ghana Statistical Service 2013a). The swift changes in the urban and rural population of most countries in Africa and Asia have led to a growth in urban food insecurity as well as increasing levels of poverty and other social challenges (Satterthwaite et al., 2010; Crush and Frayne, 2010). At the same time, an agribusiness opportunity has arisen due to the high demand for agricultural produce.

Food security is, ‘When all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life’, by the World Food Summit of 1996’. This definition encapsulates four main dimensions¹:

¹Food availability at the household level is about the household focusing on food production, reduction of postharvest losses and also ensuring the ability of the household to buy food when needed. At the same time, accessibility is, generally about the household’s ability to access the food both physically and economically. This is very prominent in urban areas where there is insufficient access to food due to poverty and high prices of food. With this, in our research we proposed that urban agriculture can have significant influence on accessibility of households. Food utilisation, however, is concerned with the consumption of micronutrients to concerns about only protein and energy as seen to be in the first two dimensions. The three dimensions are not independent of each other. Hence, they should all be stable overtime.

1 'physical availability of food'; 'economic and physical access to food'; 'food utilisation'; and 'the
2 stability of the other three dimensions over time'. It can, therefore, be inferred that food security is
3 a multivariate idea influenced by an array of factors. While urbanisation is one of the factors that
4 destabilises food security dimensions, Urban Agriculture (UA) is perceived to be a crucial strategy
5 to curtail food insecurity in urban areas and cities by several international organisations,
6 researchers and practitioners. Few critics, however, maintain that, UA does not really have an
7 impact on the poor since they do not have the economic resources to undertake the same (Webb,
8 2011; Battersby, 2013; Haysom & Battersby, 2016). Nevertheless, many scholars argue that the
9 significance of UA to food security in urban spaces cannot be overemphasised (Poulsen et al.,
10 2015). Consequently, some studies have been conducted by researchers via different qualitative
11 and descriptive approaches (Cook et al. 2015; Ayerakwa, 2017). Simultaneously, other authors
12 used inferential statistics to discuss the factors that influence food security (Agarwa et al. 2009;
13 Chatterjee et al., 2012; Joshi et al., 2019; Ayerakwa et al., 2020). However, only a few intercountry
14 studies have been conducted. For instance, Frayne et al. (2016) examined the effect of UA on food
15 security in eleven African countries. In Asia, Diehl et al. (2019) descriptively discussed the food
16 security of migrants who are urban farmers in Delhi, Jakarta, and Quito.

17
18 It is evident that, studies on UA participation and its effect on food security have been primarily
19 conducted within limited geographical areas in countries or between countries within the same
20 continent with few known contemporaneous studies in Africa and Asia. Thus, a research on the
21 two continents together will give development practitioners a snapshot of the effect of UA on food

1 security in growing urban areas in Africa and Asia and aid them to strategise to improve the same.
2 Besides, majority of the studies on food security have been widely done by the use of descriptive
3 statistics and the use of one food-security measurement. In this research, we add to the body of
4 available literature by validating a subjective food security measurement tool (Household Food
5 Insecurity Access Scale (HFIAS)) with an objective tool (per capita food expenditure) that is used
6 to measure the access dimension of food security. Moreover, we extend the frontiers of
7 methodological approach by applying the Seemingly Unrelated Regression (SUR) model to
8 understand if the factors that affect food-security accessibility are correlated. Furthermore, several
9 studies in Asia (India) and Africa (Ghana) on urban food security have been geographically limited
10 to New Delhi, Mumbai and Greater Accra, with few studies in the Middle Belt of Ghana, and Bihar
11 in India. Besides, there is a limited, rigorous, empirical study on the effect of the extent of UA on
12 food security in Asia (India) and Africa (Ghana) individually and together.

13
14 Given the dearth of concurrent research on urban cities in Africa and Asia on the extent of UA,
15 urban food security vis à vis its effect on food security, the objectives of this study are in threefold
16 as follows: first, to examine the factors that influence the extent of UA participation in Africa
17 (Ghana) and Asia (India); second, to analyse the factors influencing urban food security using
18 Seemingly Unrelated Regression; third, to analyse the impact of the extent of UA on food security.

19 The ensuing section of the study is made up of the literature review, which comprises the
20 measurement of food security and concept, significance, and the effect of UA. In the third section,
21 a presentation of the methodology is done. Section 4 contains the results and discussion, and the
22 final section outlines the conclusions and recommendations of the research.

2.0. *Measurements of food security*

Given the importance of the measurement of food security, several tools-which are both subjective and objective- have been developed to assess households food security. These tools mostly measure the four dimensions of food security (refer to food note 1 for more information). Notable scales for the measurement of food security at the household level include the Household Dietary Diversity Score (HDDS), the Household Food Insecurity Access Scale (HFIAS), Food Consumption Score (FCS), Coping Strategies Index (CSI), Household Consumption and Expenditure Survey, Anthropometry (Jones et al., 2013). These measurement tools, individually, are not able to measure the multidimensional nature of food security (Maxwell et al., 2014). Since no single measurement tool has the incorporation of all the four dimensions of food security, several authors employ either one or combinations to assess either one dimension or two at a given time (Jones et al., 2013; Maxwell et al., 2014). For example, the food security-index tool measures the calorie uptake and dietary quality amongst individuals; however, the limitation of this method is its reliance on the memory of respondents, which is subject to measurement errors (Obayelu, 2012). The Household Dietary Diversity Score (HDDS) is another scale that measures the dietary diversity amongst among households. Its advantage is implicit in its simple questioning nature which makes it less time-consuming in administering (Swindale & Bilinsky, 2006). However, like other scales, a disadvantage with this tool is, it provides no evidence on the overall dietary diversity of food consumed by individuals in the household. Per capita food expenditure is another tool which is usually used for the accessibility measurement of food security; however, it does not provide facts on the nutritional diversity in the food consumed by a household (Ogundari, 2017). Another tool that measures the accessibility dimension of food security is the HFIAS. In this study, both the HFIAS and the per capita food expenditure were used to measure the food security

status of UA households. The HFIAS is a subjective tool, whereas the per capita food expenditure is an objective tool. However, both tools measure the food accessibility dimension of food security. The former though a subjective tool, has been employed and validated at household, regional, national and intercontinental levels of food security studies by the United Organisations and other domestic and international Non-Governmental Organisations. Howbeit it being a subjective tool; it is not less essential in its usage in measuring food security (Maxwell et al., 2014; Issahaku and Abdulai, 2019). The HFIAS like the HDDS is less time-consuming and requires only basic knowledge to collect data as well as being very useful in assessing urban household's food-security status as its advantage (Becquey et al., 2010). Besides, in the context of urban agriculture, HFIAS is a useful tool since food security is primarily influenced by accessibility (Mougeot, 2005; Crush and Frayne, 2011). At the same time, urban household's food expenditure (within and the without the home) is another important cause of food insecurity (de Zeeuw & Prain, 2011).

2.1 Concept, significance and effect of urban agriculture

Urban Agriculture (UA), otherwise known as Urban Farming (UF), conveys the concept of agricultural production (horticulture, tree, food crops, floriculture plants, livestock and animal production, forest trees, agroforestry, and aquaculture) in urban and peri-urban areas for own consumption, sales or both (Graefe et al., 2008; Korth et al., 2014; Chaudhuri, 2015). Mostly, UA is done in unused, open, private lands, public (roadsides, riverbanks, along railroads, idle public lands, parks) and private spaces that are not owned by the urban farmer within urban and peri-urban areas (Crush et al., 2011). Except for the use of privately-owned lands, UA mostly practised in public spaces is not seminal, with the user rights very limited. Thus, the unavailability of land embodies the most crucial, preventive variable to UA improvement and sustainability (Orsini et al., 2013). Apart from land unavailability, several metropolitans, municipal and district planning

1 departments have also failed to advocate for UA because they view agriculture as a "rural activity"
2 which might take off the shine they envisaged for a modern city (Battersby, 2013). Thus, the cities
3 will be regarded as unmodernised by both domestic and international elites if UA is encouraged
4 (Battersby, 2013). Besides, there is a massive availability of imported agricultural products all-
5 year round in major cities; hence, the lack of interest in UA (Merson et al., 2010). Some studies
6 present a gloomy picture of the unhealthy usage of wastewater in urban farming (Graefe et al.,
7 2008; Dalla Marta et al., 2019), the tendency of urban-produced vegetable crops leading to
8 breeding mosquitoes (Mlozi, 1997), and the extensive unhealthy extensive use of pesticides with
9 gendered long term effect on health (Stewart et al., 2013; Nyantakyi-Frimpong, 2016).

10
11 Even so, UA can be a valuable source of improving urban areas and emerging cities. Albeit its
12 perceived challenges, UA can, for instance, improve food security of urban households and also
13 serve as a source of employment to the unemployed youth, particularly, the poor (Smart et al.,
14 2015). To illustrate, UA has employed more than 800 million folks and has improved food security
15 from 15% to 20% (Pearson et al., 2010; Cinà & Khatami, 2017). UA ensures the continual supply
16 of fresh agricultural produce to cities and waste reduction as well (Gerster-Bentaya, 2013; Malan,
17 2015). Moreover, food becomes local to indigenes of the urban areas, coupled with a reduction in
18 the distance associated with transportation to access food (Smith et al., 2017). Food that is grown
19 and eaten locally has the added advantage of reducing carbon emissions (Wang & Nevius, 2013).
20 Urban greening, livelihoods, and the supply of food are improved with the presence of UA
21 (Lydecker & Drechsel, 2010). Even more, it reduces the food expenditure of the poor in urban
22 areas, as most spend an average of 50% to 90% of their income on food (Graefe et al., 2008). For
23 example, in Ghana, the Ghana Statistical Service (2013a) indicated that food expenditure takes

1 approximately 47% of the total household expenses per month. Concerning this, the FAO (2011)
2 concerted, such households are most likely to spend less on nutritious food while, at the same,
3 spending less on education and health of household members. Therefore, participating in UA could
4 provide free food and facilitate savings for health and educational expenses. That said, the
5 nutritional status of household members is significantly enhanced, which subsequently has a
6 positive impact on their health outcomes (Korth et al., 2014). Also, the ecology of the urban spaces
7 could be improved and sustained by the activities of UA (Gupta and Gangopadhyay, 2013).

3.0 MATERIALS AND METHODS

3.1. Study area

The study areas in Ghana were the Bono, Bono East and the Greater Accra Regions. The study areas -specifically- were the Techiman Municipality, the Sunyani Municipal, the Accra Metropolis and La Dade Kotopon Municipal. Greater Accra Region - the capital - of Ghana, is the most urbanised region (study areas: Accra Metropolis and La Dade Kotopon Municipal) in Ghana with little spaces for commercial UA (Ghana Statistical Service, 2013b). The rapid growth in the urban population of the region has resulted in the reduction of available productive land and high demand for food (FAO, 1998). As a result, households, especially low-income ones, are stressed with food prices and are not able to purchase enough quantity and quality of food amidst increasing rent prices (Masters et al., 2019). Consequently, UA has emerged, especially among poor households, to supplement household food needs along with generating money from its sales. The Bono and the Bono East Regions in the middle belt of Ghana, however, are referred to as 'breadbaskets' of Ghana ostensibly because about 30% of local food requirements in Ghana are from the regions alone (Ghana Statistical Service, 2013c) Still, due to rapid urbanisation in its major cities (study areas: Sunyani and Techiman), most of the agricultural lands are being lost with decreasing rate of UA participation. The graphical representation of the study areas and their boundaries can be found in figure 1.

(Insert Figure 1 here, map of the study area)

In contrast, the Indian part of the study was conducted in Bihar in the Eastern part of India. Specifically, the study was done in the north (Vaishali, East Champaran, Muzaffarpur) and south (Nawada, Gaya and Patna) of Bihar. The details of the study area can be seen on the map in Figure

1. Bihar is considered to be one of the most deprived and food-insecure eastern state, which is also ranked as one of India's most impoverished states (Government of India, 2017). Presently, Bihar accounts for almost 36% of the total food-insecure people in the country (Ministry of Consumer Affairs, Food and Public Distribution, 2020). Though less urbanised compared to many Indian states, there is a recent rapid increase in urbanisation which cannot be overemphasised (Van Duijne, 2019). Besides, Bihar was purposively selected to diverge from the big cities' biased (Mumbai, New Delhi) studies which have characterised much UA research in India.

3.2 Sampling and data

According to SRID (2016), the total population of UA participants in Ghana is 662,775 with 41,734 in Greater Accra Region and 121,961 in the Brong Ahafo Region (currently divided into three regions namely; Ahafo, Bono East Regions). Given this, the Yamane (1967) approach for sample size determination gave approximately 400 urban farmers (margin of error of 5%) as a representative sample for the whole country (made up of 16 regions). Nevertheless, we interviewed 400 farmers via a multistage sampling technique to increase the reliability and precision of our estimates for the three regions. Out of the 400 datasets, 350 (88%) were useful for the analysis. First, the three regions (Bono, Bono East and Greater Accra) were selected purposively (please refer to the study area under 3.1 for reasons). Secondly, one district each was purposively selected from the Bono and Bono East Regions whereas two were selected from the Greater Accra Region (refer to Figure 1 and study area under 3.1 for details). Thirdly, based on the sample frame by various extension officers in the districts, 200 households were randomly selected from two districts in the Greater Accra Region whereas 200 households were selected from the two districts in the Bono and Bono East Regions.

1 In Bihar of India, the urban population alone is estimated to be 11,758,016 (Government of India,
2 2017). Following the Yamane (1967) approach, the representative sample of 5% error rate was
3 400 urban households. However, given that, not all urban households will be into UA, we sampled
4 350 households involved in UA through a multistage sampling procedure, but only 300 (86%)
5 were useful for analysis. First, Bihar was purposively selected. Secondly, three districts from both
6 North and South Bihar were purposively selected. UA households were randomly selected at the
7 third stage.

8
9 It is important to note that, the data was collected by a team of trained enumerators using a
10 structured questionnaire from August to September, 2019 (for Ghana) and November, 2019 to
11 January 2020 (for India). Data was collected on household information and demographics; crops
12 and plants cultivated and livestock owned; marketing channels; household income and
13 expenditures, food security status by the use of the HFIAS measurement tool and the perception
14 of respondents on the importance of UA.

15 ***3.3 Summary statistics of data***

16 Table 1 shows the variables used in analysing the factors that influence the extent of UA, food
17 security and the impact of the extent of UA on food security (model 1, 2 and 3, respectively). In
18 all, about, eighteen (18) independent variables rooted in available literature (check supporting
19 references column in Table 1 for details) were used for the analysis.

20 **(Insert Table 1 here, description of variables used for the analysis)**

21 From Table 1, the researchers hypothesised different variables under four main sub-headings,
22 namely, demographic, economic, health and nutrition, and institutional factors. Age, education,
23 household size, primary job, animal rearing, land size, food expenditure, business, safe food, fear

of pesticides, nutritious food, and distance were all hypothesised to influence the extent of UA positively. Likewise, education, experience, location, animal rearing, land size, business, extension contact, and distance were hypothesised to influence food security positively. However, age, household size, primary job, household expenditure, and contract were all expected to influence food security negatively. It should pointed out that the expected sign column in Table 1 represents the various hypothesis used in this study. The hypothesis and the choice of independent variables are grounded on, firstly, literature reviews from various empirical studies across the globe (the supporting references column represents literature that supports the hypothesis for each variable in any of the models, i.e. Model 1, 2 and 3). Secondly, consideration was given to new and important variables that have mostly not been considered in food security and UA empirical studies. The dependent variables were participation intensity, scores and per capita food expenditure of a household.

3.4 Empirical analysis

3.4.1 Measurement of food security

Two tools, namely, HFIAS² and monthly per capita food expenditure, were used to examine the food security status of the household. The former has been authenticated in many countries across the globe (Coates et al. 2007). The scale summarises different behavioural and psychological magnitudes of the food security access domain (Coates et al., 2007; Maxwell et al., 2014.). Based on these dimensions, respondents were asked to recall how they felt for the previous four weeks or 1 month (30 days) on nine itemised questions. Respondents were asked if a condition had happened in the past four weeks for which they were to answer ‘yes’ or ‘no’. With a ‘yes’ answer,

² Kindly refer to Coates et al. (2007) for more information on HFIAS score and its usage. The domains of the HFIAS scale in Table 4 of this study was adopted from the same authors.

a follow-up question on frequency of occurrence was asked to know if it happened "rarely (once or twice in the past four weeks), sometimes (three to ten times in the past four weeks) or often (more than ten times in the past four weeks)" (Coates et al. 2007). The highest total score a household could obtain from the scale is 27 and/or 0 for a minimum. The higher the value for a household, the higher the severity of food insecurity. In the study, the total cumulative score was used for the regression analysis; however, for the description of the food security status of households, the categorisation proposed by Chakona and Shackleton (2018) was adopted. Under their categorisation, households that have food security scores of 0-1 are labelled food secured; 2-7 are mildly food insecure; 8-11 are moderately food insecure; and 12-27 are severely food insecure. Similarly, FAO (2008) suggested that the categorisation can be done as follows: most food secure= 0-11, medium food secure = 12-16; and least food secure = 17 or more. The second measure of food security of the households was monthly per capita food expenditure, which is the total expenditure on food (both at home and outside the home) by a household per month. This tool has been shown to be an excellent measure of food accessibility (Jones et al., 2013; Ogundari, 2017).

3.4.2 The heteroskedastic linear regression

The heteroskedastic linear regression via the Maximum Likelihood Estimation was used to analyse the factors that influence the extent of UA participation among households. The extent of UA was the dependent variable in Model 1 (refer to Table 1 for details). The model is used primarily when the error variances are not consistent across all the observations (heteroskedasticity in the model) (Cribari-Neto and da Silva, 2011). In such an instance, the use of Ordinary Least Square (OLS) regression to estimate the variables that influence the extent of UA will remain unbiased but

inefficient (Long and Ervin, 2000). By the adoption of the *hetregress* command in STATA 15, we modelled a multiplicative heteroskedastic linear regression model via the Maximum Likelihood estimation technique. The heteroskedastic linear regression model can be modelled as:

$$y_i = M_i N + \varepsilon_i, \sigma_i^2 = \exp(z_i \beta) \quad (1)$$

where y_i , $i=1, \dots, j$, is the dependent variable; $M_i = (M_{1i}, M_{2i}, \dots, M_{ki})$ are the k explanatory variables for modelling the mean function; and $z_i = (z_{1i}, z_{2i}, \dots, z_{ji})$ are the j variables in modelling the variance function. N 's are unknown variables in the mean function and ε_i 's are unknown variables in the variance function. ε_i 's are the error terms which are self-determining and identically distributed with mean 0 and variance σ_i^2 .

3.4.3 Seemingly Unrelated Regression (SUR) model

Seemingly Unrelated Regression (SUR) model was applied in this study to examine the factors influencing food security status of UA households. Additionally, it was used to analyse the effect or impact of the extent of UA participation on food security. It is interesting to note that, the model has been applied in only a few food security studies in the USA, Asia and Africa (Naline and Viswanathan, 2016; Mulwa and Visser, 2020). SUR is a network of linear equations with errors that are interrelated across equations for a given observation, but uncorrelated across observations. Given this, two system equations (made up food security scores from the HFIAS score, and food per capita expenditure equations) were developed. The two equations could have been run into two different Ordinary Least Squares (OLS) models, however, the HFIAS scores and per capita food expenditure may be related because the two are used to assess the accessibility domain of

food security. The dependent variables in the model were demographic, economic, health and nutrition and institutional explanatory variables. Except for the variable on extension contact in the India model (refer to Table 6 and 7 for details), all other explanatory variables were similar in the two equations. Given these two equations, efficient estimates of the coefficients are derived from the model because it allows for the error term relative to the two equations to be correlated, which could not be the same for OLS. It is instructive to note that, the higher the correlation coefficient between the two equations, the better the efficiency (Zellner,1962).

The linear SUR equation is specified as follows:

$$y_{it} = \alpha_{it}\beta_{it} + \varepsilon_{it} \quad (2)$$

where $t = 1, \dots, R$, $i = 1$, food security (HFIAS) score for each household and the household per capita expenditure were the dependent variables having correlated error terms across equations but uncorrelated across observations, α_{it} represents explanatory variables such as demographic, economic, institutional and health and nutrition factors; β_{it} is the coefficients; ε_{it} is the error term which symbolises normal distribution with zero mean, variance σ^2 , and variance-covariance matrix ω . The two linear SUR equations are:

$$y_{1t} = \alpha_{1t}\beta_{1t} + \varepsilon_{1t} \quad (3)$$

and

$$y_{2t} = \alpha_{2t}\beta_{2t} + \varepsilon_{2t} \quad (4)$$

The variance-covariance matrix is as follows:

$$\omega = \begin{bmatrix} \sigma_{11}I_R & \sigma_{21}I_R \\ \sigma_{12}I_R & \sigma_{22}I_R \end{bmatrix} \sum \otimes I_R \quad (5)$$

where , σ_{ij} , $i=1$ and $j=2$

4.0 RESULTS AND DISCUSSION

Table 2 has two sections, namely, Ghana and India, showing descriptive statistics of variables. The average participation intensity was 0.12 and 0.11 in Ghana and India, respectively.

(Insert Table 2 here, summary statistics of variables)

Regarding food-security scores, Ghana had an average of 4.05 HFIAS scores for each household, whereas India had 7.91 HFIAS scores for each household. On per capita food expenditure, it was 20.48 dollars per household for Ghana and 11.54 dollars per household for India. The implication is that, household per capita food expenditure is higher in Ghana than in India in the dataset- which could largely be attributed to the cost of living in the study area. Averagely, the ages were approximately 44 years in Ghana and 46 years in India. The result is indicative that, UA, in general, is less known among the youth; hence, the youth could be encouraged to venture into UA to support the family and also make some money. The mean values for formal education indicate a level of formal education attainment among UA farmers. This average level of education can contribute directly to productivity in urban farming by improving the quality of labour and enhancing farmers ability to adopt innovations. Also, such producers are likely to read and understand the correct use of chemicals as well as the negative effects of the unhealthy practices (rampant use of chemicals for pest control, wastewater usage etc.) in UA and desist from them accordingly. The mean acreage for the land size in acres allocated for UA among households were approximately 2 and 1 in Ghana and India, respectively. On household size, it was approximately six (6) in Ghana and seven (7) in India. Averagely, households had 13 years and 11 years' worth of experience in UA in Ghana and India, respectively. Food expenditure was US\$ 109 in Ghana compared to US\$ 73 in India. In urban areas, food is usually sold at higher prices. Again, the average household

expenditure was approximately US\$ 294 and US\$121 in Ghana and India, respectively. Attribution to this could be that, urban areas in Ghana have a higher cost of living owing to heavy reliance on imports than India, which depends more on domestic production. Using a five-point interval scale, (from strongly disagree to strongly agree), respondents were asked to indicate their views on safe food. The mean of their views was high, with approximately 4 for both Ghana and India. Likewise, the opinion of respondents on fear of pesticides was averagely 3 for both countries. Again, on the consumption of nutritious food, the opinions of respondents indicated a high mean of 3.54 and 3.84 for Ghana and India, respectively. Similarly, respondents' perception of postharvest losses of urban produce showed a mean of 2.92 for Ghana and 2.94 for India, indicating, urban farmers do not really think postharvest losses are a major challenge in UA. More so, respondents who used UA as a form of business had means of 4.12 and 3.21 for Ghana and India, respectively signifying that most of the households undertook UA as a business. Averagely, from the results, households in India had better more contact with extension officers compared to Ghana. Further, farmers with a contract agreement with buyers showed an average of 0.35 in Ghana and 0.73 in India, demonstrating that, contract farming is more well-known among urban farmers in India than in Ghana. Averagely, in Ghana, the walking distance of respondents to the nearest market was 21.41 minutes while in India, it was 29.41 minutes.

In Table 3, we present the food-security status of UA households in both Ghana and India. The individual household food-security scores from the HFIAS model was categorised by following Chakona and Shackleton (2018).

(Insert Table 3 here, food security status of households)

From Table 3, about 58% of the households in Ghana (which is represented by 203 of the sample) were food secured. In contrast, none of the households in India was food secured. The differences

could be attributed to the characteristics of households in Ghana; in the middle zone of Ghana, the Bono and Bono East Regions to be specific are known to be the foodbasket of Ghana, hence, there is the likelihood that, most of the households that were interviewed in the area are pulling the food security status of the Ghana data upwards. Meanwhile in India, Bihar, is known to be one of the poorest and food-insecured states, hence, the results. About 48% of the households in India, compared to 14% of the households in Ghana, are mildly food secured. Approximately 38% of the households in India were severely food insecure compared to 12.3% of the households in Ghana that were severely food insecure. From the table, averagely, UA households in Ghana are mildly food insecure represented by 4.05 compared to 7.91 (moderately food insecure) in India. Generally, the food security status of households in India and Ghana is consistence with a 2019 report by the Economic Group. They revealed that Ghana is ranked 59 out of 113 countries with a rating of good performance in attaining food security whereas India is ranked 72 out of 113 countries with an assessment of moderate performance in the global food-security ranking (The Economics Group, 2020).

Except for the descriptive statistics in Table 4, all other information are from the HFIAS. Thus, the questions and the three main domains are all adopted from the scale. From Table 4, about 1.4% of the households in Ghana frequently worry about not getting enough food, whereas none regularly thought about the same in India.

(Insert Table 4 here, domains of food security)

Majority of the households in India were rarely (45.3%) anxious about household food supply, whereas the majority of the households in Ghana (represented by 74.6%) were never worried about food supply in the household. On the insufficient food domain, the results reveal that, majority of

the households in India were rarely a concerned with eating insufficient food in the household whereas the majority in Ghana were never worried about not getting sufficient food to eat in the household. In detail, 62% of the households in Ghana have always eaten the kind of foods they preferred compared to 46% in India. Likewise, 65.4% of the households in Ghana have never worried about eating inadequate food owing to the absence of resources compared to 36.3% in India. Only one household in Ghana eat food owing to the absence of resources. Comparatively, India had a smaller number of people (represented by 7% of the sample) who sometimes had to eat foods they did not want to because of lack of resources relative to Ghana (15.4%). Furthermore, on the insufficient food intake domain, about 87.4% of the households in Ghana had never worried about eating a smaller meal portion than they needed, compared to none in India. However, majority of the households in India, rarely (97.3%) have to eat a lesser meal than they needed. From the table, both households in India and Ghana represented by 97.1% and 98.4% respectively revealed that there had never been an instance where food was not available in the house due to nonexistence of resources. Generally, none of the households interviewed had ever eaten nothing (no food) for a day in both countries.

The Wald test of Insigma2 from Table 5, which is a test for variance function, is significant, suggesting a possible heteroskedasticity in the model; hence the model; used was best fit for the analysis. Additionally, the probability>chi value is significant ($p<0.01$), indicating that the independent variables significantly explain the dependent variables (log of the extent of UA, refer to Table 1 for details) in the model.

(Insert Table 5 here, extent of participation in urban agriculture in Ghana and India)

1 The determinants of the extent of participation in UA in Ghana and India are presented in Table 5.
2 From the table, increase in age decreases the percentage increase in the extent of UA participation
3 in India but was insignificant in Ghana. On the contrary, education has a significant positive
4 influence on the extent of participation in UA in both Ghana ($p<0.05$) and India ($p<0.01$).
5 Likewise, an increase in household size increases the extent of participation in UA by 0.058
6 percent in Ghana and 0.043 percent in India. The result validates earlier study by Mackay (2018)
7 who reported that household size was averagely bigger in UA households to non-farming
8 households in the Bono East and the Northern Regions. A plausible reason for this phenomenon
9 could be that, there is a possible increase in the consumption expenditure of the household, hence,
10 the likelihood of the household to use any available land at their disposable to produce crops or
11 rear animals to support the home. The results, however, contrast with the findings by Temple and
12 Moustier (2004) and Orsini et al. (2013) who revealed that intensification of UA might not have
13 corresponding available labour as several households in the urban areas have members in other
14 viable economic activities aside farming. Farming experience had a positive and significant
15 influence on the percentage increase of the extent of urban UA participation in India. The result
16 suggests that households who had had many years' experience in farming-which might not
17 necessarily be urban farming- are more likely to intensify UA production compared to others with
18 little or no farming experience. Also, a UA producer who (in both Ghana and India) is engaged in
19 farming as a primary job is more likely to increase his/her extent of participation compared to the
20 one who is not farmer. It can be inferred that UA is a means of livelihood for some of the
21 respondents, hence, they are more likely to increase their level of participation compared to those
22 who are in UA production as a means to support the family budget. The finding aligns with Smart
23 et al. (2015) who reported that UA is increasingly becoming a source of livelihood for many urban

1 dwellers due job loss, economic downturn as well as the limited number of employment
2 opportunities in the formal sector. Further, a household that rears animals is less likely to increase
3 the extent of UA participation compared to others in Ghana. The negative association between the
4 extent of UA participation and the rearing of animals could be attributed to the less size of land
5 requirement for livestock activities compared to crop or mixed farming (Yusuf et al., 2008).
6 Notwithstanding, animal rearing is not among urban farmers as a major UA activity compared to
7 crop production in Ghana (Asibey et al., 2019). The results suggest that animal rearing could be
8 one of the best ways to encourage UA among households since households do not need large
9 spaces to rear animals. One of the major limiting factors to the increase in UA is land availability
10 (Orsini et al., 2013). Hence, the positive relationship between land size and the extent of
11 participation in UA is consistent with earlier studies. Mostly, in urban areas of developing
12 countries such as Ghana and India, agricultural land has been deemed to be of the lowest value for
13 landowners in urban areas compared to other alternative uses, hence, little land is always available
14 for agriculture uses (Kutiwa et al., 2010). Thus, agricultural lands are only available and remain
15 so when it does not have alternative uses in urban areas. Further, in India, a household that does
16 UA as a business is more likely to increase its extent of participation in UA compared to others.
17 This holds true for most households involved in UA as they are more likely to sell products to
18 generate income (Yusuf et al., 2008; Smart et al., 2015). Earlier studies in Ghana revealed that
19 participation in UA is primarily driven by sales to gain income (Mackay, 2018). Likewise, in India,
20 it is reported that households' economic conditions are improved for involvement in UA
21 (Chaudhuri, 2015). On health and nutrition factors, the fear of pesticides usage in the production
22 of agricultural products positively influence the extent of participation in UA in both Ghana and
23 India. The result is not surprising because, in most developing countries like Ghana and India,

1 studies have revealed that pesticides usage in vegetable production and marketing exceeds health
2 thresholds (Amoah et al., 2006; Karanja et al., 2010) mainly because pesticides are viewed as the
3 only option for pests and diseases control in agriculture production, especially, vegetables (Dapaah
4 Opoku et al., 2020). As a result, one of the crucial motivations to undertake urban farming is to
5 consume healthy food, free of pesticides (Ha et al., 2019). The study further revealed a positive
6 correlation between the desire for nutritious and safe food and the extent of participation in UA.
7 The result is consistent with earlier studies which reported that, UA is a treasured supply of
8 essential nutrients, protein, high-quality and healthy food at a low cost which would not otherwise
9 be accessible (Yusuf et al., 2008; Chaudhuri, 2015; DiDomenica, 2015; Smart et al., 2015; Poulsen
10 et al., 2017).

11
12 From Table 6, two main food-security-measurement variables (food-security scores and per capita
13 food expenditure) were used to measure the food security status of the households. The chi-square
14 values are significant for the two equations, indicating that the independent variables explain the
15 dependent variables in the equations. The results from the Breusch-Pagan test for error
16 independence shows a chi-square test statistic of 7.338 with a p-value of less than 0.01, indicating
17 that correlation (approximately 0.15) between the errors in the two equations are significant hence
18 the Seemingly Unrelated Regression is a fit model. It should be pointed out that, apart from few
19 factors that were not significant under both HFIAS scores and per capita food expenditure
20 measurement of food security, all other factors that were significant under both measurements had
21 the same direction of effect on food security. It presupposes that, the subjective food security
22 measures such as HFIAS might not be less potent in assessing the food security status of a
23 household compared to the objective food-security measures.

1 **(Insert Table 6 here, factors influencing the food security status of households in Ghana)**

2

3 From Table 6, three demographic characteristics influence household food security in Ghana.

4 Specifically, an individual whose primary job is farming is more likely to be food unsecured

5 compared to an individual whose main job is not farming. Likewise, educational level positively

6 influenced household food security. The relationship prompts that, higher levels of education could

7 positively influence production and nutrition decisions. Besides, higher education could create an

8 opportunity for the household members to earn other off-farm incomes within the cities (Accra,

9 Sunyani and Techiman) which could be used to supplement the household food purchases. The

10 result corroborates earlier studies in urban households' by Antwi et al. (2019) in Ghana and

11 Adesoye and Adepoju (2020) in Nigeria. Possible job opportunities for households in urban areas

12 to involve in other off-farm jobs to support the household food expenditure could be one of the

13 key reasons of the negative relationship between household size and food insecurity in Ghana.

14 The result is inconsistent with studies by Issahaku and Abdulai (2019), and Akbar et al. (2020),

15 but corroborates studies by Ayerakwa et al. (2020) in urban Techiman and Tamale of Ghana.

16

17 Fascinatingly, the extent of UA participation decreases food insecurity in the first equation. Thus,

18 increases in the extent of UA increases the food security status of the household. Similarly, studies

19 by Smart et al. (2015) studies in Zambia and Frayne et al. (2016) in some selected African countries

20 revealed that, households involved in UA in Maseru of Lesotho, Cape town of South Africa and

21 Lusaka of Zambia had better access to food compared to households that are not involved in UA.

22 The result implies that, UA could be one of the strategies the Government of Ghana could advance

23 to improve urban households food security, in particular, the rapidly-growing emerging cities. It

24 is informative to note that, from the interviews, majority of the households produce vegetables

1 such as onions, okra, lettuce, garden eggs, tomatoes, cabbage and pepper, with few others who
2 were producing carrot, cucumber, beetroot, spring onion, parsley and local vegetables such as
3 *ayoyo, boma and sowri*. Also, out of the whole sample, only seventy-five households were rearing
4 goats, whereas about ten households had fruits such as banana and orange.

5
6 In both equations (food-security scores and food per capita expenditure), increases in household
7 expenditure were positively related to increases in food security. Similarly, Ecker (2018) reported
8 that, in Ghana, household expenditure is positively linked with food security. Further, the results
9 show that, undertaking UA as a business has a positive relationship with per capita food
10 expenditure of the household but negatively related to food security scores. Quite surprisingly,
11 food security status increases with increases in the distance from the urban farm to the nearest
12 market. The result suggests that, urban spaces close to the market promote increases in marketed
13 surplus beyond the marketable surplus of urban households as there is a high desire to trade
14 produce for money to household consumption. On the contrary, an urban farmer located in the
15 Bono East and Bono Regions of Ghana is more likely to be food secured compared to
16 contemporaries in Greater Accra. It is enlightening to note that, these regions mentioned are noted
17 to be among the leading foodbasket regions. As a consequence, food availability and accessibility
18 are high compared to households located in Accra.

19
20 In Table 7, the independent variables explain the dependent variables in the two equations as
21 presented by a statistically-significant ($p < 0.01$) chi-square values. Also, the results reveal that there
22 is a correlation (approximately 0.11) between the errors in the two equations suggesting that
23 Seemingly Unrelated Regression is a fit model for the analysis. As a consequence, it is revealing

to note that, in Table 7, except for the variable on business, all the factors that were significant in the subjective food security measurement (HFIAS scored) and the objective tool (per capita food expenditure) had the same direction of influence on food security in the urban households.

(Insert Table 7 here, factors influencing the food security status of households in India)

From Table 7, the results show that, an increase in age decreases food insecurity in India among urban farming households. Interestingly, in India also, the results show a positive relationship between the extent of UA participation and food security. Thus, the extent of UA participation has a significant positive impact on the food security of households. Similarly, in New Delhi, Diehl et al. (2019) indicated that, participation in UA had a positive relationship with food security status of participants households. From the field survey, we realised that, households were mainly engaged in mixed farming system along with the cultivation of vegetables like brinjal, okra, chilli, cauliflower, pointed gourd etc. and mostly goat-rearing. Very few households had milch cattle including cow and buffaloes. Similar to the results from Ghana (kindly refer to Table 6 for details), increases in household size decreases the probability of being food insecure by approximately 12 units. A plausible reason could be that, a number of people in the UA households are involved in other jobs; hence the possible increases in the per capita food expenditure. Thus, the members of the households who are working in other off-farm jobs may be contributing a sizeable amount of money to the households' consumption. From both equations, expectedly, increases in household expenditure decrease the household food-insecurity status. On economic factors, the results reveal that increases in the number of minutes from urban farm to the nearest market increase the food insecurity status of the household. One conceivable reason could be that; households might be buying foodstuffs from the market to supplement their food. Another reason could also be that, long distances decrease the ability of the households to sell their produce in the market for income

1 hence are less likely to have less money to spend on foods they do not produce. The result is
2 indicative that, markets are essential if UA households are to be food secured in India.

3 Further, the likelihood that an urban farmer who does urban farming as a business is likely to be
4 food secured in India is less compared to those who do not do it as a business. The result seems to
5 suggest that, urban farmers might be buying food from the market to supplement other essential
6 food needs hence the need for extra income to fulfil that obligation. Interestingly, as the level of
7 postharvest losses increases, the probability of food insecurity increases. Implicitly, this situation
8 could be counterproductive to the positive gains of UA on food security. Consequently, measures
9 to reduce postharvest losses could be one of the sustainable strategies for ensuring food security
10 among urban households engaged in UA. Unpredictably, a farmer with a contract is less likely to
11 be food secured compared to an urban farmer with no contract. This relationship could be attributed
12 to the possibility of farmers selling more than marketable surplus to take care of other urgent
13 household needs such as health care, school fees, among others; thereby, decreasing the food
14 available in the household. In contrast, a farmer with extension contact is less likely to be food
15 insecured compared to others who do not have extension contact. A possible reason is that,
16 extension officers teach farmers on improved agricultural techniques for increasing yield and the
17 various food fortification techniques to ensure the household consumes a balanced diet regularly.

18
19 To further check the effect of the extent of UA participation on food security, an analysis was
20 performed by the use of instrumental variable regression (two-stage least square regression) which
21 is presented in the appendix 1a. From Table 1a in the Appendix, holding other factors constant,
22 the extent of UA participation positively influences the impact on the food security status of
23 households. Specifically, an increase in the extent of UA participation by 1 percent, decreases food

1 insecurity scores by 0.760 units in Ghana. Likewise, a percentage increase in UA participation
2 decreases food insecurity status of the household by approximately 1.03 units in India. In the
3 table, the p-values for the complete analysis for both Ghana and India are significant signifying
4 that the variables are ideal for this model. The Hausman test and the Durbin test for endogeneity
5 (refer to Table 2a, 2b, 3a and 3b at the Appendix for details). At the same time, the strength of the
6 instruments is robust based on the first stage statistics (refer to Table 2a, 2b, 3a and 3b at the
7 Appendix for details). Moreover, from the test of overidentification analysis in Table 1a revealed
8 that the instrument used in the analysis was valid.

5.0 CONCLUSIONS AND RECOMMENDATIONS

This article focused on simultaneously analysing the factors that influence the extent of UA participation and its effect on food security in urban cities in Asia and Africa. We examined the determinants of the extent of UA by the use of heteroskedastic linear regression. We also used the Seemingly Unrelated Regression to analyse the effect of the extent of UA on food security. In terms of methodological approach, the results from the Breusch-Pagan test for error independence revealed that the determinants of the food-security-access domain tools (i.e. HFIAS and per capita food expenditure) are correlated hence the Seemingly Unrelated Regression is a fit model for such analysis.

In the study, about a little bit above the average of the households in Ghana were food secured while none of the urban households in India was food secured. On average, households in Ghana were mildly food insecure, whereas that of India was moderately food insecure. Also, while none of the households in India regularly thought of getting enough food, about a quartile of households in Ghana have thought of not getting enough food regularly.

Results from the empirical analysis revealed that, demographic characteristics such as age, education, household size, the primary job of the respondent as a farmer, and farming experience positively influenced the extent of UA participation in both Ghana and India. Economic factors such as the rearing of animals and total land size positively influenced the extent of UA participation in Ghana whereas, in India, the total land size, food expenditure and UA participation as a business had a positive influence. Meanwhile, the fear of pesticides was a significant factor for the growth in the extent of UA participation. The desire for safe and nutritious food also influenced UA participation positively.

1 The results further revealed that, various demographic, economic and institutional factors
2 varying influenced urban food security. Further, the extent of UA had a significant, favourable
3 influence on food security in both Ghana and India. One possible implication from this research is
4 that countries in Africa and Asia should rigorously promote UA among urban households to reduce
5 urban food insecurity. Also, policies should be developed to protect agricultural lands in urban
6 spaces along with integrating UA issues and programmes in emerging cities' development
7 programmes and policies. Governments and NGOs interested in the reduction of urban food
8 insecurity should aggressively advocate for UA among urban households through extension
9 education by gleaning on the health benefits of UA such as producing and consuming safe and
10 nutritious food. Similarly, animal rearing, which does not need a larger space but has a significant
11 influence on food security-could, be encouraged by various UA stakeholders.

12
13 In terms of research, the results call for extensive research on the effect of postharvest losses on
14 the extent of UA and how to combat it. To start with, postharvest education on postharvest losses
15 should be included in UA education so as not to reduce its impact. Another research implication
16 is that, similar studies can be conducted in other emerging urban cities in Africa and Asia for the
17 advocacy for specific urban-food-security policies and programmes.

18 Even though we attempted to draw on experiences from India and Ghana, we did not in any way
19 attempt to compare the food security status of UA households in the two countries. However, to
20 examine the effect of UA on food security based on shreds of evidence from Bihar State India and
21 selected cities in Ghana.

1 **Declarations**

2 **Availability of data and material**

3 The data for the study is available upon request from the correspond author

4 **Competing interests**

5 The authors declare that they have no competing interests.

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9 **Authors' contributions**

10 **RKB:** Conceptualization, Methodology, Formal analysis, Writing – original draft

11 **MS:** Conceptualization, Data collection, writing – review & editing

12 **HOK:** Data collection, writing of methodology, literature review

13

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19

20 **Conflict of Interest**

21 The authors declare that they have no conflict of interest.

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