Journal of Regional and City Planning
vol. 34, no. 1, page. 83-100, April 2023
DOI: 10.5614/jpwk.2023.34.1.5

Urbanization, Land Scarcity and Urban Farmers' Mobility: Evidence from Ghana

Michael Tuffour[1]

[Received: 19th May 2022; 1st revision: 3 February 2023; 2nd revision: 28 March 2023; accepted in final version: 29th March 2023]

Abstract. *This study assessed how urban farmers survive land scarcity challenges in the midst of rapid urbanization in a developing country such as Ghana. As land scarcity becomes more pronounced in urban areas, farmers struggle to find a place to farm within the urban space but the numerous opportunities that come with farming within the city still inspires them to find spare lands and open spaces in the city to farm. Therefore, the study examined the factors that influence urban farmers' mobility with respect to farmland in the midst of intense land scarcity. Reponses from 251 farmers were analyzed with both Tobit and Ordinary Least Squares (OLS). Land situation factors such as land ownership type, land scarcity challenges, and size of land were found to be associated with farmers' mobility. Farm characteristics such as level of market benefits, intensity of vegetable production, and level of technology were also associated with farmers' mobility within the city. Personal characteristics such as age, level of education, level of farmer engagement, and marital status also played a role. This implies urban farming sustainability requires conscious government efforts to include urban agriculture in its spatial planning decisions since there are numerous opportunities for farming within the city.*

Keywords: *Farmers' mobility; land scarcity; urban agriculture; urbanization.*

Abstrak. *Kajian ini menelaah bagaimana petani modern bertahan menghadapi tantangan kelangkaan lahan di tengah pesatnya urbanisasi di negara berkembang seperti Ghana. Ketika kelangkaan tanah menjadi lebih jelas di daerah perkotaan, petani berjuang untuk menemukan tempat untuk bertani di dalam ruang kota, tetapi banyaknya peluang yang datang dengan bertani di dalam kota masih menginspirasi mereka untuk menemukan tanah cadangan dan ruang terbuka di kota untuk bertani. Oleh karena itu, studi ini mengkaji faktor-faktor yang mempengaruhi mobilitas petani perkotaan terhadap lahan pertanian di tengah kelangkaan lahan yang intens. Tanggapan dari 251 petani dianalisis dengan Tobit dan Ordinary Least Squares (OLS). Faktor situasi lahan seperti jenis kepemilikan lahan, tantangan kelangkaan lahan, dan ukuran lahan ditemukan berhubungan dengan mobilitas petani. Karakteristik usaha tani seperti tingkat keuntungan pasar, intensitas produksi sayuran, dan tingkat teknologi juga berhubungan dengan mobilitas petani di dalam kota. Karakteristik pribadi seperti usia, tingkat pendidikan, tingkat keterlibatan petani, dan status perkawinan juga berperan. Hal ini menyiratkan keberlanjutan pertanian perkotaan membutuhkan upaya sadar pemerintah untuk memasukkan pertanian perkotaan dalam keputusan perencanaan tata ruangnya karena ada banyak peluang untuk pertanian di dalam kota.*

Kata kunci: *Kelangkaan Lahan; mobilitas petani; pertanian perkotaan; urbanisasi.*

[1] School of Sustainable Development, University of Environment and Sustainable Development, Ghana. Email: mtuffour@uesd.edu.gh

ISSN 2502-6429 online

Introduction

Similar to many cities in the developing world, cities in Ghana such as Accra and Tema have experienced a high level of urbanization. Rapidly urbanizing cities in Ghana are generally characterized by changes that lead to competitive use of land for several economic and sociocultural activities (Ghana Statistical Service 2014 2016; Seto et al., 2011; World Bank 2015a; Yankson and Bertrand, 2012). This makes land a scarce and excessively expensive commodity in these cities (Yu et al., 2022; Tellman et al., 2021; Jiang et al., 2013; Owusu 2013; Lambin et al., 2011; UN-Habitat 2014; Yankson and Bertrand, 2012; World Bank 2015a; Zhang and Xu, 2017). One essential economic activity in such expanding cities, which requires a substantial size of land, is urban agriculture (UA) (Mougeot, 2000; Satterthwaite, 2007; Satterthwaite et al., 2010; van Veenhuizen, 2006). Urban agriculture not only serves as a source of employment and a livelihood survival strategy for some urban dwellers in Africa but also serves as a contributor to urban food security and climate change resilience (Arku et al., 2012; Azunre et al., 2019; Zezza and Tasciotti, 2010; Cornish and Aidoo, 2000; Mougeot, 2006; Smit et al., 2001).

Ghana's urban centers have encountered intense urbanization in the past thirty years and urban farmers, especially those within its capital city, Accra, continue to face land challenges in the form of scarcity and unbearably high prices. The neoliberal policies that characterized the implementation of the Structural Adjustment Programme (SAP) in Ghana led to an entrenched free-market environment and this has resulted in a norm of high land commercialization in cities. In Accra and Tema, the situation is further compounded by land tenure complexities and inadequate spatial planning. Currently, urban vegetable farmers practically do not have designated spaces to farm in Accra and Tema (Mackay, 2018; Appiah et al., 2014; Naab et al., 2013; Allen et al., 2014; Owusu 2003; 2008; Cofie et al., 2005). Lands which were used previously for farming have now been sold for non-farming purposes. Farmers have no other option than to farm on spare and open spaces or unused lands that belong to government organizations and individuals in the city. Farmers suffer from land contestation with encroachers and eviction by landowners, which makes it almost impossible for them to expand their production (Tuffour, 2022; Allen & Apsan Frediani, 2013; Allen et al., 2014; Mackay, 2018; Owusu, 2013). This implies that they will not be able to produce enough to meet market demand and will not be able to increase their earnings from farming. Similar to farmers in some other cities in Osun State and Lagos in Nigeria, Accra and Tema farmers survive by relocating to 'free' lands from time to time (Tuffour, 2022; Lasisi et al., 2017; Taiwo, 2014). This process of moving from one land to another can be called farmers' land mobility (Nijenhuis, 2013).

Even though land-use challenges among farmers have been given attention in the literature (Allen et al., 2014; Appiah et al., 2014; Ayambire et al., 2019; Azunre et al., 2019; Danso et al., 2014a; Keraita and Cofie, 2014; Kufogbe and Surveyors, 1996; Appeaning Addo, 2010; Mackay, 2018), research focusing on urban farmers' mobility with respect to land use is almost non-existent. Beyond Ghana, studies have looked at land available in urban vegetable production (Badami and Ramankutty, 2015), land-use planning for UA (Lovell, 2010), changing urban land use and land-use policy (Diehl, et al., 2020), land tenure systems and UA (Suchá et al., 2020), urban growth and UA dynamics (Follmann, et al., 2021), and land policies and structures and land availability for farmers (Conway et al., 2020).

Notwithstanding the studies that have been conducted on urban land use and UA, the analysis of urbanization-induced land scarcity in UA and how it affects farmers' mobility is a grey area in the literature, hence this study. The present study was set up to assess the rate of urban farmers' mobility with respect to securing scarce farmlands for farming and examine the land, farm, and farmers' personal characteristics that are associated with the rate of farmer mobility. Furthermore,

the study hoped to contribute to the literature by considering the subject within a rapidly urbanizing city in a developing country and employed a quantitative methodology to analyze it in that regard.

Materials and Methods

Study Area

The study was conducted within the Greater Accra Metropolitan Area (GAMA), which is sometimes interchanged in the literature with Accra or the Accra Metropolitan Area (AMA). The Greater Accra Metropolitan Area (GAMA) is also referred to as Accra, Tema, and its urban suburbs. It has a total of thirteen metropolitan and municipal assemblies put together and covers approximately 1080 m^2 of land. The two largest are the Tema and Accra metropolitan assemblies (Ghana Statistical Service 2005 in Songsore 2009; Ministry of Local Government and Rural Development (MLGRD) 2017; World Bank 2015b). Separating these two famous cities in recent times has become almost impossible due to their closeness and similarity in characteristics (Stoler et al., 2012). The dominating primary economic activity in GAMA is fishing, with those in farming constituting a relatively smaller percentage. Like many big cities in Africa, Accra-Tema is dominated by secondary and tertiary economic activities such as manufacturing and trading respectively (UN – Habitat 2009). The changing lifestyle among citizens, which is usually characterized as a modern and Western adopted lifestyle, has led to accompanying diseases such as diabetes. As a means of curtailing these diseases, citizens have made the consumption of vegetables a vital part of their diets (Ghana Statistical Service Accra (GSS), Ghana Health Service (GHS) and ICF International, 2015; Food and Agriculture Organization (FAO), 2012). Notwithstanding the essence of vegetable consumption to healthy living in GAMA, the number of urban farmers has significantly reduced due land scarcity (Danso et al., 2014a; Food and Agriculture Organization (FAO), 2012; Obuobie et al., 2003).

Research Design

This study used a quantitative research design, which informed the data collection and analysis as well (Creswell and Creswell, 2017; Saunders et al., 2019; Tashakkori and Teddlie, 2010).

Data Collection

Data was collected from vegetable farmers in GAMA with a structured questionnaire. The study initially attempted to use a census since the number of urban vegetable farmers within the study area was estimated to be about 350, but only a total of 251 farmers were reached, i.e., about 72% of the estimated number. The estimated of number of 350 could not be reached because of two main reasons. First, the absence of farmers (farm owners) on their farms after several visits, and second, some farmers were unwilling to answer questions due to research fatigue. In all, a total number of sixteen sites or clusters of farms were covered. The figure obtained met the valid minimum required number of respondents for a sample, which is 163 (46%) for a margin of error (m) of 5% and a level of significance (l) of 95% (De Vaus, 2002) and the valid minimum required number when tested with the criteria of Glenn (1992), which is 187 (53% of population) for an m of 5% and a population of 350. The 251 obtained, when validated with the criteria of Bartlett et al. (2001) proved to be adequate since their minimum number is 196 (49%) for a population of 400 at an m of 5% and an l of 1%. The details of the clusters and the number of farmers reached in each cluster are indicated in Table 1 (also see Figure 1). The clusters were: Ashiaman, La-Tseaddo, Fiesta Royal, Dzorwulu-Dzorwulu-Ebony, Legon-Okponglo, Tema Motorway, Korle-bu, CSIR and Ghana Atomic Energy Commission. The remaining are Ghana Italian Petroleum

(GHAIP), Ghana Grid Company (GRIDCo), Klagon Ramseyer Site, Sakumono Beach Road Area, Airport Lands, Ashongman Mango Lane, and Pantang Hospital.

Table 1. Sites visited for data collection

Metropolitan Municipal Assembly	Site	Number reached	Estimated total number of farmers	Estimated percentage covered
LADMA	Airport	6	8	75
	La-Tseaddo	9	20	45
AMA	Dzorwulu – Fiesta Royal	5	6	83
	Dzorwulu Ebony	18	25	72
	CSIR	8	12	67
	Okponglo	9	15	60
	Korle-bu	28	42	67
Ga East	Ashongman	15	21	71
	GAEC	26	35	74
LANMA	Pantang	18	24	75
ASMA	Ashaiman	23	32	72
ADMA	Tema Motorway	52	61	85
TMA	Klagon	7	11	64
	Sakumono Beach Road	3	5	60
KKMA	GHAIP	12	16	75
	GRIDCo	12	15	80
	Grand Total	**251**	**348**	

Source: Field data

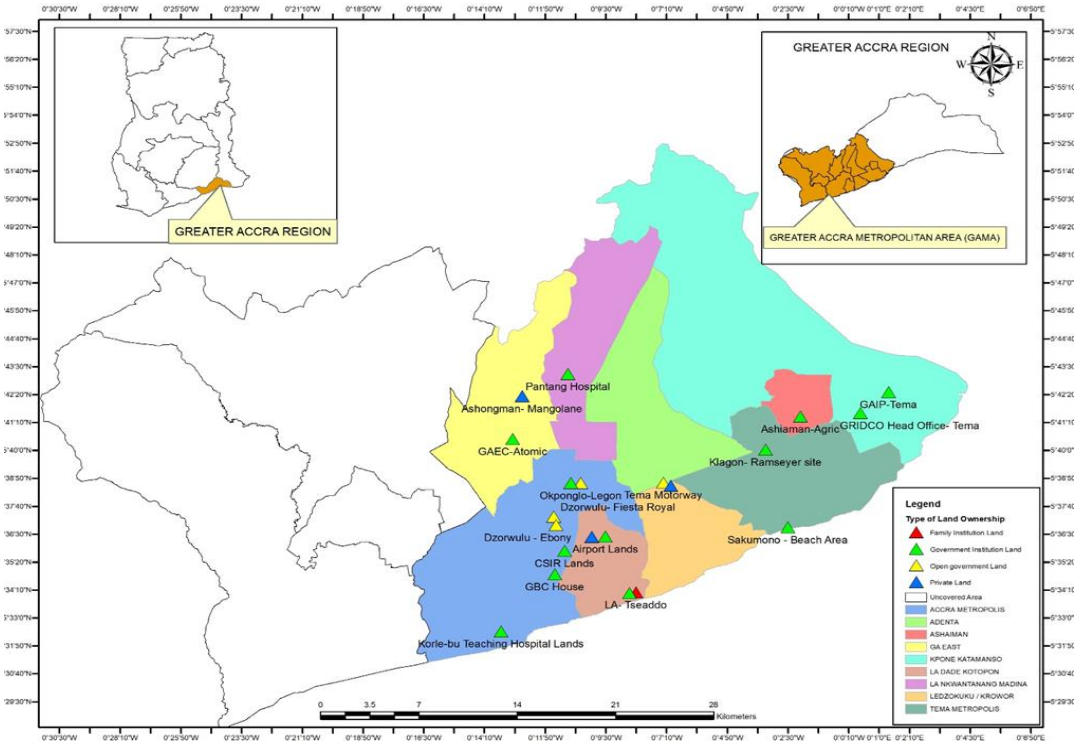

Figure 1. Location of urban farm sites.

Data Analysis

The study first estimated the intensity of the mobility of urban farmers with respect to land and after that estimated the factors that are associated with it. In estimating the intensity of farmers' mobility, the formula used was the number of times farmers had moved from one land to another, divided by the number of years in farming in the study area. The formula was used to create a mobility intensity index (see Equation 1). In Equation (1), MI is the mobility intensity index, FM is the number of places (lands) farmers have moved to farm on, and NY is the number of years of farming within GAMA.

$$MI = \frac{FM}{NY} \text{……..……..(1)}$$

After the creation of the mobility index, the second-level analysis first created a regression model (see Equation 2) and estimated the factors that are associated with farmers' mobility. The dependent variable was MI^* and the independent variables (IVs), which were categorized into three groups, i.e., land situation, farm characteristics, and personal characteristics.

$$MI^* = \alpha_0 + \beta_1 x_1 + .. \beta_7 x_7 + \cdots \delta_8 x_8 + .. \delta_{11} x_{10} + \cdots \propto_{11} x_{11} + \ldots \propto_{16} x_{16} + \varepsilon \text{ ……(2)}$$

Table 2. Measurement of variables

DEPENDENT VARIABLE			
No	**Type of variable**	**Description**	**Details**
1	Mobility intensity index	Continuous	Index of mobility
INDEPENDENT VARIABLE			
Personal characteristics			
No	**Type of variable**	**Measurement**	**Details**
1	Places farmed in GAMA	Count	Different locations farmed in
2	Years of farming in GAMA	Count	Years of farming in GAMA
3	Age	Years	Age of respondent
4	Sex	Dummy	Male and female
5	Level of education	Category & Dummy	Tertiary, SHS/Vocational/Technical, JHS/Middle School and Primary No education
6	Place of birth	Category & Dummy	Greater Accra Region, Upper East and other regions
7	Marital Status	Dummy	Married Non- married
8	Farmer's farm engagement status	Dummy	Full-time Non- full time
Farm characteristics			
No	**Type of variable**	**Measurement**	**Details**
7	Land size	Count	Hectares
8	Vegetable production intensity	Count	Number of times of growth of vegetables in a year
9	Level of technology	Count	Number of modern farm implements used
Land situation factors			
No	**Type of Variable**	**Measurement**	**Details**
10	Type of land ownership	Dummy	Government lands, otherwise
11	Intensity of land scarcity challenges	Count	Number of challenges
12	Intensity of market benefits	Count	Number of market benefits

From Equation (2), α_0 is the intercept of the linear model, x_i is the ith IV and β_i, δ_i and $\propto_1$, the coefficients of the categorized IV respectively. As indicated in Table 2, type of land ownership, intensity of land scarcity challenges and land size represent the land situation factors; level of market benefits, vegetable crop intensity, and level of technology available to the farmers represent the farm characteristics; and age, sex, education, region of birth, level of farm engagement and marital status represent the farmers' personal characteristics. In measuring the variables, the type of land ownership was dummied and categorized as either government lands or non-government lands, where the latter served as the base. The intensity of land scarcity challenges and the intensity of market benefits were measured as count. Age in years, sex as dummy with male as the base; the level of education as dummy with as categories: no education, primary, JHS/Middle School, Senior High School (SHS) and tertiary, with no education serving as the base. The place of birth was also a dummy with the categories: Upper East Region, Greater Accra Region and the other remaining regions in Ghana together as the base. We distinguished the Upper East and Greater Accra regions because the two accounted for almost 80% of the respondents. The level of farm engagement, which was also a dummy, was categorized as full-time or non-full-time, where the latter served as the base. Total land size was measured in hectares, while vegetable production intensity and level of technology were measured as count.

The study used the Tobit and Ordinary Least Squares (OLS) as two separate methods of estimation. The separate methods of estimation in a stepwise regression form helped with the consistency and reliability of the results. The study strictly followed all the underlying assumptions of the OLS and Tobit estimation methods to produce robust, consistent, and reliable results (Lin & Schmidt, 1984; Newey, 1987; Greene 1990; Koul et al., 2014).

Results

The results are presented in two main sections. First, a summary of the land situation factors, farmers' personal characteristics, and farm characteristics, and second, the results of both the OLS and Tobit stepwise regressions.

Summary of Variables

Table 3 shows the farmers' personal characteristics, the farm characteristics, and the land situation factors respectively. As for the farmers' personal characteristics, the farmers had farmed a minimum of one and a maximum of four different places. The mean number of places farmed was 1.47. The mean years of farming was 15.08. The mean age of the farmers was 41.04 years. Men constituted 94.02% while women were 5.98%. Married farmers were 73.31% and non-married were 26.69%. With respect to the level of education of farmers, the majority (33.47%) had no education, 25.90% had completed JHS or Middle School and 17.13% had completed SHS or Vocational or Technical School and 16.33%, 3.98% and 3.19% had primary school, a non-formal or tertiary education respectively. Full-time farmers constituted 72.71% and non-full-time, 22.49%. The mean land size was 1.33 hectares. Vegetable production intensity averaged 13.79. The level of technology use averaged 9.13, suggesting that on average, the urban farmers used about nine types of modern implements in urban farming in GAMA.

The mean rate of farmers' mobility with respect to land was 0.22, implying a 22% probability of a farmer moving to another land to farm per number of years in farming. Figure 2 confirms this and also indicates that a relatively small number of farmers had a high rate of mobility. Figure 3 indicates that male farmers were more mobile than female farmers while Figure 4 indicates those with primary and tertiary education were the most mobile. The mean intensity of land scarcity

challenges was 5.49. The intensity of market benefits averaged 5.60. As for type of land ownership, 82.07% used government lands and 17.93% used non-government lands.

Table 3. Summary of variables

Personal characteristics					
Variable	**Mean**	**Standard deviation**	**Median**	**Minimum**	**Maximum**
Places of farming in GAMA	1.47	0.73	1	1	4
Years of farming in GAMA	15.08	12.48	11	1	53
Age	41.40	15.01	40	19	82
Sex	*Frequency*	*Percentage*			
Male	236	94.02			
Female	15	5.98			
Marital status	*Frequency*	*Percentage*			
Married	184	73.31			
Not married	67	26.69			
Level of education	*Frequency*	*Percentage*			
None	84	33.47			
Primary	41	16.33			
JHS/Middle School	65	25.90			
Sec/Tech/Vocation	43	17.13			
Tertiary	8	3.19			
Non-formal	10	3.98			
Level of farm engagement	*Frequency*	*Percentage*			
Full-time	182	72.51			
Non-full-time	69	27.49			
Farm characteristics					
Variable	**Mean**	**Standard deviation**	**Median**	**Minimum**	**Maximum**
Intensity of market benefits	5.60	2.94	10	0	14
Vegetable production intensity	13.79	12.29	10	0	62
Level of technology	9.13	3.07	9	1	16
Land situation factors					
Variable	**Mean**	**Standard deviation**	**Median**	**Minimum**	**Maximum**
Land size	1.33	1.43	0.81	0.04	10.07
Intensity of land scarcity challenges	5.49	5.51	4	0	28
Type of land ownership	*Frequency*	*Percentage*			
Government land	206	82.07			
Non-government land	45	17.93			

Source: Field data

Table 4. Dependent variables

Dependent variable					
Variable	**Mean**	**Standard deviation**	**Median**	**Minimum**	**Maximum**
Rate of farmers' mobility	0.22	0.24	0.12	0.02	1
Rate of farmers' mobility (in %)	21.97	24.46	12.5	2	100

Source: Field data

Table 5. Factors associated with urban farmers' mobility estimates

Category of variables	Variables	Tobit Model 1	OLS Model 1	Tobit Model 2	OLS Model 2	Tobit Model 3	OLS Model 3	Tobit Model 4	OLS Model 4
Land situation factors	Government land	-11.10***	-11.10**	-8.698**	-8.698*	-6.912*	-6.912	-7.395**	-7.395
		(3.993)	(4.903)	(3.906)	(4.681)	(3.514)	(4.613)	(3.482)	(4.607)
	Intensity of land scarcity challenges	-0.935***	-0.935***	-0.959***	-0.959***	-0.973***	-0.973***	-0.922***	-0.922***
		(0.287)	(0.256)	(0.285)	(0.244)	(0.250)	(0.239)	(0.248)	(0.237)
	Land size	-1.754	-1.754**	-2.985***	-2.985***	-0.865	-0.865	-0.809	-0.809
		(1.067)	(0.746)	(1.076)	(0.857)	(0.970)	(0.732)	(0.960)	(0.737)
Farm characteristics	Intensity of market benefits			-0.360	-0.360	-0.928**	-0.928*	-0.941**	-0.941*
				(0.502)	(0.552)	(0.447)	(0.532)	(0.442)	(0.527)
	Vegetable crop intensity			-0.206*	-0.206	-0.229**	-0.229*	-0.234**	-0.234*
				(0.123)	(0.131)	(0.115)	(0.129)	(0.114)	(0.127)
	Level of technology			1.925***	1.925***	0.832*	0.832*	0.892**	0.892*
				(0.497)	(0.544)	(0.447)	(0.490)	(0.442)	(0.482)
Farmers' personal characteristics	Age					-0.513***	-0.513***	-1.853***	-1.853***
						(0.112)	(0.0903)	(0.583)	(0.511)
	Age square							0.0141**	0.0141***
								(0.00601)	(0.00496)
	Female					-7.578	-7.578*	-9.034	-9.034**
						(6.025)	(4.194)	(5.993)	(3.984)
	Primary educ.					6.803*	6.803	6.618*	6.618
						(3.805)	(4.459)	(3.765)	(4.450)
	JHS/Middle School					0.0668	0.0668	0.0218	0.0218
						(3.355)	(3.288)	(3.319)	(3.240)
	SHS/Voc. Sch./Tech Sch.					2.546	2.546	3.321	3.321
						(3.932)	(3.885)	(3.904)	(3.859)
	Tertiary educ.					14.94**	14.94	15.02**	15.02
						(7.470)	(12.40)	(7.390)	(12.59)
	Non-formal educ.					1.438	1.438	-1.550	-1.550
						(6.904)	(4.721)	(6.948)	(4.456)
	Upper East Region					-6.406**	-6.406*	-4.745	-4.745
						(3.196)	(3.531)	(3.241)	(3.429)
	Greater Accra Region					-3.821	-3.821	-4.444	-4.444
						(3.352)	(3.919)	(3.327)	(3.870)
	Full-time farmer					5.641*	5.641**	4.220	4.220
						(2.916)	(2.733)	(2.948)	(2.746)
	Married					-10.61***	-10.61***	-7.009*	-7.009**
						(3.319)	(3.337)	(3.626)	(3.192)
	Constant	38.54***	38.54***	27.06***	27.06***	64.89***	64.89***	91.04***	91.04***
		(4.333)	(5.614)	(7.290)	(8.517)	(8.662)	(9.761)	(14.09)	(14.23)
	Sigma	23.46***		22.69***		19.36***		19.15***	
		(1.047)		(1.013)		(0.864)		(0.855)	
	Observations	251	251	251	251	251	251	251	251

Standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1

Journal of Regional and City Planning
vol. 34, no. 1, page. 83-100, April 2023
DOI: 10.5614/jpwk.2023.34.1.5

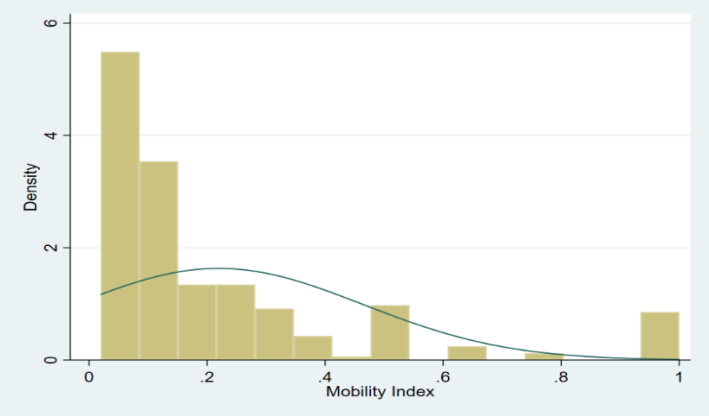

Figure 2. Distribution of rate of farmers' mobility with respect to land.

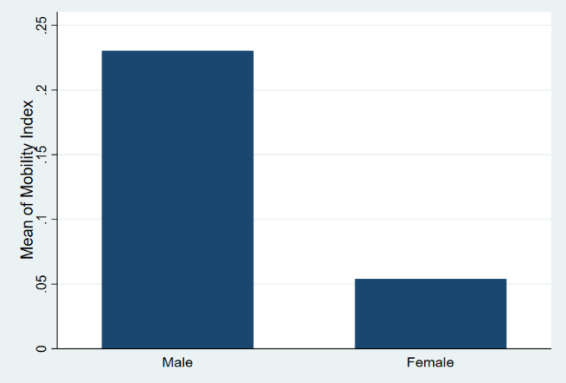

Figure 3. Distribution of the rate of mobility with respect to sex.

Figure 4. *Distribution of the rate of mobility with respect to level of education.*

Determinants of Farmers' Mobility

Table 5 presents the estimated Tobit and OLS results. For type of land ownership, farmers on government lands had a significantly lower rate of mobility compared to those on non-government lands, for both the OLS and Tobit estimations. This occurred only when the land situation factors and the farm characteristics were controlled for. Farmers on government lands were between 7.395% and 11.14% less mobile than those on non-government lands. The intensity of the land scarcity challenge decreased the rate of land mobility when the farm and farmers' personal characteristics were controlled for in both estimations. A unit increase in land scarcity intensity challenges reduced farmers' mobility between 0.922% and 1.048%. A larger land size reduced farmers' mobility when the farm characteristics were controlled for in both methods of estimation.

The level of market benefit also reduced the rate of mobility for both estimations when the farmers personal characteristics were controlled for. A unit increase in the intensity of market benefits reduced mobility between 0.928% and 0.941%. Vegetable crop intensity also reduced the rate of mobility for both methods of estimations when all the other variables were controlled for. A unit increase in vegetable crop intensity reduced mobility between 0.206% and 0.234%. Within the city, farmers enjoyed high patronage for their produce, which encouraged them to produce more through intensification. The level of technology was also significant for both estimation methods and all three categories of variables. A unit increase in the level of technology increased farmers' mobility within the urban space between 0.832% and 1.925 %. The higher the level of technology, the higher the rate of farmers' mobility with respect to land use. This means urban farmers were likely to move to other lands within GAMA to increase their production as they improved upon the level of technology in farming.

While age reduced farmers' mobility, age squared increased farmers' mobility with respect to land. Urban farmers reduced their rate of mobility until they were 65.71 years. A unit increase in age decreased the rate of mobility by between 0.513% and 0.014%. Female mobility was lower than male mobility, at 7.578% compared to 9.034%. With respect to education, farmers who completed primary school or had tertiary education were more mobile than farmers who had no education only for the Tobit estimation. The coefficients for those who completed primary school were 6.803% and 6.618%, and 14.94% and 15.02% for tertiary education. Those born in the Greater Accra Region had a lower rate of mobility compared to those born in other regions of Ghana, apart from the Upper East Region. Full-time farmers were 5.641% more mobile than non-full-time farmers for both estimations. Farmers who are married were between 7.009% and 10.61% more mobile compared to those who were not married.

Discussion

The farmers' average age of 41.04 years suggests that the farmers in the study area were relatively younger than the national age of farmers of 55 years (MoFA 2010). Other studies within Accra have suggested an average age of 40 years of about 95% of farmers (Antwi-Agyei et al., 2016; Obuobi and Hope, 2014). The domination of men in Ghana's UA is confirmed by other studies (Danso et al., 2014b; Obuobie and Hope, 2014; Armah-Klemesu and Maxwell, 1998). With respect to the results on education, studies on UA in Ghana confirm that the majority of farmers have a low level of formal education (Obuobie and Hope 2014; Ackerson & Awuah, 2010; Asomani-Boateng, 2002). The findings on the level of farm engagement agree with the findings of Caradonna et al., (2013), where the majority of farmers worked on full-time basis, but they differ from Asomani-Boateng (2002) and Bolang and Osumanu (2019), who found that non-full-

time farmers outnumbered full-time farmers in Kumasi and the Wa Municipality in Ghana respectively.

With respect to the findings on the market benefits of urban agriculture, other studies have noted that farmers in cities enjoy patronage based on their location and high demand for their goods (Drechsel et al., 2006; Obuobi and Hope, 2014). The mean value of 13.79 suggests that farmers grew an average of about fourteen rounds of crops in a year. This suggests a high level of intensification among urban farmers in GAMA, which can be linked to the impressive market benefits of farming in the city. Hensler and Amoah (2014) have noted the high level of production intensity among urban vegetable farmers in the Ghana as well. This suggests that, even though lands for farming are very scarce, farmers will definitely move to find new lands to farm on within the city due to the profitability of farming. With respect to the use of modern technology in UA production within Ghana, studies have suggested that it is relatively high (Obuobi and Hope, 2014; Egyir et al., 2014) but compared to cities in other parts of the world such as Shanghai and Paris, the use of advanced technology in Ghana's UA is very low (Hosseinifarhangi et al., 2019; Fourdinier 2019).

As indicated in Table 5, the regression results indicated that farmers on government lands were less likely to move to other lands compared to those on other types of land ownership. This implies that government land is cheaper to use when it is temporally used for agriculture. It is relatively secure and stable for use by urban farmers in GAMA (Allen et al., 2014), which may make mobility very unattractive to them. Globally and in Ghana as well, studies have found that loss of land triggers farmers' mobility, although estimates have not been published (Oda et al., 2018; Caradonna et al., 2013; Danso et al., 2014a; Allen et al., 2014; Teklu, 2005; Kanianska, 2016), which the present study did. The phenomenon of urban farmers using government lands is common in many parts of Africa due to land scarcity and ownership difficulties and complexities (Vélez-Guerra 2004). This may further explain why many farmers in GAMA hardly move to any new lands for farming and prefer to stay on available government lands. Urban land scarcity challenges such as conflicts and forced evictions are common in GAMA. This intensifies farmers use of safe and secure lands, thus making mobility more difficult (Allen and Apsan Frediani, 2013; Allen et al., 2014; Mackay, 2018). The bigger the land size of a farmer, the less likely they are to move to other lands for farming. Therefore, as long as farmers have larger lands to farm on, they will remain and do not want to move. Higher intensity in land scarcity challenges, market benefits, and vegetable crop production reduce mobility but do not increase the level of technology. This supports the assertion that land scarcity for agriculture becomes entrenched as the population increases, even though population growth increases the demand for urban farm produce. Furthermore, land scarcity challenges in the midst of high demand for agricultural produce in urban centers results in the adoption of improved technologies (Follmannetal, 2021; Houssou et al., 2018; Ayambire et al., 2019; Odame et al., 2020), even though Nin-Pratt & McBride (2014) are of the view that the rate of improvement in farming technology in Ghana is generally low amid increasing food security concerns. The findings on age support the assertion that as farmers grow, they become less interested in moving to new places to farm or even release their land for farming (Kidido and Lengoiboni, 2019; Guo et al., 2015; Supasub et al., 2020). This could explain why farmers at older ages are less likely to move. The OLS regression indicated that female mobility was lower compared to that of men. In Ghana, UA production is highly dominated by men (Hope and Obuobi 2014). One key reason is that men have more fortitude in surviving the struggles of obtaining lands in cities than women. This also makes women farm on relatively smaller lands than men, which may explain why women prefer to move less compared to men (Allen et al., 2014; Obuobie et al., 2004; Danso et al., 2004; Caradonna et al., 2012). Tertiary education increases mobility, which supports the conclusion by Guo et al. (2015) that

people with a higher level of education are most poised to increase output in agricultural production. This could be explained by their desire to use new lands. Also, Supasub et al. (2020) concluded that farmers who had higher education could more easily move to better urban lands in Chiang Mai City in Thailand. Farmers who are full-time are more likely to move, which could be explained by the fact that they have more time on their hands to produce more vegetables and if they lose land, they have no other option than to find other lands to farm on.

Conclusion

This study assessed how urbanization-induced land scarcity influences urban farmers' mobility and examined the determinants of this mobility. Within the period the farmers stayed in the study area, there was a 22% probability that farmers would move to another land to farm within the city during their years of farming. For farmers on government lands or those who had less challenges on their lands, their mobility was lower compared to those on other types of land ownership. Farmers with small land sizes moved at a slower rate within the city to farm. This was the same for those who enjoyed higher market benefits, grew lots of vegetables or were born in Greater Accra, the region where the study area was located. Farmers who employed a higher level of technology or were younger, moved faster to other lands. Men moved faster than women and so did married compared to unmarried farmers. Having primary and tertiary education was also related to higher mobility compared to being unschooled. Full-time farmers were more mobile than non-full-time farmers.

Prior to this study, estimations of urban farmers' mobility within cities based on land scarcity induced by urbanization were almost non-existent in the literature. This study has brought this concept to light through the estimation of the rate of mobility and its associated determinants within a city of a developing country. Sustaining urban farming in Ghanaian cities calls for factoring farmlands into spatial city planning through government support and supporting the use of modern farming technologies. Efforts should be made to train farmers with both low and high levels of education on the realities of land scarcity with respect to urban agriculture on how to adapt to land mobility. They should also be trained on income diversity when they lose their farmland due to urbanization. Also, stakeholders in urban agriculture production should make efforts to help young people who are prepared to make farming their full-time job obtain spare lands in the city or peri-urban centers to produce crops that can essentially contribute to urban food security and increase farmers' income, not only in Ghana but in all of Africa.

References

Ackerson, N. O., & Awuah, E. (2010). Urban Agriculture Practices and Health Problems among Farmers Operating on a University Campusin Kumasi, Ghana. The Journal of Field Actions, (Special Issue 1). retrieved from https://journals.openedition.org/factsreports/pdf/451 ISSN: 1867-8521

Armah-Klemesu, M., & Maxwell, D. (1998). Urban Agriculture in the Greater Accra Metropolitan Area. Retrieved from Accra, http://hdl.handle.net/10625/25583

Antwi-Agyei, P., Peasey, A., Biran, A., Bruce, J., & Ensink, J. (2016). Risk perceptions of wastewater use for Urban Agriculture in Accra, Ghana. PloS one, 11(3), e0150603. https://doi.org/10.1371/journal.pone.0150603

Allen, A., & Apsan Frediani, A. (2013). Farmers, not gardeners. The making of environmentally just spaces in Accra. City, 17(3), 365-381. ISSN 13604813, 14703629 doi:10.1080/13604813.2013.796620

Allen, A., Apsan Frediani, A., & Wood-Hill, M. (2014). Land and Planning for Urban Agriculture in Accra: Sustained Urban Agriculture or Sustainable Urbanization. In: Drechsel, P. and B. Keraita (eds.). Irrigated Urban Vegetable Production in Ghana Characteristics, Benefits and Risk Mitigation (pp. 146-161). Accra: International Water Management Institute (IWMI). ISBN: 978-92-9090-798-5

Appeaning Addo, K. (2010). Urban and Peri-Urban Agriculture in Developing Countries Studied using Remote Sensing and In Situ Methods. Remote Sensing, 2(2), 497-513. ISSN 20724292. doi:10.3390/rs2020497

Appiah, D. O., Bugri, J. T., Forkuor, E. K., & Boateng, P. K. (2014). Determinants of Peri-Urbanization and Land Use Change Patterns in Peri-Urban Ghana. Journal of Sustainable Development, 7(6). ISSN 19139063. doi:10.5539/jsd.v7n6p95

Arku, G., Mkandawire, P., Aguda, N., & Kuuire, V. (2012). Africa's Quest for food security: what is the role of Urban Agriculture? Retrieved from Harare: ISBN: 978-1-77937-037-2

Asomani-Boateng, R. (2002). Urban cultivation in Accra: an examination of the nature, practices, problems, potentials and urban planning implications. Habitat International, 26, 591-607. ISSN 01973975.https://doi.org/10.1016/S0197-3975(02)00027-9

Ayambire, R. A., Amponsah, O., Peprah, C., & Takyi, S. A. (2019). A review of practices for sustaining urban and peri-Urban Agriculture: Implications for land use planning in rapidly urbanising Ghanaian cities. Land Use Policy, 84, 260-277. ISSN:02648377. DOI: 10.1016/j.landusepol.2019.03.004

Azunre, G. A., Amponsah, O., Peprah, C., Takyi, S. A., & Braimah, I. (2019). A review of the role of Urban Agriculture in the sustainable city discourse. Cities, 93, 104-119. ISSN: 2334-2900 https://doi.org/10.1016/j.cities.2019.04.006

Badami, M. G., & Ramankutty, N. (2015). Urban Agriculture and food security: A critique based on an assessment of urban land constraints. Global Food Security, 4, 8-15. ISSN: 22119124 doi:10.1016/j.gfs.2014.10.003

Bartlett, J. E., Kotrlik, J. W., & Higgins, C. C. (2001). Organizational research: Determining appropriate sample size in survey research. Information technology, learning, and performance journal, 19(1), 43. ISSN: 1535-1556.

Bolang, P. D., & Osumanu, I. K. (2019). Formal sector workers' participation in urban agriculture in Ghana: perspectives from the Wa Municipality. Heliyon, 5(8), e02230.ISSN: 24058440 https://doi.org/10.1016/j.heliyon.2019.e02230

Caradonna, F., Cheng, J., El-aama, D., Hafiz, B., Isaacson, J., Pretell, M., & Reinig, M. (2013). Decision Making Processes of Vulnerable Groups: The potential of Urban Agriculture to support a just distribution of land, cultural recognition and meaningful participation, La, Accra Environmentally Just Urbanization through Urban Agriculture; Accra, Ghana Reports 2012 (First ed., pp. 225-266): University College London-UCL

Cofie, O., Larbi, T., Danso, G., Abraham, E., Kufogbe, S. K., Henseler, M., . . . Obiri-Opareh, N. (2005). A Narrative On Urban Agriculture in Accra Metropolis Accra Retrieved from Accra:

Conway, S. F., Farrell, M., Mcdonagh, John, & Kinsella, A. (2020). Mobilising Land Mobility in the European Union: An Under-Researched Phenomenon. International Journal of Agricultural Management.9. DOI: 10.5836/ijam/2020-09-7

Cornish, G. A., & Aidoo, J. B. (2000). Informal Irrigation in the Peri-urban Zone of Kumasi, Ghana; Findings from an initial questionnaire survey. Retrieved from Wallingford:

Creswell, J. W., & Creswell, J. D. (2017). Research design: Qualitative, quantitative, and mixed methods approaches: Sage publications. ISBN:9781506386706. DOI: 10.4236/health.2021.134032

Danso, G., Cofie, O., Annang, L., Obuobie, E., & Keraita, B. (2004). Gender and Urban Agriculture: the case of Accra, Ghana. Resource Centre on Urban Agriculture and Forestry (RUAF).

Danso, G., Drechsel, P., Obuobie, E., Forkuor, G., & Kranjac-Berisavljevic, G. (2014a). Urban Vegetable Farming Sites, Crops and Cropping Practices. In: Drechsel, P. and B. Keraita (eds.). Irrigated Urban Vegetable Production in Ghana Characteristics, Benefits and Risk Mitigation (pp. 7-27). Accra: International Water Management Institute (IWMI). https://hdl.handle.net/10568/65296. ISBN: 978-92-9090-798-5.doi: 10.5337/2014.219

Danso, G., Hope, L., & Drechsel, P. (2014b). Financial and Economic Aspects of Urban Vegetable Farming. In: Drechsel, P. and B. Keraita (eds.). Irrigated Urban Vegetable Production in Ghana Characteristics, Benefits and Risk Mitigation (pp. 39-51). Accra: International Water Management Institute (IWMI). ISBN: 978-92-9090-798-5.DOI; 10.22004/ag.econ.208748

Drechsel, P., Graefe, S., Sonou, M., & Cofie, O. O. (2006). Informal irrigation in urban West Africa: An overview (Vol. 102): International Water Management Institute (IWMI).

Diehl, J. A., Sweeney, E., Wong, B., Sia, C. S., Yao, H., & Prabhudesai, M. (2020). Feeding cities: Singapore's approach to land use planning for urban agriculture. Global Food Security, 26, 100377.ISSN 22119124 .https://doi.org/10.1016/j.gfs.2020.100377

De Vaus, D. A. (2002). Surveys in social research (5th ed.). London: : Routledge. https://doi.org/10.4324/9780203519196. ISBN 9781134086313(In UK)

Egyir, I. S., Cofie, O. O., & Dubbeling, M. (2014). Options for Local Financing in Urban Agriculture. In P. D. a. B. Keraita (Ed.), Irrigated Urban Vegetable Production in Ghana Characteristics, Benefits and Risk Mitigation (pp. 137-145). Accra: International Water Management Institute (IWMI). ISBN: 978-92-9090-798-5.doi: 10.5337/2014.219.

Food and Agriculture Organization (FAO). (2012). Growing Greener Cities In Africa. Retrieved from Rome: ISBN 9789251072868(In Italy)

Follmann, A., Willkomm, M., & Dannenberg, P. (2021). As the city grows, what do farmers do? A systematic review of urban and peri-Urban Agriculture under rapid urban growth across the Global South. Landscape and Urban Planning, 215, 104186. ISSN: 01692046 https://doi.org/10.1016/j.landurbplan.2021.104186

Fourdinier, G. (2019). New technologies in support of Urban Agriculture. Field Actions Science Reports. The journal of field actions, (Special Issue 20), 112-115. ISSN:1867139X, 18678521

Ghana Statistical Service. (2005). 2000 Population and Housing Census,[name of District]: Greater Accra Region (Vol. 5): Ghana Statistical Service.

Ghana Statistical Service. (2005 in Songsore, 2009). 2000 Population and Housing Census,[name of District]: Greater Accra Region (Vol. 5): Ghana Statistical Service.

Ghana Statistical Service. (2014). 2010 Population and Housing Census; Housing in Ghana (1965-0175). Retrieved from Accra:

Ghana Statistical Service. (2016). Projected population by region and sex, 2010-2016. Retrieved from Accra:

Ghana Statistical Service Accra (GSS) Ghana Health Service (GHS) and ICF International. (2015). Ghana Demographic and Health Survey 2014. Retrieved from Rockville, Maryland, USA

Glenn, D. (1992). Determining sample size. A series of the Program Evaluation and Organizational Development. University of Florida Cooperative Extension Service, Institute of Food and Agriculture Sciences, EDIS, Publication date: 6th November, 1992.

Greene, W.H (1990). Econometric Analysis. 8th Edition. Pearson. London. ISBN-13: 9780134804576 (In UK)

Guo, G., Wen, Q., & Zhu, J. (2015). The impact of aging agricultural labor population on farmland output: from the perspective of farmer preferences. Mathematical problems in Engineering, 4, (pp1-7). ISSN1024123X DOI:10.1155/2015/730618

Henseler, M., & Amoah, P. (2014). Marketing Channels for Irrigated Exotic Vegetables. In: Drechsel, P. and B. Keraita (eds.). Irrigated Urban Vegetable Production in Ghana Characteristics, Benefits and Risk Mitigation (pp. 51-61). Accra: International Water Management Institute (IWMI).

Hosseinifarhangi, M., Turvani, M. E., van der Valk, A., & Carsjens, G. J. (2019). Technology-driven transition in urban food production practices: A case study of Shanghai. Sustainability, 11(21), pp 6070.ISSN 19370695 https://doi.org/10.3390/su11216070

Houssou, N., Johnson, M., Kolavalli, S., & Asante-Addo, C. (2018). Changes in Ghanaian farming systems: stagnation or a quiet transformation? Agriculture and Human Values, 35(1), 41-66.ISSN 0889048X. DOI : https://doi.org/10.1007/s10460-017-9788-6.

Jiang, L., Deng, X., & Seto, K. C. (2013). The impact of urban expansion on agricultural land use intensity in China. Land use policy, 35, 33-39. ISSN:02648377 https://doi.org/10.1016/j.landusepol.2013.04.011

Kanianska, R. (2016). Agriculture and its impact on land-use, environment, and ecosystem services. Landscape ecology – The influences of land use and anthropogenic impacts of landscape creation, 1-26. InTechOpen (July 27, 2016). ISBN: 9789535125136

Keraita, B., & Cofie, O. O. (2014). Irrigation and Soil Fertility Management Practices. In: Drechsel, P. and B. Keraita (eds.). Irrigated Urban Vegetable Production in Ghana Characteristics, Benefits and Risk Mitigation (pp. 63-74). Accra: International Water Management Institute (IWMI). ISBN: 978-92-9090-798-5

Kidido, J. K., & Lengoiboni, M. (2019). Household land allocations and the youth land access nexus: Evidence from the Techiman Area of Ghana. Land, 8(12), 185. ISSN 2073-445X. https://doi.org/10.3390/land8120185.

Koul, H. L., Song, W., & Liu, S. (2014). Model checking in Tobit regression via nonparametric smoothing. Journal of Multivariate Analysis, 125, 36-49. ISSN 0047259X. https://doi.org/10.1016/j.jmva.2013.11.017

Kufogbe, S., & Surveyors (1996). Urbanisation and Changing Patterns of Land Use in the Peri-urban Zone Along the Airport-Ayimensah Transect of Accra, Ghana, Our Common Estate Royal Institution of Chartered Surveyors. London

Lambin, E. F., & Meyfroidt, P. (2011). Global land use change, economic globalization, and the looming land scarcity. Proceedings of the national academy of sciences, 108(9), 3465-3472. ISSN:00278424, 10916490. https://doi.org/10.1073/pnas.1100480108

Lasisi, M., Popoola, A., Adediji, A., Adedeji, O., & Babalola, K. (2017). City Expansion and Agricultural Land Loss within the Peri-Urban Area of Osun State, Nigeria. Ghana Journal of Geography, 9(3), 132–163. ISSN: 0855-9414

Lin, T. F., & Schmidt, P. (1984). A test of the Tobit specification against an alternative suggested by Cragg. The Review of Economics and Statistics, 66(1) pp 174-177. ISSN: 0034-6535 https://doi.org/10.2307/1924712

Lovell, S. T. (2010). Multifunctional Urban Agriculture for sustainable land use planning in the United States. Sustainability, 2(8), 2499-2522. ISSN 19370695. doi:10.3390/su2082499

Mackay, H. (2018). Mapping and characterising the Urban Agriculture landscape of two intermediate-sized Ghanaian cities. Land Use Policy, 70, 182-197. ISSN: 02648377 doi:10.1016/j.landusepol.2017.10.031

Ministry of Local Government and Rural Development (MLGRD). (2017). Greater Accra Metropolitan Area (Gama) Sanitation and Water Project: Final Environmental and Social Management Plan (ESMP). Retrieved from Accra.

Moeis, F. R., Dartanto, T., Moeis, J. P., & Ikhsan, M. (2020). A longitudinal study of agriculture households in Indonesia: The effect of land and labor mobility on welfare and poverty dynamics. World Development Perspectives, 20(4), 100261. ISSN: 24522929. DOI:10.1016/j.wdp.2020.100261

Mougeot, L. J. (2000). UA: definition, presence, potentials and risks. In N. Bakker, M. Dubbeling, S.Guendel, U. Sabel Koschella, H. de Zeeuw (Ed.), Growing Cities, Growing Food, UA on the Policy Agenda. (pp. 1- 42). Feldafing, Germany DSE, .

Mougeot, L. J. (2006). Growing better cities: UA for sustainable development: IDRC.Ottawa, Ontario. ISBN 1552502260

Naab, F. Z., Dinye, R. D., & Kasanga, R. K. (2013). Urbanisation and its Impact on Agricultural Lands in Growing Cities in Developing Countries: A Case Study of Tamale in Ghana Modern Social Science Journal, 2 (2), 256-287. ISSN: 2051-5499

Newey, W. K. (1987). Specification tests for distributional assumptions in the Tobit model. Journal of Econometrics, 34(1-2),125-145.ISSN:03044076.https://doi.org/10.1016/0304-4076(87)90070-4

Nijenhuis, K. (2013). Farmers on the move: mobility, access to land and conflict in Central and South Mali: 55. 270. African Studies Centre. Leiden. ISBN: 978-90-5448-134-8

Nin-Pratt, A., & McBride, L. (2014). Agricultural intensification in Ghana: Evaluating the optimist's case for a Green Revolution. Food Policy, 48, 153-167. ISSN:03069192. https://doi.org/10.1016/j.foodpol.2014.05.004

Obuobie, E., Danso, G., & Drechsel, P. (2003). Access to land and water for urban vegetable farming in Accra. UA Magazine, 11, 15-17. ISSN: 1571-6244

Obuobie, E., & Hope, L. (2014). Characteristics of Urban Vegetable Farmers and Gender Issues. In: Drechsel, P. and B. Keraita (eds.). Irrigated Urban Vegetable Production in Ghana Characteristics, Benefits and Risk Mitigation (pp. 28-37). Accra: International Water Management Institute (IWMI). ISBN: 978-92-9090-798-5

Oda, K., Rupprecht, C. D., Tsuchiya, K., & McGreevy, S. R. (2018). UA as a sustainability transition strategy for shrinking cities? Land use change trajectory as an obstacle in Kyoto City, Japan. Sustainability, 10(4), 1048. ISSN 19370695 https://doi.org/10.3390/su10041048

Odame, H. S., Okeyo-Owuor, J. B., Changeh, J. G., & Otieno, J. O. (2020). The role of technology in inclusive innovation of UA. Current Opinion in Environmental Sustainability, 43, 106-111. ISSN: 1877-3435 .DOI:10.1016/j.cosust.2019.12.007

Owusu, G. (2008). Indigenes and Migrants Access to Land in Peri-Urban Areas of Ghana's largest City of Accra. International Development Planning Review (IDPR), 30(2), 177-198. ISSN 14746743. DOI:10.3828/idpr.30.2.5

Owusu, G. (2013). Coping with Urban Sprawl: A Critical Discussion of the Urban Containment Strategy in a Developing Country City, Accra. Planum Journal of Urbanism, 1(26), 1-17. ISSN 1723-0993. http://197.255.68.203/handle/123456789/6236

Satterthwaite, D. (2007). The transition to a predominantly urban world and its underpinnings. Human Settlements Discussion Paper Series, Theme: Urban Change 4(4), 1-90. ISBN: 9781843696704. https://doi.org/10.1098/rstb.2010.0136

Satterthwaite, D., McGranahan, G., & Tacoli, C. (2010). Urbanization and its implications for food and farming. Philosophical Transitions of the Royal Society, 365, 2809-2820. ISBN: 1235646440. doi:10.1098/rstb.2010.0136

Saunders, M., Lewis, P., & Thornhill, A. (2019). Research Methods for Business Students (8th ed.). Essex: Pearson Education Limited.

Seto, K. C., Fragkias, M., Burak, G., & Reilly, M. K. (2011). A Meta-Analysis of Global Urban Land Expansion. Plos One, 6(8), 1-9. ISSN:19326203 doi:10.1371/10.1371/journal.pone.0023777.g001

Smit, J., Nasr, J., & Ratta, A. (2001). UA Yesterday and Today. In UA Food, Jobs and Sustainable Cities. New York: The UA Network, Inc.

Stoler, J., Weeks, J. R., & Fink, G. (2012). Sachet drinking water in Ghana's Accra-Tema metropolitan area: past, present, and future. Journal of Water Sanitation and Hygiene for Development, 2(4), 223-240. ISSN:20439083. DOI: 10.2166/washdev.2012.104

Suchá, L., Schlossarek, M., Dušková, L., Malan, N., & Šarapatka, B. (2020). Land tenure security and its implications for investments to UA in Soweto, South Africa. Land Use Policy, 97, 104739. ISSN: 02648377. DOI:10.1016/j.landusepol.2020.104739

Supasub, S., Sirisunyaluck, R., Chalermphol, J., Limnirankul, B., & Kanjina, S. (2020). Factors affecting the adaptation of farmers affected by the urban expansion of Chiang Mai city. International Journal of Agricultural Technology, 16(4), 1037-1046. ISSN 2630-0192

Taiwo, O. J. (2014). Determinants of peri-urban and UA locational choice behaviour in Lagos, Nigeria. Land Use Policy, 39, 320-330. ISSN: 02648377. DOI:10.1016/j.landusepol.2014.02.003

Tashakkori, A., & Teddlie, C. (2010). Sage handbook of mixed methods in social & behavioral research. Thousand Oaks, CA: Sage. ISBN: 9781483305493

Taylor J. E. (2010). Agricultural labor and migration policy. Annual Reviews of Resource. Economics, 2(1), 369-393. ISSN:19411340. https://doi.org/10.1146/annurev-resource-040709-135048

Tellman, B., Eakin, H., Janssen, M. A., de Alba, F., & Turner II, B. L. (2021). The role of institutional entrepreneurs and informal land transactions in Mexico City's urban expansion. World Development, 140, 105374. ISSN: 0305750X, 18735991 https://doi.org/10.1016/j.worlddev.2020.105374

Teklu, T. (2005). Land scarcity, tenure change and public policy in the African case of Ethiopia: Evidence on efficacy and unmet demands for land rights. International Conference on African Development Archives. Centre for African Development Policy Research. Schorlarly Works at WMU. West Michigan University, 9, 2005.

Tuffour, M. (2022). Sustaining Urban Agriculture Under Intense Urbanisation In Ghana: Emerging And Existing Roles Of Formal Institutions. Theoretical and Empirical Researches in Urban Management, 17(3), 54-70.ISSN: 20653913, 20653921. https://www.jstor.org/stable/27160134

UN-Habitat. (2014). The State of African Cities 2014: Re-imagining sustainable urban transitions. Retrieved from Nairobi, Kenya. ISSN: 9789210575614

UN-Habitat. (2009). Ghana: Accra Urban Profile. Retrieved from Nairobi . ISBN 978-92-1-132129-6

Van Veenhuizen, R. (2006). Introduction to UA. In Cities farming for future, UA for green and productive cities (pp. 2-17). Leusden, The Netherlands: RUAF Foundation, IDRC, Canada and IIRR publishers, the Philippines. ISBN: 1930261144

Vélez-Guerra, A. (2004). Multiple means of access to land for UA: A case study of farmers' groups in Bamako, Mali. Cities feeding people series. Intl Development Research. Ottawa. Canada

World Bank. (2015a). Rising through Cities in Ghana : Ghana Urbanization Review Overview Report. World Bank, Washington, DC. © World Bank Group. https://openknowledge.worldbank.org/handle/10986/22020 License: CC BY 3.0 IGO.

World Bank. (2015b). Urbanization in Ghana : Challenges and Strengths. Ghana in Brief. World Bank, Washington, DC. © World Bank Group. https://openknowledge.worldbank.org/handle/10986/22761 License: CC BY 3.0 IGO

Yankson, P. W. K., & Bertrand, M. (2012). Challenges of Urbanization in Ghana. In Elizabeth Ardayfio-Schandorf, Paul W. K. Yankson, & M. Bertrand (Eds.), The Mobile City of Accra: Urban Families, Housing and Residential Practices (pp. 27-46). Dakar: Council for the Development of Social Science Research in Africa (CODESRIA).

Yu, M., Chen, Z., Long, Y., & Mansury, Y. (2022). Urbanization, land conversion, and arable land in Chinese cities: The ripple effects of high-speed rail. Applied Geography, 146, 102756. ISSN:01436228; https://doi.org/10.1016/j.apgeog.2022.102756.

Zezza, A., & Tasciotti, L. (2010). UA, poverty, and food security: Empirical evidence from a sample of developing countries. Food Policy, 35(4), 265-273. ISSN:03069192. doi:10.1016/j.foodpol.2010.04.007

Zhang, W., & Xu, H. (2017). Effects of land urbanization and land finance on carbon emissions: A panel data analysis for Chinese provinces. Land Use Policy, 63, 493-500. ISSN 0264-8377.doi:10.1016/j.landusepol.2017.02.006.