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Dar es Salaam households are willing to pay

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We can incorporate agriculture ecosystems into urban green economy in Tanzania: Dar es Salaam households are willing to pay

Byela Tibesigwa[1] Herbert Ntuli[2] and Telvin Muta[3]

Abstract

We are living in a crisis era, with competing land-use for finite land and ill-informed myopic urban land-use policies that remain stagnant, in a world with rapidly changing urban environment, such as the mushrooming urban agriculture. While smallholder farms in and around cities, in sub-Saharan Africa, provide many ecosystem services including boosting household income and nutrition, access to land constrains these benefits. This paper examines the willingness to pay for urban farm plots, using a random parameter logit model. The estimation reveals that the marginal WTP for irrigation is US$19.47 per plot. With regard to plot size, households are willing to pay US$6.09 per hectare, while WTP for the distance to the plot is US$3.95per km per annum. WTP for an irrigated plot is about three times that of plot size and almost five times that of distance to the plot, a signal of adaptation to climate change due to extreme weather changes and water shortages in Tanzania. There is a high preference for mixed cropping, i.e., mixed vegetables and fruits. Approximately 10% of the households prefer purely subsistence farming, i.e., retaining all harvest for own consumption. The remaining 90% prefer semi-subsistence, where 57% would retain a quarter of the harvest for consumption, 27% would retain half and 6% would retain three-quarters, suggesting that farms would increase urban households' food security. Our paper nudges policymakers to interrogate current policies and craft future inclusive green economy strategies that include urban agriculture and irrigation infrastructure.

Keywords: land, urban farms, agriculture ecosystems, WTP, green economy, Tanzania

JEL Codes: Q5, Q1, Q57

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What is urban households' willingness to pay for land for the purpose of urban crop farming? What will these households produce in these urban farms, and for what purpose? These are important policy questions in sub-Saharan Africa (Yan et al. 2022; Matamanda et al. 2022), as we are living in a crisis era with competing land-use for finite land and ill-informed myopic urban land-use policies that remain stagnant, in a world with rapidly changing urban environment (Matamanda et al. 2022). The rapidly mushrooming urban agriculture ecosystems named urban and peri-urban agriculture (UPA) (Hardman et al. 2022; Ilieva et al. 2022) are the cornerstones of sub-Saharan Africa's urban households (Matamanda et al. 2022), practiced on any available space (Matamanda et al. 2022), such as backyards or unused public land[4] (Follmann et al. 2021; Ayambire et al. 2019; Bellwood-Howard et al. 2018; Bersaglio and Kepe 2014; Halloran and Magid 2013; Chah et al. 2010), mainly due to economic-growth oriented policies favoring land allocation to the urban sprawl, trade and industries (Hardman et al. 2022).

The intense interest in policy-oriented UPA is that they provide many benefits[5] such as an increment in household livelihoods through income generation and improved food nutrition (Yan et al. 2022; Hardman et al. 2022; Matamanda et al. 2022; Langemeyer et al. 2021; FAO 2011). They create agriculture ecosystems that enhance urban biodiversity and produce ecosystem services needed for urban resilience to climate change (Yan et al. 2022; Newell et al. 2022; Hardman et al. 2022). They reduce greenhouse gas emissions and prices, by shortening food supply chain and food miles brought by rural-urban transportation (Yan et al. 2022; Newell et al. 2022; Langemeyer et al. 2021). They offer therapeutic green landscapes (Newell et al. 2022; Yan et al. 2022). They are an important part of mitigation against the disruptions from the COVID-19 pandemic[6] (Yan et al. 2022; Hardman et al. 2022). UPA refers to food production systems within cities or their surroundings[7] (Newell et al. 2022; Yan et al. 2022; FAO 2011). At present, sub-Saharan Africa's UPA is primarily informal (Yan et al. 2022; Hardman et al. 2022; Nchanji

[4] The characteristic of SSA's UPA differs from developed countries' UPA, as they can occur vertically and on rooftops in addition to backyards, in-line with infrastructure development, i.e., multistoried buildings (Yan et al. 2022). Urban SSA's infrastructure is undeveloped thus urban agriculture mainly depends on land.

[5] Urban farms are agriculture ecosystems that provide a host of services (Ilieva et al. 2022; McDougall et al. 2019; FAO 2011); however, the literature mainly focuses on their role as food providers (Ilieva et al. 2022).

[6] Note that UPA, like rural agriculture, can also produce ecosystem disservices. For example, fertiliser use can negatively impact water quality. Sequestration is significant in trees rather than vegetable gardens (Newell et al. 2022). However, policy-oriented UPA is likely to mitigate against these effects.

[7] Although the definition of UPA keeps evolving and remains ambiguous (Yan et al. 2021). There is a general agreement to this narrow definition which is conceptually geographic (FAO 2011; Hardman et al. 2022).

2017; Odudu 2015) and may be grouped into horticulture, livestock, aquaculture and agroforestry (FAO 2011). Horticulture is the most popular and produces perishables such as fruits, vegetables, roots, tubers and condiments (FAO 2011).

Living on less than one US dollar a day is the reality of an estimated 43% of urban sub-Saharan Africans and a major source of malnutrition (FAO 2011; Mkwambisi et al. 2011). When faced with financial constraints, urban households often reduce their intake of fruits and vegetables while increasing their consumption of starchy staple foods, which are often cheaper (FAO 2012). Such alterations in diet negatively impact the welfare of men, women and children (Chigusiwa et al. 2022). According to FAO (2011), urban malnutrition has increased much faster than urbanisation in the developing world, with concerning health effects on child development. This is alarming, as Africa is becoming more urban, and 56% of the population will be living in urban areas by 2050 (UN 2014), and 70% of the global population will live in cities by then (Puigdueta et al. 2021). It is also estimated that the share of the African population living in slums will more than double by 2050 and the continent will have some of the largest cities in the world, e.g., Nairobi and Lagos (Jedwab and Vollrath 2019). Urbanization in Africa is happening at an accelerating pace, creating many urban problems relating to nutrition, healthcare, education, electricity, jobs, and accommodations needed by this growing population.

Urban farming is one solution, to the urban problems, because it can provide household nutrition as well as generating income through the sale of fruits and vegetables (Langemeyer et al. 2021; Puigdueta et al. 2021; Mackay 2018; Poulsen et al. 2015; Badami and Ramankutty 2015; WB 2013; FAO 2012; Brook and Foeken 2005), especially among the urban poor (Matamanda et al. 2022; Nchanji 2017; FAO 2011). This is the essence of subsistence agriculture, where at one extreme, it is purely subsistence, when it is characterised by own consumption of all harvest; at the centre is semi-subsistence[8], which is a combination of own consumption and sales; at the other extreme is commercial farming, where all harvest is for sale. UPA increases the availability of more affordable fresh farm produce in the city, and provides all the essential vitamins and minerals for good health for the urban poor (Armanda et al. 2019;

[8]Semi-commercial is used to describe a household that is engaging in farming activities on a relatively larger piece of land, but with a motive to sell and make a profit, although part of the produce is consumed at home (FAO 2011). In this paper, we define a semi-subsistence household as one that engages in farming on small pieces of land with a motive to feed the family, but can also sell some if there is excess produce.

McDougall et al. 2019; FAO 2011), the alternatives are supermarkets and chain stores which are unaffordable for this population.

In sub-Saharan Africa, it is estimated that more than 40% of the urban population engage in agriculture (see Lwasa et al. 2015; FAO 2011) increasing their self-reliance as well as resilience of food systems (Yan et al. 2022).[1] To provide some country-specific examples, in Ibadan, Nigeria, urban and peri-urban horticulture produces 80% of the vegetables (Odudu 2015). In Yaounde, Cameroon and Lilongwe, Malawi, about 35% of the households grow fruits and vegetables (Sotamenou and Parrot 2013; Mkwambisi et al. 2011). Also, in Nairobi (Kenya) and Accra (Ghana), 36% and 25% of households practice agriculture, respectively (Nchanji 2017). About 40% of vegetables from urban and peri-urban agriculture are produced in backyards and community gardens in Chad (FAO 2012). In the Republic of Congo, 1,450 hectares of land is set aside for urban and peri-urban agriculture (Tambwe 2010). In Ghana, Nchanji (2017) observed that 250 hectares in and around the urban areas are used for mixed cereal-vegetable cropping, while FAO (2012) reported that horticulture covers about 190 hectares in Abidjan, Cote d'Ivoire. Commercial horticulture in urban Cotonou in Benin provides about 1,400 permanent jobs (Shimeles et al. 2018). In Kigali, Rwanda, 15,000 hectares have been reserved for agriculture and wetlands (FAO 2012). However, participation is only 10% in urban Namibia, Botswana and Cape Verde, due to arid conditions which limit agricultural potential (FAO 2012).

Crucial, lays in the fact that current UPA, in sub-Saharan Africa (SSA), are informal, legally ambiguous or outright illegal (McLees 2011) and occur in the peripheral of cities (McLees 2011; Odudu 2015; Kiduanga and Shomari 2017; Hardman et al. 2022), in tiny home spaces (Hardman et al. 2022) or on any vacant and undeveloped land (Odudu 2015; Kiduanga and Shomari 2017; Hardman et al. 2022) such as river basins and lakes (Odudu 2015; McLees 2011), along streets (McLees 2011; Odudu 2015; Kiduanga and Shomari 2017), railways (Odudu 2015), nature reserves (Kiduanga and Shomari 2017), buffer zones at airports (Odudu 2015), industrial complexes (McLees 2011; Odudu 2015), rights-of-way e.g., power and gas lines (McLees 2011; Odudu 2015) cemeteries (Kiduanga and Shomari 2017) and open spaces reserved for recreationally ecosystems (McLees 2011; Odudu 2015; Kiduanga and Shomari 2017; Tibesigwa et al. 2020). Hence, despite its importance, UPA has been condemned by scholars and policymakers alike as fuelling environmental degradation, encroaching on urban green spaces and wetlands, threatening urban ecosystems and disturbing urban planning (Shimeles et al. 2018).

In view of increasing urban farming, uncontrolled urban sprawl, growing levels of food insecurity, low dietary diversity including the many urban challenges related to the changes in environment, there are concerns regarding how to incorporate UPA into green urban planning and development (Vermeiren et al. 2013). This has, perhaps, been fast tracked by the green revolution which interconnects the environment to sustainable economic development, and named inclusive green economy (IGE) revolution. But, currently, land remains a major constraint (FAO 2012; FAO 2011), as most SSA policies see industries, trade and the urban sprawl as major sources of revenue and development, (Kiduanga and Shomari 2017; Odudu 2015; Mkwambisi et al. 2011; Hoornweg and Munro-Faure 2008; Hampwaye et al. 2007), and hence a lack of official land zoning for UPA (Mkwambisi et al. 2011; McLees 2011; Mlonzi 2003).

Therefore, the interest of this study is to reveal preferences for plot attributes by estimating the WTP for urban plots for the purpose of crop farming. We consider these preferences as a genuine signal for demand for land for UPA by poor urban dwellers in developing countries, which policymakers should take into consideration in planning and development. The choice experiment is conducted among 705 households randomly selected from all the districts of Dar es Salaam to estimate the WTP for three farm plot attributes: farmland size, irrigation and distance of the farmland to the household. The respondents are presented with three programmes: the status quo and two programmes that include these farm plot attributes. The estimation begins with a baseline model (conditional logit) then proceeds to the random parameter logit (RPL) model, which has stricter assumptions in accounting for heterogeneity.

Our results reveal that the marginal WTP for irrigation is TSH38,944.89 (US$19.47) per plot[9]. With regards to plot size, households are willing to pay TSH12189.10 (US$6.09) per hectare, while WTP for distance to the plot is TSH7907.40 (US$3.95) per km per annum. The WTP for an irrigated plot is slightly more than three times that of plot size and almost five times that of distance to the plot. This suggests that the urban farmers likely face climate risk, in

[9] The conversion rate that we use throughout the paper is US$1 ≈ TSH2000.

addition to market risk. Interpreting irrigation as a signal of adaptation to climate change is intuitive due to extreme weather changes and water shortages in Tanzania.

Our results provide evidence for the importance of UPA in African cities. They also allow policymakers to interrogate their current policies while informing future strategies for sustainable urban green economy. The results particularly speak to policy interventions aiming to facilitate urban agriculture ecosystems along with irrigation infrastructure to enable adaption to climate change by urban farmers. For the Sustainable Development Goals (SDGs), urban agriculture ecosystems has vast potential to contribute towards their attainment, more especially, the prospects of achieving SDG 11's theme of "Make cities inclusive, safe, resilient and sustainable". For inclusive green economy (IGE) revolution, UPA have a huge role to play in transforming SSA economies to achieve green economic growth. All of which is tied to Agenda 2030 by the United Nations, Agenda 2063 by the African Union and TDV 2025 by Tanzania. This paper proceeds with section 2, which outlines the state of agriculture in Dar es Salaam. Section 3 describes the experimental design. This is followed by section 4, which explains the results, while the final section concludes with a policy message.

2. DAR ES SALAAM, URBAN FARMS AND HOUSEHOLD FOOD

Dar es Salaam is situated in the eastern part of Tanzania along the Indian Ocean coast of East Africa and occupies about 110,850 ha. The city has three districts, namely Kinondoni district, consisting of 52,000 ha, followed by Temeke with 45,000 ha and Ilala with 13,850 ha. Dar es Salaam has 1,072,840 households with a population of over 4 million inhabitants, distributed as 41.7% for Kinondoni, 32.5% for Temeke and 25.8% for Ilala. It is one of the fastest growing cities in sub-Saharan Africa. According to the 2012 census, the annual population growth rate is approximately 5.6%, which is an increase of 75% over the last 10 years; this growth is above the national average (3.2%).

Agriculture is the engine of Tanzania's economy, with a dual structure of commercial and smallholder farming systems – the latter predominant (Tibesigwa et al. 2019). As in other countries in the region, smallholder agriculture is the main ingredient in poverty reduction strategies and in efforts to achieve sustainable development (Ellis and Mdoe 2003) tied to Tanzania Development Vision (TDV) 2025, Agenda 2030 by the United Nations and Agenda 2063 by the African Union. UPA have a huge role to play in transforming the country towards IGE. This heavy reliance on agriculture produced strong policies dating back to the 1970s, motivated by poor economic performance (Namwata et al. 2015). For instance, '*Siasanikilimo'* (politics is agriculture), '*Kilimo cha umwagiliaji'* (irrigation agriculture) and '*Kilimo cha kufanakupona'* (agriculture as a matter of life and death) were policies geared toward promoting urban and rural agriculture so as to increase the national food supply (Namwata et al. 2015). By the 1980s, there were more formalised policies which were sector specific[10].

The conditions under which different land-use patterns emerge in the context of urban agriculture are not well understood (Magigi 2008). In Dar es Salaam, we observe urban agriculture overtaking the status quo in areas previously dominated by flower gardens, lawns, urban forests, grasslands and wetlands. [11]As a result, urban agriculture is closely monitored by the Ministry of Agriculture, Food Security and Co-operatives in co-operation with the Dar es Salaam City Council and Ministry of Land, Housing Settlements, and Development, and is guided by the national agricultural policy of 2013, reformed from the national agricultural policy of 1997. In comparison to the old policy, the new national agricultural policy recognises urban agriculture and aims to ensure its productivity in accordance with agreed standards for both health assurance and environmental protection. Further, it provides three major requirements: (i) supportive mechanisms for undertaking urban and peri-urban agriculture shall be developed; (ii) good agricultural practices for urban and peri-urban agriculture shall be promoted; and (iii) a regulatory framework for urban and peri-urban agriculture shall be developed. However, there is still a very big gap between policy rhetoric and policy implementation on the ground (FAO 2012). This study is intended to bridge this gap by providing evidence so that policymakers can make better-informed decisions.

Agriculture in Dar es Salaam is an integral part of urban livelihood strategies and contributes to approximately 30% to household food, including over 90% of leafy vegetables (Schiere et al. 2006; McLees 2013; Mougeout 2005; Jacob 2000). Urban agriculture is mainly for

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[10] National Economic Survival Programme (NESP), National Food Strategy (NFS), National Livestock Policy (NLP), the National Agricultural Policy (NAP) and the National Economic Recovery Programme (ERP) (Namwata et al. 2015). More recent policies include the National Human Settlements Development Policy, the Land Use Planning, the Urban Planning Act, Urban Farming Regulations, Tanzania Development Vision, National Strategy for Growth and Poverty Reduction, 'Kilimo Kwanza strategy', and the Town and Country Planning Act (Namwata et al. 2015).

[11] Microeconomic theory suggests that more efficient land uses will replace less efficient ones over time (Debertin 2012; Varian and Varian 1992). Whether urban agriculture is a more efficient land use compared to the status quo is outside the scope of this analysis because it would require us to take into consideration the value of ecosystems goods and services (Calvet-Mir et al. 2012). This is a topic for future research.

subsistence (Briggs 1991), forms at least 60% of the informal sector, and is the second-largest urban employer (Hoornweg and Fare 2008). However, as in most cities in sub-Saharan Africa, urban crop farming that exists in Dar es Salaam reflects a lack of access to land and land tenure insecurity (Ellis and Sumberg 1998). Only 5% of the estimated 36,551 farmers surveyed in Dar es Salaam have a certificate of ownership, according to the 2007/2008 national agriculture census; the remaining 95% tend to hold land through customary law, rentals, borrowing, sharing or other inferior rights (Mkwela 2013). This lack of secure land rights results in land grabs, disputes, and uncontrolled urbanization through expanding the area under slums (McLees 2011; Laiser 2016). Administrative bureaucracy and lack of transparency in land transactions worsens this situation (McLees 2011; Kiduanga and Shomari 2017). This form of land access makes agricultural production highly insecure and discourages improvements in agricultural lands (Yackkaschi 1997; Jacob et al. 2001; Foeken et al. 2004; Magid 2013).

We can distinguish among (i) high-density inner urban farming; (ii) open space agriculture; (iii) peri-urban farms and (iv) private gardens (Jacob et al. 2000; Howorth et al. 2001; Besagilo and Kepe 2014). The first – high-density inner urban farming – is mainly among the urban poor. Here, agriculture is essentially for food supply, i.e., vegetation and staple food (Howorth et al. 2001) and occurs in limited marginal land, e.g., tiny home spaces (fences, walls and recreational grounds), along utility, wetlands and transportation roadsides, or alongside railway lines or river valleys and underdeveloped housing plots (McLees 2011; Kiduanga and Shomari 2017). Under such agricultural practices, city residents are acutely aware that they are at risk of being evicted at any time (McLees 2011), and such eviction is a common practice in Dar es Salaam (Laiser 2016). As a result, there is limited investment to increase agricultural productivity on these plots (Halloran and Maggid 2013). In other countries in the region, e.g., Zimbabwe, authorities destroy healthy crops on unused urban land that belongs to the city council without consideration of the food security and welfare consequences of their actions (Moyo 2013).

The second category – open space agriculture – is dominated by vegetable gardening among low- and middle-income urban households (Jacob 1997; Jacob et al. 2000). Here, open space and other unoccupied land is mainly farmed without official permission, and includes using public lands such as undeveloped parks, natural reserves and cemeteries (Jacob 1997; Magigi 2008). For example, Dongus (2000) identified more than 641 ha of open spaces used for vegetable production in the city of Dar es Salaam. This form of agriculture leads to the disappearance of open spaces originally designated for recreational activities (Shimeles et al. 2018). While urban residents can generate income from open space farms, the uncertainty of land tenure looms daily (Mkwela 2013).

Third, peri-urban farming has all the features of rural farming but is located close to cities rather than in cities. Here, cash and food crops such as maize, fruits and vegetables are produced, with land owned by private residents, government or other institutions.

Fourth, private or home gardens are primarily among middle- to high-income people (Howorth et al. 2001), who often employ farm inputs such as labour (Kombe 2005). This is mainly run by families who cultivate different staple and cash crops such as vegetables and fruits close to their homes.

For the first three categories, many households use land that is located far away from each other and from the household. As discussed above, households often use some agricultural plots that they don't own, which are located farther away from home; they risk losing the crop during operations meant to clean the city by removing illegal activities (McLees 2011). Claim to these plots derives from the fact that the household cleared the plot and has been using the land over a number of years. Sometimes farmers grow fruit trees to demarcate boundaries and to demonstrate their claim to a piece of land (Laiser 2016). Although this claim is respected by others in the community, it is still classified as illegal occupation or use of land according to the regulations of the city (Halloran and Magid 2013; Bersaglio and Kepe 2014). There are no meaningful investments such as fences, boreholes or irrigation facilities on most plots, because the household can lose this land at any given time without compensation (McLees 2011). Due to the absence of a fence, the household frequently suffers when their crops are raided by either wildlife or thieves at night. Weak tenure security also means that the household has little incentive to invest in soil and water conservation technologies and soil fertility, which eventually leads to environmental degradation (Kiduanga and Shomari 2017).

Scholars argue that the potential for UPA can be unlocked through appropriate policy interventions that will incentivise farmers to adopt more agile and robust farming systems such as conservation agriculture and agricultural intensification, while at the same time incentivising the private sector to work with urban smallholder farmers so that they can access better markets (Halloran et al. 2013; Moyo 2013; Barrett 2008). Consistent with this line of thinking, the Ministry of Land and Human Settlement Development formally incorporated urban agriculture into zoning guidelines in 2000 (Mlonzi 2003). The policy states that the government needs to designate specific areas where people will be granted legal rights to engage in urban agriculture in ways that do not interrupt the planned urban development. However, in practice, this has not materialised in the city of Dar es Salaam and urban agriculture remains largely unregulated and unplanned (McLees 2011). The major reason is that urban agriculture is seen as a threat to urban green infrastructural development in developing countries, since it is done on a subsistence basis by poor households (Shimeles et al. 2013). In this regard, our study will provide further evidence that urban agriculture is a potential tool to unlock the benefits of urban ecosystems, provided it is well planned and done in a sustainable manner.

3. EMPIRICAL STRATEGY

3.1 Production Economics Theory

The production economics theory is grounded on the farmer's profit maximization behaviour (Varian 1992; Debertin 2012). Farmers choose different combinations of attributes of farming such as improved technology (new varieties, fertilizers, chemicals and irrigation), adoption of climate-smart agricultural practices (drought-resistant varieties, terraces, manure and mulching), mixed farming (crop and livestock) and non-technological factors (topology, plot size and distance from the homestead to the plot) to maximize profits per hectare. Assuming a single input (x) and single output ($y = f(x)$), the farmer's profit function can be written as follows:

$$\pi(p, w) = \max pf(x) - wx$$

where the output and input prices are p and w respectively. This framework can be extended to a model with more than one output and inputs assuming a vector of outputs and inputs (Y_t^j, X_{it}) and prices (p_{it}, ω_{it}). Letting x_{it} be one element of the vector of inputs X_{it}, the first-order condition of the farmer's maximization would tell us:

$$p_{it}\frac{\partial Y_t^j}{\partial x_{it}} = \omega_{it}$$

i.e., a farmer makes input decisions based on the marginal value of production. Adopting new technology (e.g., irrigation) can potentially change the marginal product curve of a farmer's land. Non-technological factors such as acquiring a new plot on fertile land and distance to the plot also matter, because farmers invest on plots that are near their homesteads, thereby increasing productivity on these plots (Deininger et al. 2016). This means that both technological and non-technological attributes of farming can change either the slope or the intercept of the marginal productivity curve.

Increased farm productivity can improve households' food security and nutrition and/or their income. The important pathways through which farming attributes in general (and plot attributes in particular) increase productivity are through a decrease in production costs and mitigation of production risk due to crop failure. Thus, technology adoption is also likely to affect the marginal value of production if it directly leads to changes in the quantity of inputs demanded (Debertin 2012). The same applies to non-technological factors such as distance to the plot, since this brings in the issue of travel time, which is also an important input or variable in the analysis (Ntuli 2008; Deininger et al. 2016). Kadigi et al. (2017) observed that the time taken to reach the field affects productivity since it affects the quality of labour supplied. Land is another important input which changes the marginal value of production; land is assumed to be fixed in the short-run but variable in the long-rum (Debertin 2012).

Although production economics theory provides some insights, it is not enough to explain household preferences for attributes of urban plots. Other tools, theories and frameworks are used to model preferences. In this study, we use choice experiments to model household preferences for urban plot attributes.

3.2 Conceptual Framework

The choice experiments' theoretical grounding is rooted in Lancastrian consumer theory, and the modelling is based on the random utility framework, where individuals face a set of alternatives and choose between alternative options with attributes of varying levels (see Tibesigwa et al., 2020; Ntuli et al., 2020; Birol et al. 2006). In such a scenario, an individual will select the alternative which will generate the highest utility (Birol et al. 2006). Hence the utility for an individual *i*, for *i* = 1,2,….N, with a preferred and chosen alternative *j*, for *j* =1,2,…J, from choice set C, containing all possible alternatives in a choice experiment, is expressed by equation (1):

$$U_{ij} = V\left(A_j, S_i\right) + \varepsilon\left(A_j, S_i\right) \qquad (1)$$

This utility is an additive function and comprised of two components: a deterministic and an unobservable stochastic component (Greene and Hensher 2003; Train1998). The first component on the right-hand side is the deterministic component of the utility function, which is observable, while the second component on the right-hand side is the stochastic component, which is unobservable, and reflects the fact that predictions are likely to be uncertain. Both components consist of the urban agriculture attributes (A_j) and individual characteristics (S_i). An individual *i* derives the greatest utility by choosing an alternative *j* from a set of alternatives in the choice experiment as expressed by equation (2):

$$P_{ij} = \left(V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik}\right);\ \mathrm{k} = 1,2,3\ \forall\ \mathrm{k} \neq \mathrm{j} \qquad (2)$$

Following the literature, we begin by estimating the utility with the conditional logit (CL) model, which assumes that each ε_{ij} is independently and identically distributed (IID), with Weibull distribution, and consistent with the independence of irrelevant alternatives (IIA) (Thiam et al. 2021; Tibesigwa et al., 2020; Ntuli et al., 2020). The implication here is that the probability of choosing between options is not affected by other alternatives. The CL model of the probability of individual *i* choosing alternative *j* can be estimated by equation (1) with the following general form:

$$P_{ij} = \frac{\exp\left(V\left(A_{ij}, S_i\right)\right)}{\sum_{k \in C} \exp\left(V\left(A_{ik}, S_i\right)\right)} \qquad (3)$$

From equation (3), the conditional indirect utility function is estimated by equation (4), which assumes a linear specification, where β is the alternative specific constant (ASC). As before, the coefficients in equation (1) are the vectors associated with urban agriculture attributes and individual socioeconomic characteristics.

$$V_{ij} = \beta + \beta_1 A_1 + \beta_2 A_2 + \ldots + \beta_n A_n + \delta_1 S_1 + \delta_2 S_2 + \ldots + \delta_m S_m \qquad (4)$$

However, the CL model is likely to violate the IIA property and hence is likely to produce biased estimates because the model assumes that all individuals have similar preferences. In fact, socio-economic and other varying characteristics are likely to be heterogeneous (Greene 1997; Czajkowski et al. 2014). After running the CL model, we perform the Hausman test to see whether the IIA property is indeed violated and then run the RPL model, which is presented in equation (5):

$$U_{ij} = V\left(A_j, S_i\right) + \varepsilon\left(A_j, S_i\right) \qquad (5)$$

The advantage of the random parameter logit (RPL) model is that it relaxes the independence of irrelevant alternatives (IIA) assumption and assumes continuous preference heterogeneity (Train 2009). Under this model, the utility for individual *i* from choosing alternative *j* is shown in equation (5), which is a modification of the utility function in equation (1).

$$U_{ij} = V\left(A_j(\beta + \tau_i), S_i\right) + \varepsilon\left(A_j, S_i\right) \qquad (6)$$

Under the RPL model, preference heterogeneity is allowed to vary across individuals by τ_i as a result of individual characteristics. In this case, the probability of an individual *i* choosing option *j*, while accounting for preference heterogeneity, is represented by equation (7):

$$P_{ij} = \frac{\exp\left(V\left(A_j\left(\beta + \tau_i\right), S_i\right)\right)}{\sum_{k \in C} \exp\left(V\left(A_k\left(\beta + \tau_i\right), S_i\right)\right)} \qquad (7)$$

In all models, parameters are specified as normally distributed, and the cost parameter is assumed to be fixed, while the rest of the parameters are randomly distributed. We then equate the utility levels from the different choice model specifications, i.e., CL and RPL models, where we solve for price by obtaining the compensating surplus measure, which is the individual's willingness to pay (Hanley et al. 2001; Hanemann 1984). The welfare changes experienced from changes in the level of an attribute can be computed using the estimated coefficients from any of the choice models as follows:

$$CV = \lambda^{-1} \ln \left\{ \frac{\sum_{j \in C} \exp\left(V_j^1\right)}{\sum_{j \in C} \exp\left(V_j^0\right)} \right\} \qquad (8)$$

In equation (8), the compensating variation (CV) is the welfare measure, and λ is the marginal utility of income, which is the estimated cost attribute from the choice experiments model. The utility functions of any individual before and after changes in the urban agriculture environment are represented by V_j^1 and V_j^0 respectively. From here, the marginal willingness to pay (WTP) for a change in any urban agriculture attribute is calculated as a ratio of $-\beta_z/\lambda$, where β_z is the estimated coefficient of the zth choice attribute. The WTP estimates are calculated using the Wald (Delta) method.

3.3 Experiment, Sampling, and Survey Design

In designing this experiment, we followed the guidelines for stated preference studies according to Johnston (2017). We began by conducting four focus group discussions (FGDs) in Dar es Salaam; three were conducted with the general public, and the fourth with government employees. This is because FGDs allow for discussion and probing within a small group to uncover a level of nuances unlikely to emerge from a structured survey, and detailed information may be obtained from such a setting. The attributes used in the experimental study were initially designed using information gathered from the literature review. The information obtained from the FGDs was then used to refine the attributes and the survey questions.

3.3.1 Sampling

In determining the appropriate sample size, we used a standard simple random sample size formula. This produced a sample size of 705 households. To identify households, we used three-stage stratified probability sampling, which allows each household, i.e., our sampling unit, in Dar es Salaam, to have an equal chance of being included in the sample. This approach is used to accommodate for the differences in the physical distribution of households, at district, division, and ward level. That is, stratification produces homogeneity in each stage, and allows the sample to be representative of the population in Dar es Salaam. Another advantage is that this approach produces self-weighted means and reduces variances.

This is important because districts, divisions and wards in Dar es Salaam are highly correlated with socio-economic conditions. We observe further variations in the socio-economic variables. The human development report places Ilala as having the largest number of poor people per kilometer (299), followed by Temeke (295) and Kinondoni (282). Further, 29% of households in Temeke live below the poverty line, while there are 16% and 14% respectively in Ilala and Kinondoni. In general, Kinondoni has higher socio-economic scores, while Temeke is less developed, with lower socio-economic variables. These socio-economic classification patterns are similarly observed at division and ward level.

Each of the districts is sub-divided into divisions, and then each division is further classified into wards, and the wards are divided into streets. In the three-stage stratified probability sampling, we began with the three districts, i.e., Ilala, Temeke and Kinondoni, where sample size selection is proportionate to the population of each district. In the second stage, the strata are based on 10 divisions, while the last stage is based on the wards. This sampling is likely to produce an exogenous sample because our choice variables do not form the basis for stratification. That is, our strata, which use geographic boundaries, are independent of the location of ecosystems that are considered in this study. Some good examples of endogenous stratification are onsite sampling, or sampling along the studied ecosystems. For more information on stratification and endogenous or exogenous sampling, see Hindsley et al. (2011); Imbens and Lancaster (1996); and Hausman and Wise (1982). At the ward level, we use random numbers to identify the household to be interviewed. The advantage of this approach is that, for a developing country, like Tanzania, detailed maps on household numbers are unlikely to be available. Given our sample size of 705, this implies that each block is assigned approximately 22 households. The assignment of blocks to households was random using random numbers, but this was done proportionately at district level. Each survey instrument or respondent was randomly assigned one block of the choice experimental design, with each block containing four choice questions. In each choice question, the respondent was given the task of choosing programme 1, programme 2 or no programme.

3.3.2 Survey and experiment

A single round of the survey was administered to the household head, spouse or adults above 18 years of age in the household with knowledge of the subject area. The survey instrument has six sections. The first section introduces the topic by asking background information. This is followed by a section that describes the choice tasks in smallholder urban agriculture.

The choice task begins by explaining that there is a proposed programme in urban agriculture, with planning still at its early stages. The choice set consists of three options: two alternative programmes and the status quo. The other two alternatives represent deviations from or improvements in the status quo.

The choice task proceeded by explaining the urban agriculture programme, stating that it is one of the green initiatives in the city, which recommends that farm plots be available for renting to residents for urban agriculture. The respondents were then given options where they have to indicate their preferences. These options were described using the following attributes: the size of the plot, irrigation, and distance of the plot from the homestead. Here the plot size attribute is captured in hectares (a quarter, half, one or two hectares), the irrigation attribute is whether irrigation is present on the plot (that is irrigation or no irrigation), and the location attribute is the distance of the farm plot from the household in kilometres (five, ten or fifteen kilometres).

Both of the proposed agriculture programmes aim to reduce uncertainty around smallholder urban agriculture by improving tenure security and recognising the activity as a legal livelihood undertaking. Thus, the attributes that differ between programmes 1 and 2 are plot size, irrigation and distance to the plot. When we ask respondents to make a choice among the three alternatives, we assume that they are aware of the current uncertainty of tenure associated with the status quo since they do not own land.

Next, the choice task explained that the funding for the program is separate from the rest of the city budget; that a yearly fee will be collected from a mobile phone from each household in the city; and that, if a household has more than one phone, then only one fee will be deducted. The revenue from the fee would be designated to a separate fund purposed exclusively to finance the program. It is further explained that the fund will be administered by a management board involving representatives from the citizen associations, environmental organizations, and local government representatives. The board will make sure that the money from this fund is used correctly and efficiently. The provision of fund accounts and audits will be announced every year on the internet, via mobile based platforms, in the press and on television. It was important for us to use a mobile phone and explain in detail the management of the fund because, from our FGDs, we found that the city residents were concerned about misuse of funds, and other payment vehicles such as tax were opposed. The attribute levels and an example of the choice set are reported in Tables 1 and 2, while the appendix provides the full details of the programme. The choice experiment consists of 30 blocks (sub-samples) and 4 choice questions selected on the basis of D-efficiency, using a Bayesian design.

Thereafter a debriefing session obtained the reasons for their decisions. In conclusion, the survey instrument collected information on individual, household and neighbourhood socio-economic characteristics. In each section, visual aids were used to increase the respondents' understanding of the survey. On average the survey took about 50 minutes to administer.

4. RESULTS

4.1 Dar es Salaam household characteristics, pure-subsistence and semi-subsistence urban farming practices

Table 3 shows the summary statistics of our sample. The descriptive statistics show that 45% of the respondents are men, with an average age of 41 years. Close to 71% of the respondents are married, and 75% are employed. The average number of years in school is eight years, which corresponds to secondary school level. Regarding household characteristics, each household has an average of five household members, with two of them being children under the age of 18 years. The average monthly household income is TSH847,708 (US$422.85), and of the five household members, approximately two contribute toward the household income.

Figure 1 shows how households would utilise the farm produce from urban smallholder plots under the three choices. Our results suggest that the majority would engage in semi-subsistence farming (90%). More specifically, 57% mentioned that they would keep a quarter of the crops produced from urban agriculture for household consumption, 27% would keep half of the production for consumption, and 6% would keep three-quarters for household consumption. The remaining 10% would keep all production for household consumption, i.e., pure-subsistence farming. At the district level, we witness some variation (Figure 1). In Kinondoni, we witness the majority of pure-subsistence farmers (19%), while in Ilala and Temeke this is 5% and 3% respectively. Looking at the distribution of semi-subsistence farming in each district, we find that 60% in Temeke will keep a quarter of the farm produce, 57% in Ilala and 55% in Kinondoni.

When asked about the type of crops they would prefer to produce, there was a wide variety of crops that were mentioned (see Table A.1 in the appendix). There is a high preference for mixed cropping, as most respondents (by percentage) mentioned a variety of crops that would be planted on the urban plots. The most popular mixed crops consist of a menu of vegetables (43.8%). These mainly include leafy green vegetables, e.g., spinach and other non-leafy vegetables such as tomatoes, green peppers, onions and carrots. This is followed by fruits, mainly watermelons (6.1%), followed by a mixture of vegetables and maize (5.0%). The most popular mono-cropping includes watermelons (4.9%), maize (2.6%), beans (1.7%), and tomatoes (1.7%).

4.2 Determinants of pure-subsistence and semi-subsistence urban farming

Next, we show the determinants of subsistence farming in Table 4, where panel A reports the coefficients from the ordered logit model, Panel B the logit model results, and panel C the generalised ordered logit model results. Starting with the ordered logit model in Panel A, the dependent variable is ordinal due to the nature of the outcome variable, and is grouped into the following: (i) would keep a quarter of the crops produced from urban agriculture for household consumption; (ii) would keep half of the production for consumption; (iii) would keep three-quarters of the production for consumption; (iv) would keep all production for household consumption. In Panel B, we replace the outcome with a dummy variable, which is equal to one if the household is expected to practice pure-subsistence farming (i.e., would keep all production for household consumption), and zero if the household would keep some of the crops for household consumption.

Next, we ask what drives the commercial orientation in Dar es Salaam's UPA farmers. Considering both the ordered logit model in Panel A and the logit model in Panel B, variables representing household attributes such as age, education, income, household size and yard size are statistically significant, thus highlighting these as important characteristics which determines the decision to retain the produced crops for household consumption. The coefficient gender is positive and significant, suggesting that women report higher retention of crops for household consumption. Age reveals a non-linear relationship to crop retention, i.e., the probability of retaining farm produce for home consumption increases with age until a certain age (approx. 90 years) and then decreases. Additionally, those with a higher education will report a larger amount of crop retention, which is similarly observed among those who are married. The coefficient on household income is negative and significant, suggesting that urban households with less income would retain more of the crops produced for household consumption. As expected, the household size coefficient is positive and statistically significant, which is an indication that larger households in urban areas will retain more of the crops produced. As anticipated, the size of the home yard, which is measured in square meters, has a negative and statistically significant sign, suggesting that households with larger yards would retain a smaller percentage of crops.

4.3 Random parameter logit estimation results

The estimation results are presented in Table 5. Panel 1 shows the results from our base model, i.e., conditional logit model (CLM), and panel 2 presents the random parameter logit (RPL) results, while panel 3 introduces interactions of socioeconomic characteristics to the RPL model. In each of the models, the choice attributes are assumed to be normally distributed and random, while the cost coefficient is fixed. We begin by testing the Independence of Irrelevant Alternative (IIA) property in the base model, using the Hausman test, and report in Table 6. The results indicate that the IIA assumption is significantly violated if any of the alternatives are dropped from the choice set, suggesting that the use of conditional logit will bias our results. For this reason, we will only interpret the results of the RPL model.

The results in panel 2 show that the ASC has a negative and highly significant coefficient, indicating high responsiveness to changes in the choice set. As expected, the cost coefficient is negative and significant, which suggests that utility decreases with increases in the cost. While plot size and irrigation are positive and highly significant attributes in the choice of urban agriculture, the distance of the farm plot attribute appears to be insignificant. This suggests that the availability of irrigation and a larger farm plot increase the household's utility from engaging in urban agriculture.

Panel 3 interacts socioeconomic characteristics with the attributes in the RPL model so as to identify the sources of heterogeneity and preference variation. Most notable is the fact that the distance of the plot to the home is now positive and statistically significant in this model. The interaction between the attributes (plot size, plot distance and plot irrigation) and households who will consume all crop output is negative and significant, indicating that those who view urban agriculture as a purely subsistence activity are less likely to prefer any of the urban agriculture attributes. The interaction between number of children and distance from the households to the farm plot has a negative effect on farm choice, suggesting a preference for nearby farms for those with children. The interaction between Temeke district and plot size is negative, showing more preference for smaller farms. The interaction between plot distance from the household and Temeke district is also negative, revealing a preference for nearby farms. We find that distance of the plot to the home is positive and statistically significant. With regard to the size of the plot, crop production is likely to increase with an increment in the size of the plot, hence providing a plausible explanation for an increase of utility with an increase in plot size.

4.4 Willingness to pay for urban crop farms

The marginal willingness to pay (WTP) estimates or the implicit prices are displayed in Figure 2. Here we show the values from our two models, where the CLM provides base values, while the RPL provides the desired values when we account for preference heterogeneity. Note that these values present the minimum amount that respondents are willing to pay for urban agriculture. We observe narrower marginal WTP bounds as we move from Panel A (CLM) to B (RPL) and C (RPL with interactions); this is as expected, due to controlling for heterogeneity. The marginal WTP for irrigation is TSH38,944.89 (US$19.47) per hectare. With regard to plot size, households are willing to pay TSH12189.10 (US$6.09) per hectare. Under distance to the plot, the WTP is TSH7907.40 (US$3.95) per km per annum.

The WTP for irrigation is slightly more than three times that of plot size and nearly five times the WTP for plot distance. This suggests that the urban farmers likely face climate risk – hence, the need to adapt, in addition to market risk. Interpreting irrigation as a signal of adaptation to climate change is intuitive due to extreme weather changes and water shortages in Tanzania. Irrigation has been found to be a significant adaptation strategy for African smallholder agriculture in the face of climate change (Mulwa et al. 2017; Kurukulasuriya and Mendelsohn 2006), as it allows farmers to grow crops all year round, thereby producing more output per hectare annually.

5. DISCUSSION

It is undisputable that urban smallholder crop farms provide important benefits for poor urban households in sub-Saharan Africa city residents (Shimeles et al. 2018; Martellozzo et al. 2014; Moyo 2013;). As such, the integration of agriculture into urban development strategy is important for the long-term sustainability of sub-Saharan Africa cities (Abegunde 2011; Grimm et al. 2008; Mendes et al. 2008; May and Fortunate 2008), and in transforming sub-Saharan Africa economies towards inclusive green economy (IGE), in-line with the achievement of Agenda 2030 by the United Nations and Agenda 2063 by the African Union.

This article demonstrated how Dar es Salaam city residents are willing to pay to access plots for the cultivation of horticulture crops. Increased access to urban and peri-urban plots will ultimately increase food supply at household level and on the market in addition to increasing food security. Our results show robustness across the models in the signs of the coefficients, and to some extent in the level of significance. We observe two key findings: First, urban agriculture attributes, especially irrigation, provide positive and significant welfare benefits to Dar es Salaam residents. Second, there is significant preference heterogeneity for urban agriculture attributes across individual residents.

Our results show great variability in the sample, as revealed by the descriptive statistics. Consistent with other studies done in the region, we expected the sample to have slightly more women than men (McLees 2011; Magigi 2010). Generally, the level of education in urban areas in Tanzania is quite low because of rural-urban migration and the fact that most people from poor households opt to find employment to feed their families rather than completing secondary school (Bersaglio and Kepe 2014). Quite a huge proportion of households sell large quantities of their farm produce, showing a strong tendency to gravitate towards commercialization. This phenomenon is observed in most African countries because of its potential to generate extra income for the household to complement wage income (Kiduanga and Shomari 2017; McLees 2011; Mlozi 2003; Howorthet al. 2001). Mkwela (2013) observed that a mixture of both poor and relatively wealthier household resort to urban agriculture and they sell most of their products on the market as a livelihood strategy since they are no longer working. Evidence from Zimbabwe reveals that urban agriculture is not only driven by commercial objectives (Kutiwa et al. 2010), but the motives for participation in urban agriculture differ according to whether the household seeks to achieve food security, supplement household dietary requirements, or increase total household income (Bersaglio and Kepe 2014).

In the results, 10% of the farmers would keep all farm produce for household consumption and are considered to be pure-subsistence farmers, while 90% of the farmers who would keep only a certain amount of the products are semi-subsistence farmers (see, e.g., Davidova et al. 2009; Barrett 2008). The pure-subsistence farmers could be very poor households with big families and no wage income (and hence depend heavily on own farm produce) or relatively wealthy households (whose willingness to participate in market activities depends on the extent to which crop income contribute towards total household income) (Hoornweg and Munro-Faure 2008). Therefore, from an economic point of view, income from urban agriculture can be used to substitute wage income by poor households without other income sources, which forces them to sell most of the food they produce, while nonpoor households use it to complement total household income and to cushion themselves against shocks (Mkwambisi et al. 2011). Either way, participation in UPA depends on the prevailing wage rate for casual labour and market conditions for farm produce – i.e., if the wage rate is very low, poor households will choose to employ all their labour in urban agriculture and vice versa (Dillon and Barrett 2017). Although poor households sell most of their farm produce, the benefits accruing to relatively wealthier households from urban agriculture could be more than what poor households are actually getting since they own big pieces of land and are able to hire labour (Kutiwa et al. 2010).

From our results, we observe that Kinondoni has a relatively higher number of pure-subsistence farmers compared to Ilala and Temeke. Our results speak to the latter view because relatively many households in Kinondoni keep all farm produce for own consumption, yet at the same time this area is well-off compared to these two districts. This important result seems to suggest that poor households are more likely than their counterparts to gravitate towards full commercialization. This idea opposes traditional microeconomic theory, which suggests that farming households are more likely to commercialize as income increases, since they now have the means to invest in efficient technologies to increase farm productivity or income and thus become less dependent on other income sources (Salami et al. 2010). In the relatively poor districts, we find heavy reliance on cash income from crops. Our results demonstrate the importance of crop income in poor urban communities in Tanzania.

Our results show preference for high-value crops such as vegetables and fruits as opposed to food crops such as maize. Theory predicts that farmers demand high-value crops if land is scarce to maximize profit per hectare and to stay in business (Kiduanga and Shomari 2017). The opportunity cost of farming in urban areas is very high, implying that farmers need to derive income that is at least as high as the prevailing wage rate, i.e., income they would get if they were recruited for a part-time job somewhere (also referred to as the shadow price of labour in the literature) (Dillon and Barrett 2017). The choice of crops or farm produce in Dar es Salaam is meant to maximize profit using a very small piece of land.

Our results demonstrate very high preference for mixed-cropping, as most respondents mentioned a variety of crops that would be planted on urban plots. This could be a way to mitigate the risk of crop failure due to diseases, drought or flooding, as well as market risk, since the market is sometimes flooded by one type of crop, thereby depressing its price. This pattern is also observed in other countries in Southern Africa (Kiduanga and Shomari 2017; Moyo 2013; Sotamenou and Parrot 2013). Moyo (2013) observed that there is a ready market for vegetables in African cities, as most poor households from high-density suburbs and the slum areas prefer to purchase groceries and vegetables on the streets in small quantities.

When we consider the results of the ordered logit model, we find that most variables representing household attributes are highly significant, including the household head characteristics. The finding that women reported higher retention of crops for household consumption is in agreement with the literature focusing on women and smallholder agriculture in Africa (see, e.g., Tibesigwa and Visser 2016). The result is also not surprising given that women are involved in food budgets, while men focus on major household decisions such as buying assets and building houses in the African culture (ibid). The striking similarities in behaviour between women in rural and urban areas suggest that women are more careful or risk averse when it comes to food insecurity issues caused by future shortages in the house (Hoornweg and Munro-Faure 2008). The same result is observed in areas such as environmental resource utilization (Sundström et al. 2019; Stern 2008). The non-linear relationship between age and crop retention is also consistent with the idea that older people are more risk averse than young people (Ntuli et al. 2019; Kahler and Gore 2012). Our results show that the likelihood of crop retention increases until the age of 90 years when the household head is still mentally capable and thereafter young people, who are relatively more open to risk and interested in market-based activities, take over. A possible explanation is that, beyond the age of 90 years, household size tends to be small and household heads tend to depend more on their children and grandchildren to till the land. This makes it possible that these households might be enjoying surplus and thus might not have need for food retention.

Our results suggest that the contribution of crop income to total household income is negligible for more educated households, who would rather keep the produce for own consumption. This could be because educated people easily get employment and the effect of crop income on total household income is overwhelmed by the effect of income from employment for relatively wealthy households. For relatively wealthier households, a similar effect is reported in the literature for environmental resource utilization (Ntuli and Muchapondwa 2017; Cavendish 2000). An educated household could be more risk averse and aware that food shortages might occur any time since they might have more information about climate change (Ntuli et al. 2019). This is also in line with the current literature on smallholder agriculture and household income (Tibesigwa and Visser 2016; Barrett 2008). Bersaglio and Kepe (2014) reported that relatively wealthier households are less likely to engage in smallholder farming as they devote more time towards off-farm activities. As opposed to wage income, a salary is several times higher and therefore more attractive than agricultural income if the decision maker is confronted with a situation where farm income could be used to substitute rather than complement salary income (Dillon and Barrett 2017). Consistent with traditional microeconomic theory, farmers are more likely to commercialize as income increases since they now have the means to invest in efficient technologies which increases farm productivity (Salami et al. 2010).

The idea that large households retain more crops is not surprising since this tradition is still active in most African cultures (Tambwe 2010). The positive coefficient on household size supports another idea proposed earlier, that is, pure subsistence farmers could be very poor households with big families and no wage income, hence their heavy dependence on own farm produce. Meyer and Nishimwe-Niyimbanira (2016) observed that the composition of larger households in low-income areas and under an urban setup comprises a few adults and many children, including grandchildren. Since larger households consume and require more food, children are likely to suffer malnutrition if they experience food shortages; so, as precautionary measures, they tend to retain a greater proportion of farm produce (Chigusiwa 2022).

The idea that households with larger yards retain less farm produce is immediately intuitive because, other things held constant, relatively large plots yield more output than what the household can consume, and the surplus is sold on the local market. Usually, households owning larger yards are relatively wealthy, invest in technologies that increase the productivity of the plot, and are likely to produce more food than they need (Bellwood-Howard et al. 2018). As a result, what they consume could be much less in absolute terms relative to what they sell. Thinking in terms of welfare, this result could be interpreted to mean that households with more land benefit more from urban agriculture than those with less land since land is no longer a binding constraint on household market participation for those with large plots.

This may also be related to the fact that households with larger yards are likely to grow subsistence crops, especially food crops such as cereals within the home yard. Larger urban farm plots likely would be used for more commercial purposes; hence, there is a negative sign on the coefficient. It could also be that those with larger plots are more efficient farmers since they are able to consolidate land by taking away land from less efficient farmers in the presence of a rental market (Zeng et al. 2017; Kadigi et al. 2017; Chamberlin and Ricker-Gilbert 2016). Previous studies have shown that there could be efficiency gains as plot size initially increases, but up to a certain point, after which efficiency starts to go down as farm size continues to increase (Kadigiet al. 2017; Zeng et al. 2017; Salami 2010). This is a similar concept with the famous law of diminishing marginal returns in microeconomics. This happens because we are increasing plot size while other variables that matter for efficiency, such as experience and capital, are fixed. There is a huge debate in the literature on the efficiency of large versus small plots (Zeng et al. 2017; Ali and Deininger 2015; Deininger et al. 2012). Some studies found loss of efficiency through subdivisions of farms (Deininger et al. 2016; Hung et al. 2007), while other studies found increased efficiency in smaller farms (Kawasaki 2010; Rahman and Rahman 2008). With regard to this debate, Zeng et al. (2017) argue that whether efficiency increase or decreases when a farm is divided depends on the context in question, i.e., the type of farmers who inherit the farm and the size of the farms relative to the original farm.

Considering the results of the RPL, we find that the coefficient for the variable measuring the difference between status quo and non-status quo alternatives (ASC), or the status quo bias as it is commonly referred to in the literature, is negative and highly significant, confirming the absence of the status quo bias. Consistent with the literature, the cost coefficient is negative and significant, thereby allowing us to work in WTP space. The results of the RPL model suggest that both plot size and irrigation matter for choice of urban agriculture, while distance to the plot seems not to be an important variable at all. However, distance to the plot becomes positive and highly significant when we consider the RPL model with interactions. This result could be interpretated as a signal for the demand for more agricultural land in Dar es Salaam and for irrigation infrastructure by UPA farmers. The WTP for irrigation is slightly more than three times that of plot size and nearly five times the WTP for plot distance.

The fact that the WTP for irrigation is much higher than plot size and distance to the plot suggests that the urban farmers could be facing climate risk – hence, the need to adapt in addition to market risk. Interpreting irrigation as a signal of adaptation to climate change makes sense given the occurrence of extreme weather conditions and water shortages in most African cities. Several studies have found irrigation to be a significant adaptation strategy for African smallholder agriculture in the face of climate change, as it allows farmers to grow crops all year round, thereby producing more output per hectare (Mulwa et al. 2017; Kurukulasuriya and Mendelsohn 2006). The demand for irrigation infrastructure is constrained by poverty, as most poor people cannot afford to buy irrigation equipment. Policy interventions such as subsidies, cheap loans and tax breaks on manufacturers of irrigation equipment are required to facilitate update of irrigation infrastructure by small farmers in developing countries. Irrigation also allows farmers to produce more output and get more income by farming throughout the year (Lee-Smith 2010). The types of crops grown under urban agriculture require more water than traditional crops grown in rural areas under rain-fed agriculture, which necessitates irrigation (Martellozzo et al. 2014).

Chikazunga and Paradza (2013) and Poole (2017) found plot size to be an important decision variable in farming, as it relates to whether the household wishes to engage in purely subsistence or semi-commercial farming. Farmers are able to increase revenue and profits by recruiting more land in the long run, because land is fixed in the short run (Debertin 2012). Theory suggests that more efficient farmers consolidate small pieces of land into large farms by overtaking less efficient farmers (Rahman and Rahman 2008). Less efficient farmers are kicked out of the market since they incur more costs, which erode their profits. UPA farmers increase their landholding by clearing more land if unused space is still available or renting from other users who find it difficult to use their plots due to financial constraints (Briggs 1991).

Since agriculture has been predominately rural, the literature has shown that distance of farm plot to the households or roads or markets is an important factor in smallholder agriculture (see Muraoka et al. 2018; Dillon and Barrett 2017; Kabir et al. 2017). Our finding that distance of the plot to the home is positive and statistically significant is somewhat difficult to interpret. This result also contradicts conventional wisdom from microeconomic and production economics theory that farmers prefer and value plot that are closer to where they live (Bersaglio and Kepe 2014). In support of this argument, evidence shows that on-farm investment decreases with distance to the plot as we move away from the homestead (Laiser 2016). Speculatively, our result could be explained by the fact that we are considering agriculture in an urban setting where land is scarce; hence. The utility or preference for peri-urban agriculture might increase with distance. In other words, the farther away you go, the more likely you are to find high-quality land with good agricultural soils or a much bigger plot. Such plots are located at the periphery of urban land where economic activities and population densities are still low (Mackay 2018). However, farming on the periphery of urban land comes with additional costs which might make the business unattractive. First, the time it takes to reach the plot could be too much for poor households, which might affect the quality of labour employed in farming (Ntuli 2008). Farming households might incur significant transport costs, given that farming needs attention on a daily basis (Kutiwa et al. 2010). Finally, loss of crops due to theft and wildlife intrusion in areas where wildlife is still abundant can be a major drawback if the plots are unfenced (McLees 2011).

Rain-fed agriculture is the dominant system among smallholder farmers in sub-Saharan Africa in general, and Tanzania in specific (Tibesigwa et al. 2021). It is estimated that rain-fed agriculture produces about 60% of world’s food (Copper et al. 2008). In sub-Saharan Africa, approximately 90% of staple food is produced by rain-fed agriculture (Shiferaw et al. 2014; Copper et al. 2008). Because of this dependency, it is becoming problematic in light of weather and climate variability. In Dar es Salaam, and Tanzania in general, water is scarce especially in dry season, and the public water supply can hardly keep up with the increasing demand of the urban population. Tap water is available to only a limited number of households and there is increasing competition for water (Masanja 2003). Farmers depend on surface and ground water; in many parts of Dar es Salaam, the groundwater table is high, allowing for low-cost shallow wells. Besides this, urban farmers use waste water as an irrigation strategy (Jacob et al. 2000). The use of waste water[12] from domestic and industrial waste for urban agriculture is a common practice in Tanzania, especially in urban centres, mainly among the poor (Maggid 2013). Therefore, these are plausible drivers of utility increasing with irrigation being available on the plot.

Considering the results of the model with interaction terms, the RPL suggests that those who view urban agriculture as a purely subsistence activity are less likely to prefer any of the urban agriculture attributes. This makes sense since those who view urban agriculture as a subsistence activity are either relatively wealthier households who are not interested in producing surplus crop for the market because the returns are negligible relative to total household income (e.g., Poole 2017; Chikazunga and Paradza 2013) or very poor households who do not have capacity or resources to invest in irrigation infrastructure or work on a larger plot and are indifferent between plots that are near or farther away from the homestead (Kurukulasuriya and Mendelsohn 2006). If the objective is just household food security and the piece of land is just adequate to meet family demand, they are better off without any of these features of urban agriculture. However, most households participating in urban agriculture sometimes produce more food than what their family needs and excess food is usually sold on the local market, indicating the motive goes beyond food security issues to profit maximization (Lee-Smith 2010; McLees 2011; Martellozzo et al. 2014).

The negative effect of the number of children suggests that households with young children, say children under the age of five, would prefer plots that are much closer to their

[12]Many farmers also tap directly into sewage system to get 'fertile' irrigation water. In fact, some farmers prefer waste water because of the perception that it contains high nutrient contents, which reduce costs for artificial fertilizers (Mlonzi 1997). A problem with waste water is the high content of heavy metals, e.g., lead, copper, zinc and manganese[12] (Mobufu 2012; Sahu and Kacholi 2015).

homesteads because of the need to quickly get home after work in the fields in order to attend to children or prepare food for them. The negative effects of the interaction terms between Temeke district and either plot size or distance to the plot provide further supporting evidence of poor families' preference for smaller farms that are much closer to their homesteads, since the district is relatively poorer compared to Kinondoni and Ilala. This is consistent with expectations. We do not expect poor households to demand large plots or live far away from their plots since this could be the only livelihood activity available to them in the face of dwindling employment opportunities (Ntuli 2008).

The positive WTP values signals the smallholder farmer's willingness to pay for attributes of UPA in Dar es Salaam. In particular, the farmers are willing to pay more for irrigated plots, which might suggest a need to adapt to climate change, thereby mitigating against climate risk and household shocks. The positive WTP for both irrigation and plot size suggest a strong tendency for farmers to gravitate toward small-scale commercial farming. This observation is further concretized by the fact that both variables are also significant in our regression models. The results of the WTP also support the idea that pure subsistence farmers just need enough farmland to feed their families, while semi-subsistence farmers require more land to produce surplus food to sell on the local market. This also supports our earlier contention that making plots available is likely to increase food security at both household and community level in addition to reducing poverty and inequality.

6. CONCLUSIONS AND POLICY RECOMMENDATIONS

This study demonstrates how Dar es Salaam city residents are willing to pay to access plots for the cultivation of crops. These preferences are considered as a genuine signal for demand for land for UPA by poor urban dwellers in developing countries, which policymakers should take into consideration in planning and development. Our results show robustness, i.e., strong agreement, across the models in the signs of the coefficients, and to some extent the level of significance, where we observe two key findings: First, urban agriculture attributes, especially irrigation, provide positive and significant welfare benefits to Dar es Salaam residents. Second, there is significant preference heterogeneity for urban agriculture attributes across individual residents.

We find that urban smallholder farmers will mitigate against market risk and crop failure by growing a range of crops. Quite a huge proportion of households will sell large quantities of what they produce on their farm, thereby demonstrating a very strong tendency to gravitate towards commercialization. In particular, the majority mentioned that they would retain some of the crops produced from urban agriculture for household consumption, i.e., 57% would retain a quarter of the production, 27% would retain half, and 6% would keep three-quarters, while only 10% reported that they would retain all of the farm produce. Hence, besides observing a positive willingness to pay as a strong signal of demand or support for UPA, we also note that UPA can improve income and food security in urban households.

The results provide evidence for the importance of UPA in African cities. They allow policymakers to interrogate their current policies while informing future strategies for sustainable urban green economy. The results particularly call for policy interventions aiming to facilitate urban agriculture ecosystems along with irrigation infrastructure to enable adaption to climate change by urban farmers. For the Sustainable Development Goals (SDGs), urban agriculture ecosystems has vast potential to contribute towards their attainment, more especially, the prospects of achieving SDG 11's theme of "Make cities inclusive, safe, resilient and sustainable". For inclusive green economy (IGE) revolution, UPA have a huge role to play in transforming SSA economies to achieve green economic growth. All of which is tied to Agenda 2030 by the United Nations, Agenda 2063 by the African Union and TDV 2025 by Tanzania.

The potential of smallholder urban agriculture can be unlocked through a number of ways. Firstly, agricultural intensification and zoning is necessary so that less land is either demanded or used for crop cultivation in cities. Secondly, sustainable agricultural practices are required not only to protect the environment, but also to produce healthy food which can fetch good prices on the market, as opposed to commercial production which relies heavily on technology. This is where conservation farming (minimum tillage, crop rotation and use of crop residue) becomes handy as a technology for urban agriculture. Thirdly, this can be achieved through value addition and access to better-paying markets rather than selling their perishable farm produce on the streets. Market linkages with established companies will help poor farmers to access domestic upper markets and overseas markets where their produce will fetch better prices. Finally, there is a need for policy interventions to help urban farmers adapt to climate change by investing in irrigation infrastructure, since our results signal a very high demand for such technology. Such policies can come in the form of subsidies on irrigation equipment, cheap loans and tax breaks for manufacturers of irrigation equipment.

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Table 1: Urban agriculture attributes and levels of the experimental design

Attributes	Descriptions	Levels
Plot size	• farm plots will be available for renting to residents for urban crop farming • Size of the plot	1/4 or 1/2 or 1 or 2 hectares
Irrigation	• Whether irrigation is present in the plot	No irrigation/Irrigation
Location/distance	• Distance of farm plot from household	5/10/15 km from your home
Cost	• Your additional yearly fee for the plot rental: Your household's required payment is a fixed payment for one year (with the option of renewing yearly)	TSH5000, TSH7000,TSH9000, TSH11000, TSH15000, TS17000, TSH20000, TSH30000, TSH50000, TSH100000

Note: US$1 ≈ TSH2000

Table 2: Urban agriculture choice set example

Please Vote/choose:

	Program 1	Program 2	No Program
Plot size	½ ha	1 ha	No urban agriculture
Irrigation	No	Yes	
Location/distance	5 km	15 km	
Your additional monthly fee	TSH17000	TSH 15000	No additional costs
I would vote for this option	❒	❒	❒

Note: US$1 ≈ TSH2000

Table 3: Descriptive Statistics

Variable	Mean	SD
Age	41.16	12.80
Gender (0 = F, 1 = M)	0.448	0.497
Education years	9.719	4.323
Married	0.705	0.456
Employed	0.757	0.429
Employed full-time	0.184	0.388
Employed part-time	0.006	0.075
Full time student	0.009	0.092
Part-time student	0.189	0.391
Staying at home	0.040	0.195
Retired	0.013	0.112
Self employed	0.560	0.496
No. of household members	4.702	2.817
No. of children in the household	1.930	1.723
No. of members with an income	1.684	1.187
Household income (TSH)	847708	1568096
Crop consumption-quarter	0.440	0.496
Crop consumption-half	0.209	0.406
Crop consumption-three quarter	0.043	0.202
Crop consumption-all	0.079	0.270

Note: US$1 ≈ TSH2000

Table 4 Determinants of subsistence farming

	Panel A	Panel B	Panel C		
	(1)	(2)	(3)	(4)	(5)
	ologit	ologit	gologit	gologit	gologit
Gender	0.0395	-0.140	0.208***	-0.653***	0.574***
	(0.0576)	(0.103)	(0.0615)	(0.0843)	(0.174)
Age	0.0452***	0.0291	0.0707***	0.142***	-0.466***
	(0.0154)	(0.0268)	(0.0166)	(0.0274)	(0.0563)
age2	-0.000499***	-0.000149	-0.000821***	-0.00180***	0.00612***
	(0.000172)	(0.000290)	(0.000185)	(0.000326)	(0.000668)
Education	0.0565***	0.0279**	0.0669***	0.164***	-0.153***
	(0.00812)	(0.0133)	(0.00908)	(0.0120)	(0.0245)
Married	-0.0115	0.0215	0.0577	-0.00620	0.517***
	(0.0639)	(0.111)	(0.0677)	(0.0911)	(0.129)
Employed	0.0117	-0.238*	-0.0289	-0.411***	1.191***
	(0.0725)	(0.123)	(0.0759)	(0.0980)	(0.194)
Income	-0.110***	0.305***	-0.331***	-0.0221	0.828***
	(0.0327)	(0.0508)	(0.0366)	(0.0451)	(0.0709)
Householdsize	0.117***	-0.00394	0.145***	0.0996***	-0.0924***
	(0.0102)	(0.0173)	(0.0116)	(0.0138)	(0.0253)
Yardsize	-0.161***	-0.135***	-0.176***	-0.152***	-0.247***
	(0.0169)	(0.0302)	(0.0185)	(0.0286)	(0.0404)
Kinondoni	0.346***	1.131***	0.126*	0.974***	0.327**
	(0.0648)	(0.123)	(0.0691)	(0.102)	(0.139)
Temeke	0.117*	-0.802***	0.217***	-0.0130	-2.675***
	(0.0698)	(0.200)	(0.0754)	(0.137)	(0.261)
Constant cut2	1.770***				
	(0.474)				
Constant cut3	2.334***				
	(0.475)				
Constant cut1	0.282	7.162***			
	(0.474)	(0.795)			
Constant			1.957***	-5.502***	-2.887**
			(0.517)	(0.702)	(1.186)
Observations	5,724	5,724	5,724	5,724	5,724

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 5: Estimates from different models

	Panel 1 Conditional Logit Base model	Panel 2 Mixed Logit Controlling for preference heterogeneity	Panel 3 Mixed Logit Controlling for preference heterogeneity (with interactions to identify source of heterogeneity)
Cost	**-2.08e-05*** **	**-2.82e-05*** **	**-3.14e-05*** **
	(1.46e-06)	(2.02e-06)	(3.39e-06)
ASC	**-0.226***	**-2.919*** **	**-2.277*** **
	(0.120)	(0.410)	(0.395)
plot size	**0.127*** **	**0.203*** **	**0.383*** **
	(0.0370)	(0.0497)	(0.127)
plot distance	**0.0367**	**-0.0267**	**0.248** **
	(0.0355)	(0.0462)	(0.116)
plot irrigation	**0.453*** **	**1.126*** **	**1.222*** **
	(0.0396)	(0.0858)	(0.242)
plot size*HH consume a quarter crops			0.0260
			(0.144)
plot size*HH consume half crops			0.0853
			(0.255)
plot size*HH consume 3 quarters crops			-0.254
			(0.202)
plot size*HH consume all crops			-1.174***
			(0.256)
plot distance*HH consume a quarter crops			0.0816
			(0.126)
plot distance*HH consume half crops			0.0989
			(0.217)
plot distance*HH consume 3 quarters crops			0.107
			(0.170)
plot distance*HH consume all crops			-0.982***
			(0.147)
plot irrigation*HH consume a quarter crops			0.0290
			(0.201)
plot irrigation*HH consume half crops			-0.403
			(0.356)
plot irrigation*HH consume 3 quarters crops			-0.313
			(0.324)
plot irrigation*HH consume all crops			-0.850***
			(0.213)
plot size*no. of children			0.0465
			(0.0284)
plot distance*no. of children			-0.0640***
			(0.0226)
plot irrigation*no. of children			-0.0408
			(0.0424)
plot size*household income			-0.00364
			(0.0443)
plot distance*household income			0.0271
			(0.0442)
plot irrigation*household income			0.0299
			(0.0959)
plot size*kinondoni district			-0.124

			(0.142)
plot size*temeke district			-0.315**
			(0.143)
plot distance*kinondoni district			-0.102
			(0.120)
plot distance*temeke district			-0.274**
			(0.113)
plot irrigation*kinondoni district			0.0587
			(0.212)
plot irrigation*temeke district			0.207
			(0.251)
SD			
ASC		6.655***	3.169***
		(0.543)	(0.426)
plot size		0.166	0.785***
		(0.174)	(0.171)
plot distance		0.0611	-0.163*
		(0.104)	(0.0976)
plot irrigation		1.035***	1.052***
		(0.136)	(0.146)
Observations	8,460	8,460	8,460
LL	-2861.373	-2153.915	-2077.007
AIC	5732.745	4325.829	4220.014
BIC	5767.961	4389.217	4452.437

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 6: Independence of Irrelevant Alternative (IIA) assumption test

Alternative dropped	Chi.Sq (5) (χ^2)	Probability
Choice 1	252.88	0.00
Choice 2	176.99	0.00
Status-quo	387.27	0.00

Table 7: Marginal willingness to pay (TSH/Year)

	Panel A: Conditional logit Base model	Panel B: Random parameter logit Controlling for preference heterogeneity	Panel C: Random parameter logit Controlling for preference heterogeneity (with interactions)
Plot size	6117.23 [2546.6, 9687.8]	7191.07 [3576.6, 10805.5]	12189.10 [3868.8, 20509.4]
Distance	1767.15 [-1479.5, 5013.8]	-947.32 [-3836.7, 1942.1]	7907.40 [851.7, 14963.2]
Irrigation	21844.32 [16221.5, 27467.0]	39903.17 [29047.7, 50758.4]	38944.89 [22116.4, 55773.4]

Note: US$1 ≈ TSH2000

Figure 1: Percentage that will be retained for household consumption from urban agriculture

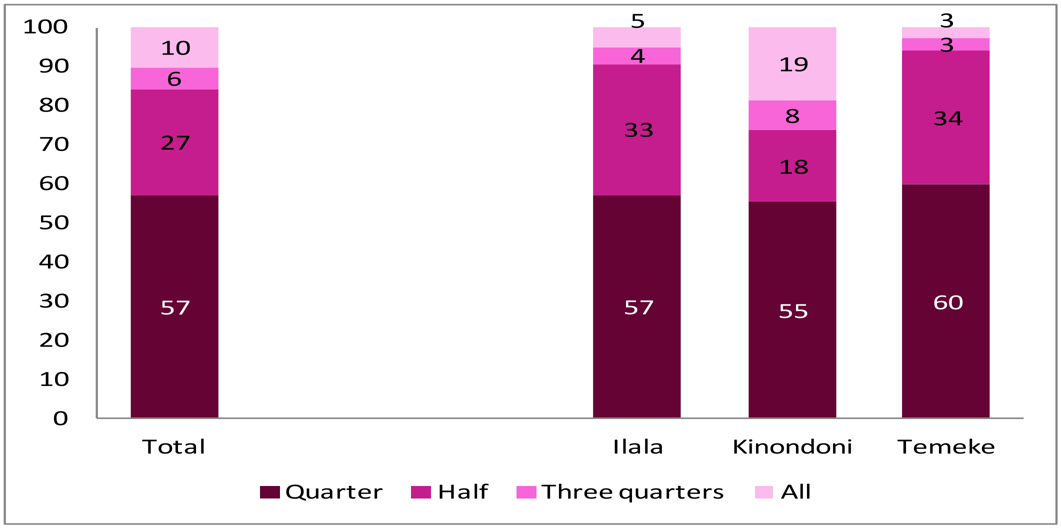
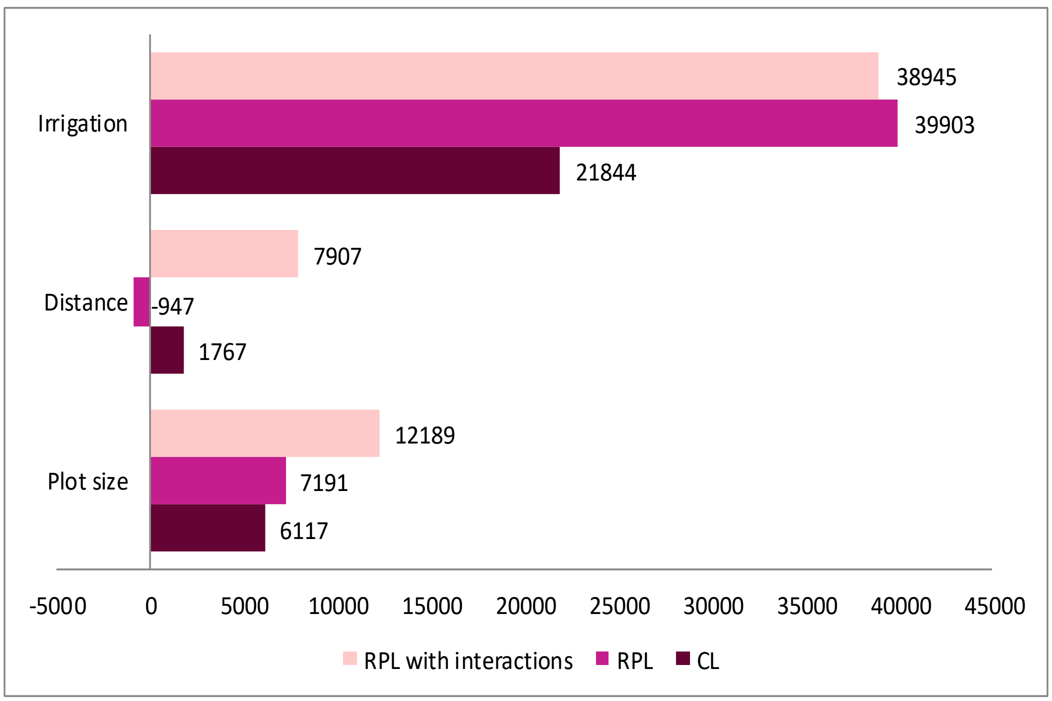


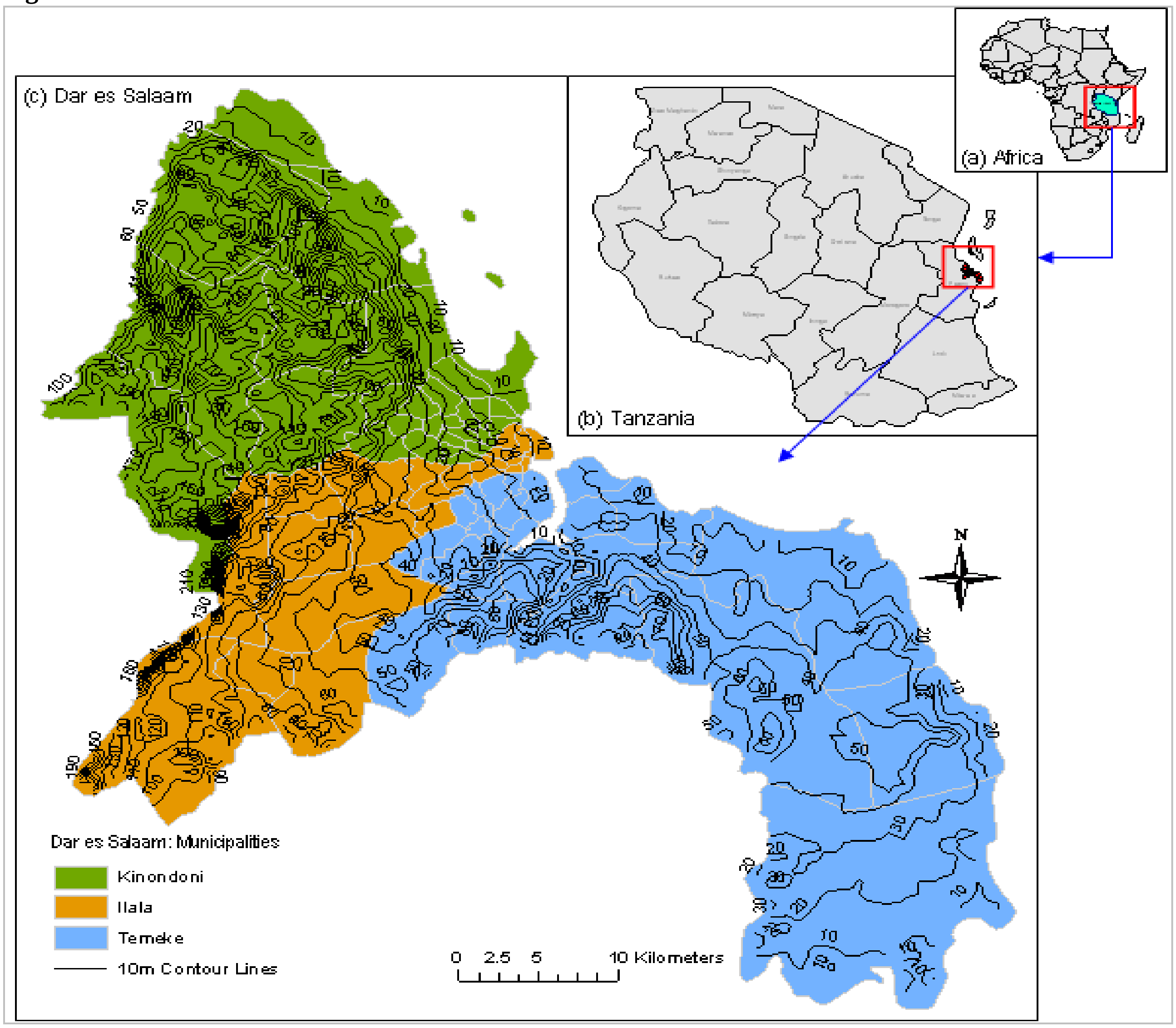
Figure 2: Comparing marginal WTP from each model



Note: US$1 ≈ TSH2000

Appendices

Figure A.1: Dar Es Salaam Boundaries



Source: Kebede and Nicholls, 2011

Figure A.2: Description of the choice experiment

Urban agriculture development

There is a proposed program to urban agriculture. Several options are considered for the program, with planning still at its early stages.

Funding for the Program

The funding for the program is separate from the rest of the city budget. One funding monthly fee will be collected from a mobile phone from each household in the city. For example, if your household has more than one mobile phone, only one will be deducted. Revenues from the fee would be designated to a separate fund purposed exclusively to finance the program.

Fund will be administered by a management board involving representatives from the citizen associations, environmental organizations, and local government representatives. The board will make sure that the money from this fund is used correctly and efficiently. The provision of fund accounts and audits will be announced every year on the internet, in the press and on television.

The fund and the program would be in place for five years. Thereafter, the program will be reviewed to decide about its continuation. The review will include a survey of residents to learn whether they are satisfied with the program.

3.1 Do you or someone in your household use a mobile phone?
[1] Yes [2] No

If you don't have a mobile phone, please continue the survey, assume that in the near future you will have a phone and pay the bill?

Your Opinion about the Program

Next, I will ask you about different options for the *program*. I will ask a series of questions, each of which asks you to consider several program alternatives, selecting the one you would like best.

Each program option will also involve costs to you. If you don't like any of the options presented, you can support none of them.

Before we continue, note again that there is no right or wrong answer to these questions. Some people may think the programs are worth their cost, while some may not. We want to get the opinions of all people.

The program

Urban agriculture is one of the green initiatives in the city. The green initiative recommends that farm plots be available for renting to residents' for urban agriculture.

In the following questions, I ask you to select your favorite option. Each option is described using the following attributes:

- *Plot size*: Size of the plot (quarter, half or one hectare)
- *Irrigation*: Whether irrigation is present in the plot (yes or no)
- *Location*: Distance of farm plot from household (5, 10 or 15 km)
- Your additional yearly fee for the plot rental: Your household's required payment (with the option of renewing yearly)

Please Vote/choose:

Table A.1: Types of crops that will be grown in the urban plots

Crops	%	Crops	%
Bananas	0.2	Potatoes	1.0
Beans	1.7	Potatoes, tomatoes	0.2
Beans, maize	1.6	Potatoes, maize	0.2
Beans, vegetables	0.3	Potatoes, maize, beans	0.2
Cassava	0.9	Pumpkin	0.2
Cassava, passion	0.2	Rice paddy	0.9
Cassava, vegetables	0.5	Rice paddy, cassava, maize, vegetable	0.2
Cassava, sweet potatoes	0.2	Rice paddy, vegetables	0.5
Cassava, bananas, vegetables	0.2	Rice paddy, maize	0.7
Cassava, carrot, beans, spinach, cabbage	0.2	Rice paddy, maize, vegetables	0.7
Cassava, maize	0.5	Sesame seeds	0.2
Cassava, maize, vegetables	0.2	Sesame seeds, tomatoes	0.2
Cassava, maize, beans	0.2	Spinach	0.9
Cassava, pineapples, maize, vegetables	0.2	Spinach, ladyfinger, watermelons	0.2
Cassava, sweet potatoes, vegetables	0.2	Spinach, potatoes	0.2
Coriander, green beans	0.2	Spinach, eggplant	0.2
Cucumbers	0.2	Spinach, watermelons	0.2
Cucumbers, watermelon	0.5	Strawberry, maize, vegetables	0.2
Flowers	0.7	Sunflower	0.2
Fruits	6.1	Sweet potatoes, cassava, vegetables	0.2
Fruits, maize	0.3	Tomatoes	1.7
Fruits, vegetables	4.9	Tomatoes, watermelon, cucumbers	0.2
Garlic, okra	0.2	Tomatoes, cabbage, spinach, chillies	0.2
Ginger	0.2	Tomatoes, green peppers, peanuts	0.2
Grapes, vegetables	0.2	Tomatoes, maize, spinach, sweet potato leaves	0.2
Maize	2.6	Tomatoes, watermelon	0.7
Maize, watermelon	0.3	Vegetables	43.8
Maize, beans, vegetables	0.5	Vegetables, potatoes, cassava, pineapples	0.2
Maize, cassava, tomatoes, vegetables	0.2	Vegetables, beans, maize	0.2
Maize, cassava, peas	0.2	Vegetables, cassava, potatoes	0.2
Maize, cassava, watermelon, vegetables	0.2	Vegetables, fruits, beans	0.2
Maize, onions, cabbage, vegetables	0.2	Vegetables, fruits, coconut	0.2
Maize, rice, peas	0.2	Vegetables, fruits, maize	0.5
Maize, sweet potatoes	0.3	Vegetables, fruits, rice	0.2
Maize, vegetable, beans, fruits	0.2	Vegetables, Irish potatoes, legumes	0.2
Maize, vegetable, cassava, green peppers	0.2	Vegetables, maize, cassava	0.2
Maize, vegetables	5.0	Vegetables, sugarcane, watermelon	0.2
Maize, vegetables, cassava	0.2	Vegetables, watermelons	2.4
Mushrooms	0.5	Watermelon	5.9
Mushrooms, cucumber, watermelon	0.2	Watermelon, cassava	0.3
Onions	1.0	Watermelon, maize, rice	0.2
Onions, rice, sunflowers, maize	0.2	Watermelon, maize, vegetables	0.5
Oranges	0.3	Watermelon, passion	0.2
Peaches	0.2	Watermelon, chillies, cucumbers, sweet potato leaves	0.2
Peanuts	0.3	Watermelon, pineapples	0.3
Pineapples	0.3		