



Efficacy of Agricultural Extensions and Environmental Conservation Awareness on the Sustainability of Urban Agricultural Practice: Case of Daraja Mbili and Lemala Wards in Arusha City, Tanzania

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ABSTRACT: Urban agricultural activities can have a minimum or a substantial contribution to the livelihoods of people. They can either conserve or pollute the environment and degrade the land. The information about ensuring agricultural productivity with less effect on the environment is dynamic and the causes of dynamisms are not clear. The study was conducted to examine the cause of dynamisms in relation to changing institutional frameworks and political regimes. The study used qualitative research design and a case study strategy and 60 respondents were interviewed. We did content analysis to analyse qualitative data. The findings revealed that agricultural extension services and trainings, as well as environmental conservation awareness about good agricultural practice were provided to farmers and non-farmers, although the success was not promising. The uncoordinated agricultural activities were rhetorically managed and sometimes managed in uncoordinated ways. In tune with provision of agricultural extension services and awareness of conserving the environment to farmers, the mere conservation of the environment was not successful, unless it had a possibility of increasing agricultural productivity and helping farmers to get their livelihood needs.

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Urban agriculture is action of growing edible and non-edible plants as well as keeping livestock in the urban areas for the purpose of getting food, earning income and conserving the environment (Sima *et al.*, 2010; Magigi, 2013). Due to rampant and rapid urbanisation in sub-Saharan Africa (SSA), the worry of providing informal employment opportunities and feeding the urban population without impairing the environment is becoming a contentious debate (Lee-Smith, 2010). Urban agriculture can partly provide solutions to food scarcity and unemployment problems (Magigi, 2013). However, uncontrolled agricultural activities can also cause the problems of land degradation and environmental pollution (Hallett *et al.*, 2016). There information on how urban agricultural activities should take place is contrary to the actual way they take place (Delgado, 2018). The controversy occurs on how social and economic benefits can be met from

urban agricultural activities without endanger environmental benefits. Urban agriculture is regarded inappropriate urban land use due to the adverse effects it causes to the environment and human health (Hallett *et al.*, 2016). On the other hand, well managed agricultural activities provide not only on food and income to people, but also greens and cools the urban environment and the use cover and tap crops and adopting terrace farming minimise soil erosion (Peters, 2010; Magigi, 2013). The benefits of urban agriculture to farmers and non-farmers in terms of food and income and its adverse effects to the environment depend on how urban agriculture is governed by relevant stakeholders by using appropriate institutional frameworks (Pearson *et al.*, 2010; Cabannes, 2012; Magigi, 2013). However, what outweighs the other in terms of positive environmental effects, the provision of livelihood needs of the farmers and adverse

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environment effects due to uncontrolled urban agricultural activities is an issue debated differently both at national and international levels (Peters, 2010; Hallett *et al.*, 2016). The capacity of urban agriculture to meet food needs in a city also depends on the ways in which urban agricultural activities may be managed (Hallett *et al.*, 2016). Farmers in New York City were trained by agricultural officers to prepare and manage compost manure; hence, they decreased the environmental pollution and cost of dealing with organic waste (Ackerman *et al.*, 2014). The provision of agricultural extensions is among the ways of providing agricultural knowledge to urban farmers to increase agriculture productivity and to minimise the effects of uncoordinated agricultural activities to the environment and other non-agricultural land use (Reynolds, 2011). The urban areas with high housing density and population, the availability of land for farming activities is limited, but the demand for agricultural products is high (Cabannes, 2012; Lau, 2013). Thus, training farmers to adopt farming technology that required small space, but and ensures an agricultural productivity is important (Reynolds, 2011). Rangrajan & Riordan (2019) suggest that in cities with limited space for urban agriculture, urban farmers may be trained to grow crops that utilise small spaces or growing trees which provide fruits and at the same time cool the environment. The technology and extension services provided to urban farmers may be successful if the existing institutional frameworks recognise and support urban agriculture (Cabannes, 2012). In China and Vietnam, the production of fish and, to some extent, macrophytes (vegetables grown in water) are grown in ponds using diluted and treated-wastewater. The fish production knowledge was provided to urban farmers through agricultural extensions and training, because fish farming in urban areas was recognised by national policy (Belevi & Baumgarther, 2003). In some urban areas of sub-Saharan Africa, untreated wastewater is used as an alternative for irrigating vegetables because safe irrigation water is scarce or accessed through a billing system that can hardly be met by farmers (Ndunda & Mungatana, 2012). Urban farmers in South Africa are trained to change their archaic agricultural methods in order to increase agricultural productivity and conserve the environment, but the knowledge of using health risk-reduction intervention to wastewater-irrigated agriculture is seldom provided to farmers (Ndunda & Mungatana, 2012; Owusu *et al.*, 2012). Farmers in urban areas might not be provided with awareness information on to irrigate crops by using wastewater because the use of wastewater is not allowed by local bylaws and national policy (Owusu *et al.*, 2012). Growing vegetable in environmentally prone areas causes degradation and soil erosion, but

adverse effects of uncontrolled urban agricultural activities can be minimised by adapting appropriate farming techniques such zero tillage, planting of tree and shrubby crops, mulching land and growing cover crops (Cahya, 2016). Proper farming in urban areas depend on the way urban farmers are trained to use the technology appropriately and do farming on the land set aside for farming activities (Peters, 2010; Reynolds, 2011). Growing fruit bearing trees in urban areas ensures food security and support eco-friendly environment (Colinas *et al.*, 2019). Urban farmers in Gaborone grew vegetable crops along Notwane and Gler River's floodplains because there was no ideal land they could use for agricultural activities (Mosha, 2015). In turn, such uncontrolled agricultural activities lead to land degradation and soil erosion along and in the river valleys (*ibid.*). The practice of urban agriculture is growing both in developed and developing countries, but it is not clearly known whether agricultural officers are interested in providing agricultural extension services to urban farmers and how exiting institutional frameworks support or hinder the practice of urban agriculture (Reynolds, 2011). In Kongi East, Nigeria, 80 per cent of the urban farmers did not have access to agricultural extensions because the modality of provision and accessibility of the services was not clearly outlined in the institutional frameworks (Tokula, 2018). Urban agricultural extension services can be extended beyond the management of crop and livestock issues to cover the aspect of preparing and implementing land-use plans for agro-ecosystem and agroecology practices (Pimbert, 2017; Prasetyo *et al.*, 2020). Agro-ecosystem can partly conserve urban environment from being degraded, but it require more land for it to be more effective (Pimbert, 2017). Although there was limited access to land for farming activities in Kampala City, Agricultural and Livestock Policy of Kampala City (ALPKC) state that agricultural extension services should be provided to farmers who lawfully occupy land in the urban and peri-urban areas (Tumutegyereize *et al.*, 1999). Thus, in Kampala, the provision of on-site agricultural extension services disregarded farmers who squatted on public restricted land (*ibid.*). In the peri-urban areas of Thailand, the cost of revitalising the degraded land due to uncontrolled shrimp farming was less than the gains from exporting the shrimp (Makaya & Todzwo, 2019). Thus, such type of agriculture was managed to minimise its adverse effects to the environment. When land degradation and environmental pollution outweigh the social and economic benefits derived from urban agriculture, urban agriculture can be perceived as a bad activity and it cannot be supported (Delgado, 2018; Makaya and Todzwo, 2019).

Section 4.16.1 (i and ii) of Tanzania Agricultural Policy of 2013 acknowledges inadequate supportive mechanisms and weak regulatory framework for urban and peri-urban agriculture (URT, 2013). Section 4.16.2 states that increased productivity and profitability of urban agriculture depends on the manners it takes place and less effects it causes to the environment and health of the general public. Fletcher *et al.* (2012) mention that challenges associated with lack of access to agricultural land, lack of practitioners' knowledge of the best practices of urban agriculture and lack of economic viability of urban agriculture may partly hinder the implementation of policy with good intention to urban agriculture. The Tanzania Environmental Policy of 1997 states that local authorities both in urban and rural areas have responsibilities of protecting and conserving environment through awareness creation and education provision, seeking funds from local sources for implementing policy statements relating to environment (URT, 1997). The uncoordinated institutional frameworks may attribute to inadequate implementation of good policy for urban agriculture (Schmidt, 2012). The agricultural extension services are provided in Tanzanian context because agriculture is recognised by certain policies (URT, 2013). Yet, the efficacy of urban agricultural training, extension services and environmental conservation awareness, and factors hindering or supporting them are changing, depending on institutional frameworks of a nation and urban authorities. Therefore, this study examined the efficacy of agricultural extensions and environmental conservation awareness on the sustainability of urban agricultural practice, particularly in Daraja Mbili and Lemala.

MATERIALS AND METHODS

Selection and Description of the Study Areas: Wards of Daraja Mbili and Lemala in Arusha City were selected as study areas because they had active farmers who were provided agricultural training, extension services, and environmental conservation awareness by agricultural officers and environmental officers. Keeping livestock and growing crops within and away from farmers' residences were the most common activities in these wards. Besides, the wards are crossed by Rivers Themis and Naura which have fertile valley and retained water for irrigation during dry season.

The rivers' banks were earmarked as reserved areas. Yet, farming activities were practised along the banks of the rivers. The wastewater was used for irrigating horticultural crops in Lemala and people have different opinion regarding this habit. Moreover, the reconnaissance study indicated that in Lemala ward

there is Engra hill which was conserved for environmental purpose, but farmers evaded it for growing crops. There was Environmental Bylaws of 2008, which is implemented at different context. Moreover, Daraja Mbili had a higher housing and population density. Yet agricultural activities were done in the residential areas.

Source of Data and Analysis: The study deployed a case study design to allow wider understanding and in-depth investigation on the way agricultural extensions and environmental awareness information were provided and put into practice. A total of 60 respondents were interviewed. The data were collected using in-depth interviews. Information obtained through observation complemented in-depth interview information. We did content analysis of the data. The empirical findings were interpreted and discussed in relation to related reviewed literature to generate additional knowledge about sustainability urban agricultural practice.

RESULTS AND DISCUSSION

Results: The training offered to farmers in Daraja Mbili and Lemala included greenhouse farming technology, mushroom farming, making compost as well making and handling biogas. People interested in farming were trained in plant vegetative propagation technique and general management of crop production and livestock keeping. The study revealed that biogas making and management technology provided farmers with heat and light energy for lighting and cooking. This indirectly minimised the amount of trees that could be cut for charcoal and firewood. However, only farmers who had land and kept livestock and who were interested in biogas were the ones who put biogas technology into practice. Other extension services provided to interested farmers who kept livestock included debarking and artificially inseminating the cows. In both Daraja Mbili and Lemala, farmers were trained in the management of crop pest and disease. The farmers' awareness on using the improved seeds of vegetable and spice, advice of keeping improved breed of dairy cows such as Jersey and Friesian for improved milk production were also raised. Daily cows were kept under zero grazing and they were fed fodders in an enclosed area. Feeding the livestock in an enclosed area through zero-grazing methods minimised the effect of land degradation that could be caused by free grazing of cattle. During the survey, six farmers at different locations in Lemala were found growing spinach and lemon grass in sacks filled with soil and organic substrates. This was a strategy of farming in a small piece of land. Despite farmers being trained in greenhouse farming technology, the land in both wards was sold at an average of TZS16, 000.00

per square kilometer. This was a lot of money to afford it.

Two and three farmers from Daraja Mbili and Lemala respectively attend a citywide seminar in 2017 on the production of artificial mushrooms in an enclosed hut. Moreover, 40% (n=40) of farmers in both wards who were registered in farmers' register book got opportunity to attend training on crop production and livestock management organised by the Selian Agricultural Research Institute (SARI). However, one of the farmers from Daraja Mbili complained that the seminars which included some payment for the trainees were not disclosed to all farmers. The study revealed that farmers who were proposed for agricultural training and seminars were those who knew how to read and write Swahili, who were active and could put the theoretical training into practice. The selection of the farmers to attend a city-wide training was preceded by an evaluation of their best practices of agricultural activities. In farmers' exhibition day that took place from 1st to 8th August every year, farmers and non farmers from the study areas had an

opportunity to learn new ideas on how farmers outside the city performed their agricultural activities because such exhibition included even farmers from rural areas of Arusha region.

Furthermore, the fliers in Swahili language and agricultural extension service provided to farmers and non-farmers helped them to manage properly the droppings from chicken and other livestock such as pigs and cattle. The proper management of waste minimised bad odour from disrupting non livestock keepers. Wherever poor management of livestock waste discomfort neighbours, the culprit was charged a fine not less than TZS 50,000.00 as per Environmental Bylaws of 2018. On the other hand, when a culprit is charged a fine due to growing vegetables on the restricted banks of the Rivers Thembi and Naura, his/her crops should be not destroyed until they got harvested. It was inhuman to destroy the crops which a culprit had already been charged the fine. Urban farmers had different opinion regarding agricultural training they wished (see Table 1).

Table 1: Types of agricultural training the farmers wished they could have participated

Activity	Response (n=40)		Clarification
	Yes	No	
Establishment and caring commercial nursery for ornamental and non-fruit bearing trees	20%	80%	-Yes- farmers were not interested in training that directly impact on their food and income
Making compost	40%	60%	-No: Limited number of farmers had not ventured in livestock keeping, they did not own land legally, soil had some natural fertility
Vegetative propagation technique	55%	45%	-Yes: Techniques could sometimes be used to earn money for commercial nurseries when propagating fruit trees and ornamental flowers
Making and managing biogas system	40%	60%	-No: Effective biogas depends on the number and type of livestock kept, it is not possible to be done by non crop growers, constrained by limited access to land
Mushroom farming	35%	65%	-No: The market was no reliable, land access was a challenge, capital was not enough
Livestock keeping and management	50%	50%	-Yes: Some activities can be understood when one get more information and experience from others -No: Some farmers had knowledge due to long experience, agricultural officers could be consulted

Source: Survey Data, 2019

When agricultural training and extension services and were provided to farmers by governmental agricultural officers, the cost of services was met by the government. The agricultural officers employed by the Government of Tanzania were paid a salary as public servants. However, cost for trimming the beaks of chicken, performing artificial insemination to cows and castration to male piglets, attending complicated cow parturition during the night time was covered by responsible farmers. There was no fixed amount of money charged for the service; rather, the cost was

negotiable between the farmer and officer. The study also revealed that on-site extension services in both wards were being provided only to farmers who grew crops on the land they occupied lawfully. The provision of on-site services to farmers who squatted on public restricted land could imply that such illegal farming activities were indirectly legitimised by the agricultural officers. However, farmers who opted to visit agricultural officers in the city or ward office for advice and clarity of the farming problems they faced were assisted unconditionally. The typical greening

and conserving the urban environment was promoted by environmental officers, supported by the city authority and Non-Governmental Organisations focused on environmental management. One of the Non-Government Organisations in Arusha City called RIKOLTO also focused on training urban farmers and interested people to adopt farming and management techniques that ensure food production without harming the environment. Four farmers from each ward who participate in that training were trained in greenhouse and polypropylene bags farming as well as adopting organic farming and agroforestry activities. The result from the training led to the formation of Themi living garden community focused on dissemination of urban edible gardening information and services in Arusha City. People from Daraja Mbili and Lemala had opportunity to access the information and one farmer from Daraja Mbili and two farmers from Lemala had a membership in that organisation. Themi living community established and managed a semi-natural conserved urban garden with cool, attractive scene and a natural River Themi nearby. The Arusha City Council's environmental unit has established a commercial nursery for shade, timber and fruiting-bearing trees at Themi ward which was closer to Lemala ward. Those trees were sold to any person in the city who wished to plant them within areas of residencies or institutions, including those found in Daraja Mbili and Lemala. The environmental officers came up with a Swahili saying "mti na mazingira" literally meaning "tree and environment". People in the group were trained on the basic knowledge of tree varieties, vegetative propagation techniques, tree growth requirements and management practices so that they could elucidate the same knowledge to tree buyers who were interested in the information. One tree of about 30cm height planted in polypropylene was sold at a subsidised cost of TZS 2,500 per tree instead of TZS 3,000. This was a strategy to promote agroforestry which advances the production of fruit trees and trees for cooling, greening and intercepting speed of wind in the residential areas. Wherever any person had a space which he or she owned legally, he or she was advised and insisted to plant at least one tree in the habitable place. Since few numbers of farmers and non-farmers had their own land, the exercise was not done in many areas within and outside Daraja Mbili and Lemala. Environmental officers were responsible for creating awareness among the farmers and non-farmers about avoidance of agricultural activities that could lead to land degradation and environmental pollution. This was also applicable in Daraja Mbili and Lemala. However, in practice, the provision of environmental conservation awareness and training offered by environmental officers did not emphasise about

promotion of urban agriculture to meet income and food needs of the farmers. The issues related to typical food production and livestock keeping as well as their management was considered to be the duty of agricultural officers. The environmental department of Arusha City Authority ordered farmers to stop growing food crops along the Engra hill through deep ploughing which caused soil erosion. The agricultural officers on the other hands encouraged farmers and non-farmers to grow fodder grasses which need neither deep tilling nor frequent weeding. The grasses were cut and fed livestock kept under zero grassing. The study revealed that about 1/3 of the undulating slope of Engra hills grew fodder grass such as Panicum maxima, Elephant grass and Vetiver grass. However, about 2/3 of the area was encroached up on for unauthorised crop cultivation because there was a weak coordination between environmental officers, agricultural officers and farmers.

Moreover, banks of Rivers Naura and Themi were invaded and used for unauthorised farming activities. However, the extent had been reduced due fining the culprits, the full success was not attained. The bylaws were enforced by environmental officers without involving the local community. On the other hand, the enforcement of environmental bylaws was considered to be the responsibility of environment officers alone. Agricultural officers seldom involved in activities that amounted to a mere protection of the environment. On the other hand, the farmers considered the environmental bylaws as meant to prohibit them from practicing agriculture without being provided an alternative land for farming.

In Lemala, the ward and the City officials cooperated with officials of Arusha Water Supply and Sewerage Authority (AWSSA) and agreed that farmers in Lemala could use the wastewater for irrigation. It was suggested that wastewater could be used to irrigate the area around the root-zone of banana, passion fruits, citrus, pawpaw and avocado trees whose fruits could not easily be contaminated. However, during the critical shortage of water, farmers used wastewater to irrigate even the consumable parts of vegetable leaves, such Amaranths and Spinach, knowing that no one could notice them. They irrigated the crops using hand-watering cans without having protected equipment. The study revealed that using the wastewater to irrigate edible part of the vegetable could harm the health of vegetable consumers. Owing to that situation, urban agriculture was perceived negatively by certain people.

Discussions: In both Daraja Mbili and Lemala, the provision of agricultural extensions aimed at

transforming farmers archaic methods of farming in order to improve agricultural productivity in crops and livestock. The provision of agricultural extension services was to some extent successful because when the knowledge communicated to farmers was put into practice by farmers, it helped them to address some farming challenges that could hardly be solved in the absence of the knowledge provided. The growing of vegetable in the greenhouses and keeping of the improved breed of dairy cow and growing fodder grass with trees were the results of the agricultural extension services and training of farmers. The use of biogas could have reduced to a greater extent the cutting of trees for charcoal and firewood, but very few farmers have adopted the technology because they were not livestock keepers. Besides, the small size of land did not allow people to keep many livestock to ensure the ample availability of livestock droppings for making the biogas. Livestock manure was also used directly to fertilise the soil. Thus, it minimised the extent such livestock could pollute the environment when managed improperly.

Despite the good intentions of agricultural education and agricultural extension services, they were just provided to farmers without scrutinising whether or not the farmers were in position to implement them effectively. For example, farming through greenhouse was very expensive to be afforded by a single farmer. Yet, farmers were trained about that technology. The assumption of the agriculture officers was that after having the technology, interested farmers could strive to find the money for putting the technology into practice. Recognising urban agriculture as one of the land uses, provision of extension services to farmers must be accompanied with easy access to funds in order to implement agricultural technology that can minimise the adverse effect on the environment (Prasetyo, *et al.*, 2020). As farmers relied on urban agriculture to get the capital for expanding their farming activities, training farmers on how they can access agricultural credit from micro-credit institutions seem to be imperative, but that was not the component of agricultural training offered by agricultural officers to farmers.

Limited access to land for doing urban agriculture was a most challenge to urban farmers, in study areas. However, ensuring land access for urban agriculture was not the responsibility of the agricultural officers. Nevertheless, disregarding it as none of their concern impeded the efficacy of agricultural training and extension services they provided to urban farmers. This implies that the viability of agricultural training also depends on land availability and easy access. Addressing challenges of access to land for

agricultural activities would appear to be a more appropriate task succeeded by provision of agricultural extension services. Farmers who hardly couple with land access hurdles, they opted squatting on the unauthorised public land for growing vegetable with short growing cycle for immediate harvest. Limited access to agricultural land in Daraja Mbili and Lemala did not depict clearly what was reported by Reynolds (2011) that a food system can be sustained in the urban areas through the provision of agricultural training and services to urban farmers when access to land for agricultural use is not a problem. Ideally, the challenges associated with access to land for urban agriculture can be addressed by urban planners; but the urban planners were not directly responsible for promoting food production activities. They were obliged to ensure uncontrolled urban agricultural activities do not disrupt housing and road infrastructure development.

The conservation and the greening environment in urban areas through urban agricultural activities were somehow evident in urban parks, public space and along Themi Living Garden. However, the scope of it was limited in the Daraja Mbili area which has higher population and housing density. Yet, urban farmers cared most about environmental conservation issues such as inter-cropping fodder grass with timber trees and planting trees along the dwelling house only when they were likely to benefit directly or indirectly from them. Otherwise, they did not concentrate much on a mere conservation of the environment because a mere conservation of environment did not address directly the income and food needs of the farmers. The findings of this study is similar the findings of Delgado (2018). A researcher reports that ongoing debate about having conserved environment and urban agricultural-based food in cities cannot succeed when food or environment protection needs are achieved at the expense of another or when there is no clarity in the policy and laws of how agriculture can be done and environment can be conserved by relevant stakeholders. Less productive farmers and whose activities lead to soil erosion along the banks of River Themi and Naura, as well as along the slope of Engra hills had no opportunity to attend a city-wide organised agricultural or environmental training. The exclusion of less active urban farmers in agricultural seminars and training has made some of them to grow crops and keep livestock in the disorganised ways. This contravened to the intention of the agricultural training as specified in Tanzanian Agricultural Policy of 2013. The farmers invaded the environmentally prone areas because there were no immediate alternatives to meet their daily livelihood needs in terms of income and food. It is through similar disregarding of farmers in

training opportunities, the farmers' uncontrolled agricultural activities in Kadoma City have resulted to severe environmental degradation (Makaya & Todzwo, 2019). However, a farmer being trained in a particular aspect of urban agriculture did not guarantee that good agricultural practices could be easily adopted, but it improves his/her reasoning capacity on avoiding agricultural activities which are detrimental to the environment.

The use of wastewater to irrigate the vegetable and other crops can be good or bad depending on the level of toxicity contained in the water and the means such water is irrigated to the crop. In Lemala it was believed by agricultural officers that using wastewater to irrigate non-edible parts of the crop or vegetables could have less impact to the health of consumers. However, there was no mechanism to ensure that wastewater was not used to irrigate the leaves of the vegetable crops consumed by people. Vegetables irrigated by using such water could be hardly identified when brought to urban market places for sale. Thus, people may consume contaminated vegetable unknowingly. Besides, unpleasant odour and engagement in the irrigation process using wastewater without health protective facilities indirectly affect the health of farmers. Wastewater should be treated prior being allowed for irrigation and farmers should be trained on how to safely use untreated wastewater for irrigation (Owusu *et al.*, 2012).

The charging fines to the culprits who violated the environmental bylaws is somehow helpful to minimise the uncontrolled agricultural activities that lead to environmental degradation and pollution, but the approach was not effective. A mere protection of the environment and strict enforcement of bylaws without address farmers' agricultural hurdles was regarded as oppressive to their right to do agriculture in the urban areas because it hindered them to meet food and income from agricultural activities. Nevertheless, weak enforcement of bylaws and infrequent patrolling the area has led some of the public restricted land to be trespassed for urban agricultural activities which were degrading the environment in the river valleys and slope of Engra hills.

Conclusions: Despite agricultural extension services and environmental conservation awareness being provided to farmers, sustainable agricultural practices are not fully attained. The mismatch existed owing to weak coordination among staffs in the department of environment, urban planning and agriculture as well as urban farmers. Environmental bylaws were also enforced in weak coordination between environmental officers and urban farmers at ward level. The

knowledge for enhanced coordinated and integrated agri-environment measures that could ensure agricultural productivity and protection of the environment missed in the findings of this study, but it is very essential for enhancing sustainability of urban agriculture. Developing collaborative strategies to ensure easy access to land for planned agricultural activities is also essential. Workable and participatory strategies for implementing provisions of policy on urban agriculture and environmental conservation must be devised by relevant stakeholders.

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