Adaptation of Excavation Pits for Sustainable Urban Farming and Eco-Supportive Infrastructure in Kaduna State, Nigeria

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Abstract

Urban farming comprises cultivation of staple food crops during the rainy season and dry season production of vegetable. The latter is heavily-depended on sustainable access to irrigation water which is a constraining factor for many intended urban vegetable cultivators. Utilization of water from excavation pits for irrigation activities provides eco-supportive infrastructural base for urban farmers in Zaria which is the focus of this paper. The objectives of the paper were to examine the contribution of the farming activities to income and food security of the farmers and analyse the eco-supportive component of the use of excavation pits. Data were obtained from 10 farmers between December, 2011 and May, 2012 through structured interview and observation. Findings of the study reveal that crops cultivated were tomato, pepper, onions, sweet and Irish potatoes, cabbage, green peas and sugarcane from which the farmers derive food and income. Though the income to farmers vary based on production factors like acreage, types of crops, and use of input, the farmers obtained higher incomes from the farm compared to their primary occupations. The utilization of excavation pits for farming is eco-supportive by regulating the water balance of the microenvironment, the green area serves as carbon sink particularly during the dry season, and it is a low-cost water extraction process compared to sinking boreholes for the same purposes. The constraints observable are related to insecure land tenure, disturbance from straying domestic animals and theft of farm produce. Recommendations include regulation of water extraction to ensure sustainability and deliberate concentration of excavation pits such that larger and deeper pool of water can be available for farming activities.

Key words: Excavation pits; 'Eco-supportive' infrastructure; urban agriculture; food security; Sabon-Gari local government area; Kaduna state.

1. Introduction

Urban centres in developing countries due largely to internal migrations are growing at alarming rates, threatening food sustainability and security in urban space. In rural and urban areas, food security is based on the negotiated utilization of environmental resources and urban dwellers who are poor engage in farming unused urban space to augment food and income. However, due to low level of income of many of these urban farmers many could not afford irrigation necessary input and infrastructure for increase productivity. Consequently, many remained wet-season farmers like their resource-poor rural farmers counterparts.

In Nigerian urban centres, intensive farming activities comprise staple food crops and vegetable production. Cultivating staple food crops takes place mostly the during rainy season while vegetable farming which is commercial-focused is all season but rely seriously on constant and adequate supply of irrigation water. As a result, urban farmers utilize water from perennial water bodies to cultivate vegetables. Examples of such include urban farmers in Ilorin Metropolis that use water from As a river (Yusuf and Abbas, Unpublished). Also in Zaria, farmers use waster of Kubanni River to grow vegetables. Indeed, the most important resource for urban vegetable production is water. In terms of agricultural productivity, infrastructure have five effects such as (i) production (direct and indirect) effects and the stabilization of agricultural production; (ii) income effects; (iii) employment effects; (iv) resource allocation effects and (v) welfare and quality of life effects. These farming infrastructures are relevant to urban farming.

Adopting farming infrastructures provides a framework for situating eco-supportive infrastructure in sustainability of urban agriculture. The term eco-supportive infrastructure is a contrast of ecological, environmental and human supportive infrastructure and was first used in 2011 by Yusuf and Ukoje. According to the authors *'eco-supportive infrastructure are facilities, resources and services that enhance the sustainable actualization of rural (urban) environmentally-depended livelihoods and simultaneously facilitating environmental remediation'* (Yusuf and Ukoje 2011; 12). Eco-supportive infrastructure that could sustain livelihood should satisfy these conditions as highlighted by the authors: flexible to overcome some forms of biophysical and fiscal constraints; accessible to and affordable by the most resource–poor rural (and urban) vulnerable groups (women, landless labourers *etceteras*); based on materials/and intermediate technology available within rural (and urban) environment with minimal external procurement; adapted to the perceptual realities of rural (and urban) dwellers over space ; and, environmentally sustainable within a participatory framework.

Given the preceding section, an example of eco-supportive infrastructure deployed for sustainable urban farming is pool of water collected at excavation pits. Excavation spits abound in urban areas where soil and or gravels have been mined for construction of houses, roads, culverts, and other construction purposes. The relics left by the mined soils/gravels accumulate rain water which usually remain after the rainy season and can be used for farming purposes among low-income, small-scale urban farmers (Figures 1-4). The utilization of these excavated pits contributes to food and income of urban farmers at very low cost yet these, like other aspects of urban agriculture are not adequately investigated. This is the aim of this paper.

Urban agriculture is defined as the practice of farming within the boundaries of towns or cities or the production, processing and distribution of food stuff from crop and animal production (Mougeot,1993; FAO, 2007)). There are two main types of urban cultivation; enclosed cultivation and open-space cultivation. People who cultivate in the enclosed areas around their residences are called enclosed cultivators. The term open-space cultivation is used for cultivation away from the individual's residence. Open-space cultivators are usually of lower socio-economic status including semi-skilled and unskilled workers and/or formally unemployed. However, while most enclosed cultivators get involved in urban agriculture to cultivate vegetables for home consumption; open-space cultivators employ it as a source of livelihood and income. Either way, rain-fed or irrigation system is used. Irrigation infrastructure is the cornerstone of optimum uplifting of the socio-economic welfare of the small-scale urban farmers (Neuppenau, 2002)

It is estimated that about a fifth to a third of families in some cities are engaged in urban farming, with some not having any other source of sustenance or income (Rees, 1997). This development is significantly high in developing nations, where interest in urban farming is increasing due to the prevailing relatively harsh economic conditions. In Maputo about 30 percent of the land is being used for urban farming, while in Dar es Salam urban farming practice provided work for approximately 67 percent of the city's adult population in 1991, thus making it the second largest source of employment in Dar es Salam (Bryld, 2003)

Sustainable agriculture is an offshoot of sustainable development focusing on prudent use of resources that guarantees long period of access and reduced level of environmental despoliation (Yusuf, 2009). The hybridization and utilization of natural and technological resources with minimal environmental consequences and strain on the financial resources of poor farmers is also sustainable agricultural practice. (Etuah-Jackson et al, 2001). According to local ecological conditions and habitat, urban farming can contribute to preserve natural areas despite the increase of the price of land (Borne et al, 2003) to favour intensive production of perishable foods like fruits and vegetables.

The objectives of this paper are to examine utilization of the excavation pits as component of eco-supportive infrastructure for sustainable agriculture, identify the contributions of excavated pits to food security of the farming households, analyze the income obtained by the selected open cultivators using these excavation pits; and, examine the constraints to continuous utilization of these excavation pits as components of 'eco-supportive' infrastructure in urban farming. These objectives are meant to contribute towards policy development for 'eco-supportive' infrastructure and sustainable urban agriculture.

Fig 1. Excavated pits where clay soil was mined

Fig 2. Excavated pits where gravel was mined

Fig 3. Pump machine in the excavated pit

Fig 4. Urban farm sustained by the pits.

2. Study area

The study area is Sabon-Gari local government area (LGA) of Kaduna state. Sabon-Gari LGA is located within longitudes 7^{o} -70^{o} E and latitudes 10^{o} 90' and 11^{o} 30'N. The area falls within the northern Kaduna sub-region. The area has a characteristic tropical continental climate, marked by distinct wet and dry seasons. Generally, Kaduna northern area has a relatively low precipitation with average annual rainfall of about 127mm. the peak period of rainfall is August-September.

The vegetation type is savanna vegetation where trees, shrubs and grasses are scattered over space. The trees have characteristics thick bark and hard leaves to survive the harsh environment. Trees found in the area include baobab, silk cotton and Shea-butter. Shrubs include *Isoberlina doka, Parkia biglobosa* etceteras. According to the 2006 census, the population of the area is 286871 (Federal Republic of Nigeria, 2007) over 65% of which are rural dwellers. Socio-culturally, the indigenous people are Hausa by Language and culture. However, development has led to intermingling of Igbos and Yoruba especially in the urban centres. Islam is the dominating religion with few Christians in the urban areas.

3. Materials and method

Reconnaissance was first conducted to get acquaintance with the farmers, their production activities and processes, farmland size and ownership and the varieties of crops cultivated. After the reconnaissance survey, 10 respondents were considered representational to participate in the study because the farmers engaging in dry season farming were 21 though those engaging in wet season farming in the same location were more. The relatively small sizes of holdings and the similarity in irrigation technique informed the small sample size. Data collection spanned six months from November 2011 to May 2012.

The survey design was intensive and data were collected field three times a week for an average of four hours daily. The data sets were collected from primary sources comprising structured interview and non-participant observation. Techniques of data analysis were descriptive statistics to present findings on volume of production, income and other benefits while qualitative methods were used to discuss findings on problems militating against ecosupportive-based urban food farming.

4. Results and discussion

The data gathered comprises socioeconomic attributes of the respondents, production logic and constraints to farming activities. These are presented in the subsections that follow.

4.1 Socio-economic characteristics of respondents

The age categories of the farmers ranged between 21 to 58years. All of them were Muslims, married with house hold sizes ranging between 3-15 persons and have been farmers since their youth. Only 4 engaged hired labour while others use family labour for several farming activities such as harrowing, planting weeding, chasing away straying domestic animals, irrigation activities and harvesting.

Their primary occupational characteristics vary widely. Only four of them have a stable salary from the formal sector while the others were self-employed in the informal sector. Among the formal sector workers, two worked as security guards, one is a policeman while the fourth is a staff of the local government council secretariat. Based on this there is, disparity in income such that the monthly income of the security guards was <N4000.00 while the other two earned a monthly salary of up to N45, 000.00. Those engaged in the informal sector include 3 traders, 1 motorcycle mechanic, 2 commercial motor cyclists with monthly income varying between N2000.00 to N6000.00. From these socioeconomic variables, many of those in the informal sector when the household dependants were considered were below the poverty line which necessitate engaging in urban farming. All the farmers are sole enterprises while only two operate jointly.

4.2 The Farm: Farm Size and Crop Zoning

The fulcrum of cultivation is the accumulated water in the excavated pits hence farmers converge around the three major pits in the area. Holdings are typically small with a farmer cultivating less than a hectare. Farm holding is a function of factors such as types of crop, financial resources of farmers; number of farmers within space and time, volume of collected water.

Crop zoning does not reflect a clearly defined pattern the partly is because water can reach and point on the farm through connection of pipes regardless of the distance from the pits. Nonetheless, and uses (such as road, church, school) adjacent to the farm constrained expansion to one side of the pits. It is instructive that the same farmland is intensively cultivated for wet season farming. The major wet season crops are maize, rice, beans, groundnut, okro, and millet.

4.3: Farming Activities, harvest and sales

All the farmers worked part time engaging in farming for between 2-5 days in a week. The years of cultivating the area ranged between 2- 8 years. Farming activities include weeding, planting application of chemical fertilizers and insecticides watering and harvesting. All the farmers participate in all these activities at different forms depending on the crops. Planted during the 2011-12 farming season are tomato, pepper, Irish, and sweet potatoes, onions, cabbage and sugar cane carrots; but pepper, and tomato were common to all the farmers.

4.4: The Excavation Pits and irrigation processes

The water that accumulates in the pits is the eco-supportive infrastructure that guarantees farming in the study location. The pits were areas where soils and gravels were mined during the construction of the Zaria-Kano highway. The areas of the pits vary between 200-300 metres square with depths ranging between 35-45 metres. After the 2011 rains, the accumulated water in the pit was at a depth of usually above 30metres but extraction for irrigation activities, block molding and evaporation continuously reduce the volume. The farmers claimed that the accumulated water serves the farmers round the year. Water extraction varies based on types of plant, but water extraction from the pits was daily with an average farmer irrigating his farmland for between 6-8 hours daily. All the farmers own a water pump for irrigation purposes. The schedule of irrigation is presented in table 1.

Table 1: Irrigation schedules of farmers

Crops	No of farmers	Hours per day	Interval of irrigation
Tomato	10	7	4
Pepper (*Tatase*)	10	7	5
Lettuce	2	5	4
Carrot	1	6	5-7
Potatoes	2	4	5-7
Onions	1	4	4
Cabbage	2	7	5-7

Source: Author's field survey, 2012

From the table 1 the crops that require more irrigation time was tomato while the least was onion with 7 hours daily, 4 days interval and 4 hours daily/ 12 days interval. The difference is because the yield and fruiting of vegetables like tomato, pepper, is continuous hence the harvest while that of root crops like onions, carrot and potatoes are single harvest.

4.6: Yield of crops and Income of farmers

Yield cultivated crops vary between farmers and crops. Generally, yield is a function of given the constancy of water supply, size of cultivation regularity of cultural practices like weeding, fertilizer and insecticide application. Record was kept for all the farmers to update their period of harvest. Since different farmers harvest at different times the cumulative harvest, price of harvest hence income vary considerably. From the summary of production logic, that excavation pits contribute significantly meaningfully to livelihood options of the urban farmers.

Table 2: Harvest and Sales of Tomatoes

Period/week	No of baskets	Farm gate price/basket*	Total proceeds*
$1^{st} - 2^{nd}$	12	N700.00	N9,000.00
3^{rd} -5^{th}	21	N 700.00	N14,700.00
6^{th} -8^{th}	36	N600.00	N21,600.00
9^{th} -12^{th}	75	N350.00	N,24,850.00
9^{th}-10^{th}	41	N350.00	N14,350.00
11^{th}-12^{th}	21	N350.00	N7,350.00
Total	**206**	**----------**	**N91,850.00**

Source: Author's field survey, 2012

- ***A US Dollar is exchanged for 162 Naira***

Undoubtedly, utilizing excavation pits for irrigation activities provide cheap source of water for the farmers; an alternative to sinking boreholes for the same purpose which is beyond the financial threshold of the farmers. To sink standard borehole costs between N250, 000.00 and N350.00.00. The harvest for tomatoes and pepper and the income are presented in tables, 2 and 3 and figures 1and 2.

Table 2: Harvest and sales of Pepper

Period/ week	No of sacks	Farm gate price/sack	Total proceeds
1^{st} -2^{nd}	7	N2,500.00	N 17,500.00
4^{th} -5^{th}	9	N2,600.00	N 23,400.00
7^{th}-8^{th}	11	N2,700.00	N 29,700.00
9^{th}-10^{th}	14	N2,8 v750.00	N 38,500.00
11^{th} -13^{th}	16	N2,800.00	N 44,800.00
15^{th} -18^{th}	15	N3,000.00	N 45,000.00
19^{th}-23^{rd}	12	N3,000.00	N 36,000.00
25^{th}	5	N3,000.00	N15,000.00
Total	**89**	**……**	**N 250,000.00**

Source: Author's field survey, 2012

The production analysis was done only for tomato and pepper since they are common to all farmers. The output was N341,850.00 while the input was 112,225.00 resulting in an economic rent of N229,635,00. The contribution to food is also significant as all the farmers used some of their harvest for domestic consumption. Besides, pepper and tomato were sliced and sun-dried for rainy season purposes. The proceeds from the sales of harvest are used to obtain food stuff and other household material needs. Another indirect benefit to the farmers is the spiritual reward they claimed to obtain by giving out harvest as gift to community members, see Table 3.

However the economic rent is not evenly distributed because of differentials in production function defined by size of farm and input used by individual farmers. Nonetheless, all the farmers claimed to make substantial profit relative to their investments. To drive home this contribution, illustration of three farmers is instructive. Two of these are security personnel

Table 3: Summary of benefits derived from farming activities.

Crops	No of farmers	Uses/Benefits
Tomato	10	Sales, consumption and gift
Pepper	10	Sales, consumption ,gift and seedlings
Carrot	1	Sales, consumption and gift
Irish potato	1	Consumption
Sweet potato	1	Sales, consumption and gift
Onions	1	Sales and consumption
Cabbage	2	Sales, consumption and gift
Green peas	1	Consumption and seedlings
Sugar-cane	2	Sales, consumption and gift

Source: Author's field survey, 2012

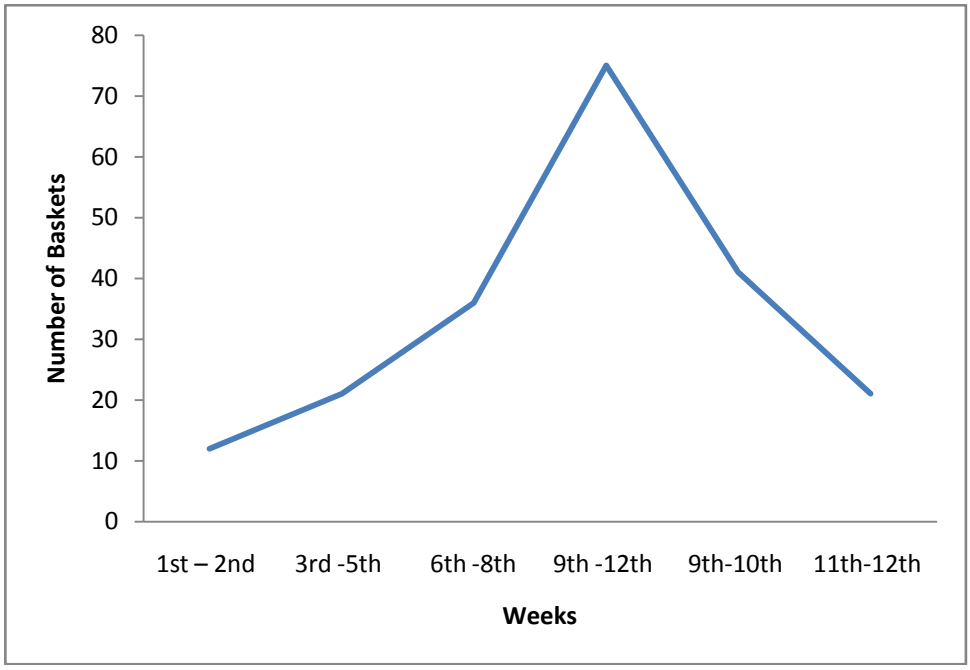

Fig.1: Harvest of Tomatoes

Source: Author's survey, 2012

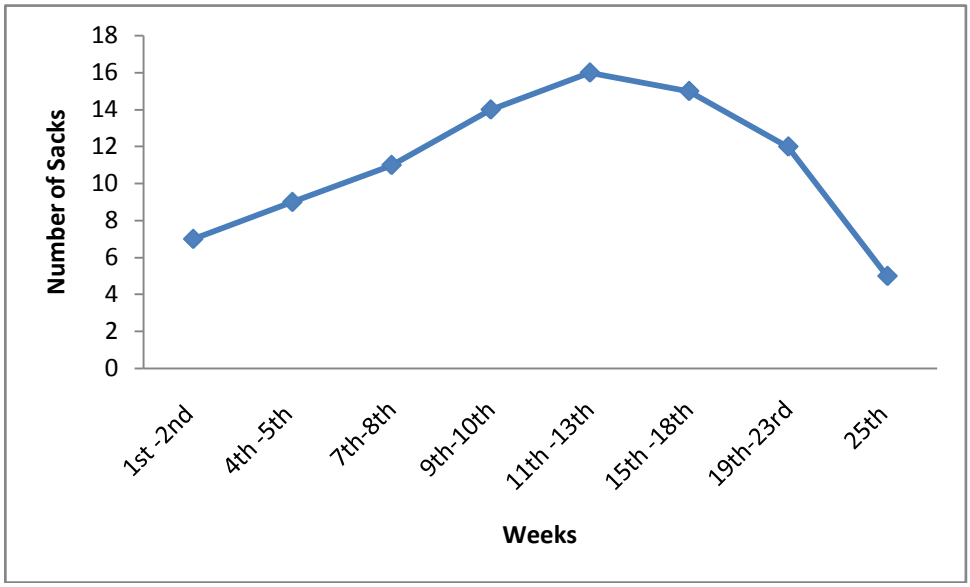

Fig. 2: Harvest of Pepper

Source: Author's field survey 2012

whose monthly salary is N4,000. However their weekly proceeds from the farm was between N7000.00-N8000.00. This means their income from the farm is twice their monthly emolument as security guards. The third farmer is a motorcycle repairer whose income from the farm exceeds his earnings from the artisanal livelihood. In fact N85,000.00 from the 2010-2011 planting season was used to offset a motor cycle debt incurred by one of his children which would have been impossible without the farm. This motorcycle repairer now spent 3-5days on the farm while remaining two days were for the workshop.

In terms of environmental remediation, using the excavation pits preserve the environment by making it green throughout the year and sustaining the flora and fauna in the micro environment. These farmers also cultivate the same area during the rainy season, planting maize, sorghum, groundnut and cowpea which are the staple food crops.

Mixed cropping is adopted by seven of the ten farmers. The system according to the farmers minimizes efforts and maximizes yield. Weeding, irrigation, fertilizer application and insecticide spraying are done at once for the crops. However, cropping ratio is the maximum of 2 vegetable crops to 1 tuber crops to ensure maximum yield and returns. For example a farmer planted carrot alongside pepper at different stages of growth. Carrot was planted first while pepper was planted six weeks after. The same was for Irish potato which was cultivated alongside tomato when the latter was fruiting.

The succession of root and vegetable crops according to the farmers has been a practice that guarantees food security and income sustainability against crop failure. According to them, pepper and tomato were common because of market assurance hence cultivated alongside crops like carrots, potatoes whose level of assurance is less guaranteed because of exogenous factors.

4.7: Challenges in using excavation pits for Urban Vegetable Farming

Like other urban farming activities is open space and under in secured tenure and ownership using water excavation pits for irrigation farming have its challenges. The first one is non adoption of organic and sustainable farming practices by the farmers. Investment in organic soil improver is higher in terms of obtaining manure and transportation to the farm compared to inorganic fertilizers. This might of the long run leads to salinization and pollution of ground water in the area.

Intensive system (the area is also used for wet season cultivation) adopted without organic soil improver and biological pest and weed control might affect the sustainability of the practice. The farmers are free tenant because they cultivate the land without paying rent to the owner (National Islamic Centre) hence cannot invest in sustainable agricultural practices whose benefits are long term.

Besides, disturbance by domestic livestock (goats and sheep) in the vicinity also poses challenges. Farmers employ chasing hands to stone the animals. Related to this is theft of farm produce. Because the area is close to kwangila, a suburb in Sabon gari local government area, people still ripe fruits of tomato and pepper and uproot carrot and potato tubers.

Water availability is presently not a serious problem although the future might be uncertain given the scary prognosis from climate change scientists. It was only in 2008 that the farmers claimed that the water in the pits dried before the onset of 2009 rainy season.

5. Conclusion

Using water form excavation pits support the ecology (flora, fauna and contribute) to income and food of urban farmers. This study has simply demonstrates this in facts and figures. The recommendation is that road and engineering construction activities are part of development processes, these pits where available can be used for farming activities to support human development. It is not out to place, if deliberate excavation of earth material can be done such that the left over pits can conserve water for human use. This is the essence of eco supportive infrastructure; preserving the physical and life supporting environment and sustaining the social and human environment.

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