



Urban Agriculture and Environmental Quality in A Fast-Growing Tropical City of Uyo, Nigeria

by

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Abstract

This study aimed at identifying effect of urban agricultural practices on environment of the study area. Sample size consisted of 192 farmers selected through multi-stage sampling technique from the farmers in the study area. Survey was carried out using participatory approach on farmers with the use of questionnaire. Results were analysed to identify impact of practices on soil quality using farmers' perspectives. Conventionally, impact was identified using conventional agricultural assessment framework. The relationship between farming practices and soil quality was established by correlation analysis. Crop production practices identified by farmers were the use of hormones, pesticides and fertilizer usage, clearing and stubble burning, tillage practices, irrigation and reduced fallow period. From conventional soil analysis, low organic matter content and high acidity are indicators of low fertility. Farmers' perception of impact of farming practices on soil quality correlates well with soil quality analysis. The study recommended the need for farmers' participation in formulation of agricultural policies in order to articulate their opinion. Also, conservation tillage that is adapted to soil type and topography as well as farming policies that include financial reward to farmers that comply with environmental standards is recommended. Framework for assessing ecological status of water resource should inculcate incentives and institutional capacities. Overall, extension service for awareness creation through demonstration should be inculcated.

Keywords: Crop farming, environmental quality, framework, impact, soil quality

1. Introduction:

Uyo is a growing city with high density of structures such as houses, commercial buildings, roads, institutions and multiplicity of urban activities. Agriculture forms part of

the urban activities as practised by urban farmers due to economic downturn. They produce crop and animal products for home consumption and also sell out to support the family. Urban agriculture involves cultivating, processing, distributing food and associated products in and around the city. Farmers adopt a wide range of approaches and techniques most of which are not environmentally friendly. They become suppliers of resources, inputs and services, producers, transporters and processors, retailers and consumers as well as managers. Delgado (2018) observed that the relationship which these farmers thread among and between themselves as well as with resources is diverse. Oftentimes, it is complementary and synergetic, competitive and antagonistic, collaborative or adversarial, equitable or exploitative (Golden *et. al.*, 2018). Most urban farmers are low-income men and women who grow food crops largely for self-consumption on small plots which often they do not own, with little, if any, support for protection (FAO, 2019). The problem of study is that globally, the environment is changing day by day and it has become a challenge to living forms due to the fact that there is no consideration to the environmental quality that the practice is putting to the environment. The business sector has strictly reduced its environmental pollution through a number of measures. The negative environmental impact of urban agriculture has raised concern of the global community over the sustainability of its practices (Golden *et. al.*, 2018; Junge, *et. al.*, 2019). Over the years, Uyo, the capital city of Akwa Ibom State has witnessed increasing trend towards cultivation of urban space. This is done as a support activity to boost income generation and provide food supplement to meet increasing demand for vegetables and other food products (Benites and Vaneph, 2001). Intensive soil cultivation with reduced fallow period is embraced. Tilman *et. al.*, (2002) reported that the activity is accomplished using modern inputs and techniques leading to erosion, depletion of soil fertility and structure with consequent effect on water resource. Bockstaller *et. al.*, (2010) noted that the soil is a dynamic resource and its fertility rests on the capacity to sustain crop productivity, maintain water and air quality as well as support habitation. Assessment of farming practices anchors on the capacity of soil to continually meet farmers' need with no detrimental consequence on ecosystem (Fig.1) (Tilman, *et al.*, 2002). The urban space is intensively cultivated with regular soil tillage and reduced fallow period. Farmers engage in gardening with enormous potential for irrigation (Fig. 2). More and more areas are cultivated yearly with intensive use of pesticides, fertilizers and improved seedlings (Fig. 3 & 4). Gana (2000) observed that use of modern inputs enhances productivity with disregard to sustainability agenda.

2. Objectives of the Study

This paper reviews the linkage between urban agricultural practices and environmental quality in the sustainability agenda.

- (i) to investigate the agricultural practices in the study area;
- (ii) to appraise the negative impact of these practices on the environment;
- (iii) to investigate whether there are other agricultural practices that have little or no negative impacts on the environment and

- (iv) to seek alternative practices that would ensure food supply and also protect quality of the urban environment.

3. The Study Area

This study was carried out in Uyo ($4^{\circ} 55' - 5^{\circ} 07' N$ and $7^{\circ} 47' - 8^{\circ} 04'E$). Temperatures are uniformly high, often between $30^{\circ}C$ ($86^{\circ}F$) and $22^{\circ}C$ ($71.6^{\circ}F$). The soil has restricted clay content hence low water and nutrient holding capacities and is subject to erosion whenever the vegetal cover is removed. Lal, (1981) reported that soils with low clay and organic matter content, especially in the surface horizon, are generally unstable to raindrops.

4. Materials and Methods

The research employed a two-stage methodology: questionnaire survey and literature review. Literature review aimed at identifying lapses from the farming strategies adopted as opposed to conventional practices. The farming population consisted of that recorded by Akwa Ibom Agricultural Development Project (AKADEP), Uyo and is classified into 3 blocks. The blocks were divided into cells, with 8 cells per block. Total cells in the 3 blocks were 24. From each of the 24 cells there were 80 contact farmers making 1,920. A total of 192 farmers (making 10% population) were selected through multi-stage sampling technique. From this study, 192 copies of the questionnaire were distributed to farmers. Of this number, 175 copies were returned, giving 91% response rate for the survey. In this presentation, Tables 1-8 are used to show the distribution surveyed.

5. Findings and Discussion:

In this research, the achievable results are as presented in Tables 1– 8:

Table 1: Distribution of Respondents Based on Method of Land Preparation.

| Assessment of land preparation practices | Frequency | Percentage |
|------------------------------------------|-----------|------------|
| Ridge making | 28 | 15 |
| Mounds making | 48 | 25 |
| Bed making | 45 | 23 |
| Tillage | 59 | 31 |
| Zero tillage | 12 | 6 |
| Total | 192 | 100 |

- i). **Land preparation:** As shown in Table 1, 31% of farmers tilled the land in preparation to planting crops, 25% made mounds while beds making was practised by 23% of the farmers. About 15% engaged in ridge making, only 6% farmers practiced zero tillage in their production practice.

Land preparation components include tillage, ridge, mound and bed making lead to soil structure degradation (Huwe, 2002). This depends largely on soil type, topography, organic matter content, time of tillage and soil moisture level. Poorly structured soils with low percentage of clay and organic matter are more at risk of damage (Bockstaller *et al.*, 2010). Particles are eroded to pollute water resources through sedimentation and contamination. Loss of topsoil gets on the increase every time tillage is performed (Holland, 2004), (Table 1). Research by Tilman, *et al.*, (2002) shows that storm events contribute to increased concentration of suspended sediments in water bodies. Eroded materials from tilled land enhances deposition of sediments in receiving streams and is capable of blocking river beds hence affecting spawning habitat for fishes, light penetration and drift rates (Relyea, *et al.*, 2000). Habitat heterogeneity of keystone species and degradation of aquatic ecosystem are also indicators of sedimentation (Holland, 2004). Apart from the above highlights, heavy metals originating from inorganic fertilizers, pesticides and irrigation water degrade water quality (Nicholson *et al.*, 2003).

ii). Irrigation practice:

Table 2: Distribution of Respondents Based on Irrigation Practices

| Irrigation practice | Positive response | Negative response | Total |
|----------------------------------------|--------------------------|--------------------------|--------------|
| Farmland is irrigated | 116 | 2 | 118 |
| Irrigation water flows back | 108 | 10 | 118 |
| People collect water for domestic use | 102 | 16 | 118 |
| Eroded fertilizer affects aquatic life | 95 | 23 | 118 |

Study further indicates in Table 2 that irrigation practiced extensively in the dry season causes rising ground water and residual inorganic fertilizers. It reduces soil pH to being slightly acidic and could pose a problem of salinity if proper management is not enforced (Dowgert, 2010). Study by Bauder, *et al.*, (2001) revealed that the CEC level of soil can increase which favour high potential for retaining of plant nutrient. Organic matter and organic carbon also increase their levels which serve in indicating the health states or quality of the soil as it contributes to its biological, chemical and physical properties. In a research conducted by Hanson, *et al.*, (1999), it was observed that macronutrients such as Ca^{2+} and Mg^{2+} required by crops become unavailable due to reduced pH and this in turn reduce the fertility of the soil. The chemical additives leach with irrigation water and trace elements collect in water resources causing diseases in living organisms. Excessive irrigation leads to salinity (Sinha, *et al.*, 2009).

iii). Pesticides usage:

Table 3: Distribution of Respondents Based on Pesticide Usage

| Pesticide usage | Frequency | Percentage |
|-----------------|-----------|------------|
| Herbicide | 63 | 33 |
| Fungicide | 40 | 21 |
| Insecticide | 41 | 21 |
| Nematicide | 28 | 15 |
| Others | 20 | 10 |
| Total | 192 | 100 |

The survey in Table 3 shows high percentage use of pesticides. Percentage of farmers using herbicide yearly was 33% while 21% used insecticide, and 21% farmers made use of fungicides. The Table reveals that while 15% farmers used nematicides, others used other forms. Its usage is capable of eliminating harmful insect pests, microorganisms, and other pests causes challenges on human health and natural balance. Bockstaller *et. al.*, (2010) observed that it targets multiple species as destroying, repelling and mitigating agent. In combination, they are used to enhance integrated pest management and act as a comprehensive prophylactic and remedial treatment (Gentz *et. al.*, 2010). But they are associated with different types of toxicities. According to Majewski and Capel, (1995), about 80-99% of the applied pesticides can volatilize within a few days of application. The volatilized pesticides evaporate into the air and subsequently cause harm to non-targeted organisms. Uncontrolled usage of pesticides results in reduction of several terrestrial and aquatic animals and plants. Even the survival of some rare species of bald eagle, peregrine falcon and osprey has been threatened (Helfrich, *et. al.*, 2009). Additionally, air, water and soil bodies are contaminated with these chemicals to toxic level. Among the categories of pesticides, insecticides are considered to be most toxic whereas, fungicides and herbicides are second and third in toxicity. Water soluble pesticides get dissolved in water and enter ground water, streams, rivers and lakes causing harm to untargeted species. On the other hand, fat soluble pesticides entre the bodies of animals by a process known as bioamplification. They get absorbed in the fatty tissues of animals hence resulting in persistence in food chains for extended periods of time (Warsi, 2015). They have drastic effects on non-targeted species and affect animals and plant biodiversity.

iv) Inorganic fertilizer application:

Table 4: Distribution of Respondents Based Fertilizer Application.

| Inorganic fertilizer application (Yrs.) | Frequency | Percentage |
|-----------------------------------------|-----------|------------|
| Once | 24 | 20 |
| Twice | 42 | 35 |
| More than twice | 50 | 42 |
| Not at all | 2 | 3 |
| Total | 118 | 100 |

Most farmers used inorganic fertilizers to boost production as shown in the study. Averagely 42% farmers applied it more than twice yearly while 35% did so twice yearly. Only 20% farmers seemed to apply it once a year. On the average, only 3% farmers did not apply inorganic fertilizers at all. Intensive use of inorganic fertilizer hardens the soil, decreases soil fertility, pollutes air and water as well as release greenhouse gases thereby bringing hazard to human health and environment. There is depletion of essential soil nutrients and minerals that are naturally found in fertile soils. Reducing the rates of its application can reduce pollution without hurting yield (Wang *et. al.*, 2017). Its usage aggravates decline of soil organic matter and accelerates soil acidification. Such property affects the community structure of soil microbes. It influences soil microbial diversity through direct effects on soil nutrient content (Wang *et. al.*, 2017). Long-term application of N fertilizers, in combination with other mineral fertilizers affects nitrogen cycle and related bacterial population. While continuous application reduces soil pH which is closely associated with decreased bacterial diversity, there is significant change in bacterial community composition. Geisseler and Scow (2014) posited that it tended to decrease soil microbial biomass at $pH \leq 5$ and promote accumulation at high pH level, Bell (2015). While specific bacteria in plant rhizosphere benefit plant growth by using available N, P and K_3 , inorganic fertilizers affect the community structure of ammonia-oxidizing bacteria in soil (Chu, *et. al.*, 2007). Overuse of chemical fertilizers lead to secondary salinization, decreased soil fertility and environmental pollution as documented by (Sharma, *et. al.*, 2014).

Apart from the farming practices presented in Tables 1–4, other practices with negative impact includes use of plant hormones, reduced fallow period, land clearing and stubble burning. These practices are further presented and discussed in Tables 5-8.

v) Plant hormones usage:

Table 5: Distribution of Respondents Based on Usage of Plant Hormones

| Usage of plant hormones | Frequency | Percentage |
|-------------------------|-----------|------------|
| Once | 27 | 15 |
| Twice | 48 | 25 |
| Sparingly | 42 | 23 |
| As often as need be | 61 | 31 |
| Not at all | 14 | 6 |
| Total | 192 | 100 |

The Table shows that many urban farmers used hormones. Precisely, 31% of farmers used as often as the need arose. While 25% use twice during farming season, 23% of them used sparingly. However, 15% used once while only 6% did not use it at all. In an attempt to continually supply vegetables, farmers use hormones to improve crop vigour, promote growth and reduce stress on crops. They are used to increase yield especially of leafy vegetables. They stimulate root growth and enhance mobilization and translocation of nutrients within plants. It is widely known to increase stress tolerance, boost early maturity and increase disease resistance in crops (Rappaport, 1980). Nickell, (1982) in his study observed that they affect germination of seed of some plants. In cereals, Morgan

(1979) observed that they prevent lodging. It prevents pre-harvest fruit drop and hasten maturity. Characteristics such as height, seed number as well as fruit ripening are enhanced using hormones. Usage is harmless when appropriate dosage and time are applied but the same could be toxic if used carelessly (Jungk and Rademacher, 1983).

(vi). Reduced fallow period:

Table 6: Distribution of Respondents Based on Fallow Periods

| Fallow period (Yrs.) | Frequency | Percentage |
|----------------------|-----------|------------|
| 0-1 | 120 | 63 |
| 1-2 | 38 | 20 |
| 2-3 | 20 | 10 |
| 3-4 | 12 | 6 |
| 4 and above | 2 | 1 |
| Total | 192 | 100 |

The Table explains that the bulk of farmers (up to 63%) fallowed less than one year. While 20% fallowed for two years, only 10% did so for a period of three years. On the whole, 6% fallowed up to four years while 1% fallowed four years. The implication is that as fallow periods are reduced, fields are rarely set aside to recover (Robinson and Southerland, 2002). Holland (2004), observed that short fallow period introduces disaggregation of soil structure and disruption of functions of soil organisms. Such adverse effect on soil structure coupled with loss of nutrients have encouraged farmers rely on improved crop varieties with extensive use of agrochemicals to fertilize soil, control weeds and pests. The effect of short fallow periods are well documented and globally recognised as undesirable (Hunt *et al.*, 2006). Nutrients concentration not taken up by crops is washed into water bodies where they cause eutrophication. Much of the excessive soil nutrients can be attributed to intensive pesticide and fertilizer application and it has been estimated that 61% of nitrates and 40% of phosphates in waters are derived from agricultural inputs as a result of leaching and erosion (ADAS, 2007). Water pollution may occur from point source as nutrients may reach to adjacent water bodies through overland and sub-surface flows (Hart *et al.*, 2004). Reduced fallow period provides for no soil nutrient replenishment by nitrogen fixation. Assessment of soil quality indicators (organic carbon, enzymatic activities, microbial biomass function and bacterial diversity, electrical conductivity) are negatively impacted by reduced fallowing (Patman, 2015).

(v) Land clearing:

Table 7: Distribution of Respondents Based on Effect of Land Clearing

| Land clearing technique | Frequency | Percentage |
|-------------------------|-----------|------------|
| Ploughing in | 14 | 7 |
| Packing | 53 | 28 |
| Burning | 125 | 65 |
| Total | 192 | 100 |

Several techniques are adopted to clear the land. The Table reveals that 65% farmers burn while 28% pack the trash. However, 7% plough in same as manure. ADAS

(2007) observed that as this practice take place, it induces erosion and surface runoff of polluted water gets to its peak at rainfall when there is little crop cover to take up mobilised nutrients. Erosion is accelerated when soil is left exposed to wind and/or water (Adeyolanu and Ogunkunle, 2017) and eroded materials are deposited in water bodies downstream. Holland (2004), reported that increased phosphates and nitrates in water bodies through inorganic fertilizers application can cause algal bloom and excessive growth of aquatic macrophytes in flesh water. Substantial nutrient input can lead to increased bacterial decomposition of dead organic matter, which in turn, declines oxygen concentration.

vi). Stubble removal:

Table 8: Distribution of Respondents Based on Stubble Removal

| Stubble removal | Frequency | Percentage |
|-----------------|-----------|------------|
| Burning | 150 | 78 |
| Burying | 20 | 10 |
| Packing | 22 | 11 |
| Total | 192 | 100 |

Soon after harvesting of crops, farmers burn the stubble to prepare land for seed sowing. The Table indicates that 78% of farmers burn the stubble while 11% packed to one place, often times the boundary. However, 10% practiced burying. But it is clear that stubble burning cause very important environmental problems. From wind and water erosion, product losses to break in natural vegetation, the topsoil loses its vitality. In addition to destruction of soil organisms which are of value in decomposition, it generates carbon (IV) oxide. Soil organic matter which plays key roles in determining soil nutrient status, water holding capacity and susceptibility of soil to degradation is lost (Giller and Cadish, 1997; Shingirai, 2014)). Negassa (2001), Solomon *et. al.*, (2002) and Toriro, (2009) studies revealed that burning significantly influence water holding capacity. It destroys organic matter which serves as a sink of atmospheric CO₂. Increased soil carbon content is indicated by higher microbial biomass and elevated respiration (Sparling *et. al.*, 2003). Chen *et. al.*, (1998) had posited that its presence in the soil affects topsoil bulk density. Stubble burning deprives soil of organic matter and impairs soil structure by reducing aggregate stability, microbial biomass and activity (Neves *et. al.*, 2003).

4. Conclusion and Recommendations

Agricultural practices can either sustain or degrade the environment, (Nyasha; Makaye, 2015). Negative effects centre on degradation of soil quality, surface water and aquifers. Practice minimum tillage or zero tillage where land is cleared and packed without ploughing. Conservation tillage which includes such techniques as direct sowing, minimum tillage, none or surface incorporation of crop residues, and establishment of cover crops is recommended. Establishment of cover crops on fallow areas will reduce water and sediment run off as well as improves organic matter content of soil thus preventing degradation (Tomer *et. al.*, 2005). Evaporation will be minimised as plant residues preserve moisture. There will also be reduced proliferation of weeds, crop

diseases and pests under fallows, thus reducing need for application of pesticides. Tillage across the slope should be adopted to reduce runoff and increase water percolation. Ploughing should be followed immediately by planting so as to reduce exposure of soil surface to action of rain. On sloppy lands, contour and strip farming should be adopted to retard the flow of water thus reduce soil erosion. This will allow more water to be absorbed into the soil. Rather than intensive cultivation, crop rotation is recommended. This reduces impact of weeds, insects and pests, hence providing alternative source of nutrients. It also reduces soil erosion and water contamination through agrochemicals.

The use of chemical fertilizers by urban farmers should be discouraged. Instead, they should be encouraged on permaculture which integrates water, energy and wastes so as to avoid the use of synthetic fertilizers, thus encouraging sustainability. Organic manuring and increased fallow periods are also recommended to regenerate soil fertility. Regarding pesticides application, the use of synthetic product like polyester to control weeds and pest is recommended. Integrated approach, involving simultaneous application of one or a combination of mechanical, physical, cultural and biological control is also recommended. Also, agricultural policies where farmers are financially rewarded based on compliance with environmental standard as well as extensive sensitization on international environmental agreement such as Convention on Biological Diversity of 1993 and Kyoto Protocol of 1997 should be intensified for sustainable farming. Extension workers should be actively involved in restoring derelict land based on resources available for amelioration. Their duty should centre on sensitization and awareness creation among farmers regarding sustainability through demonstrations.

Cooperation and control rather than opposition and restriction can maximize the benefits of urban agriculture while minimizing its environmental challenges. Above all, aggressive and sustained public sensitization programmes on the negative impact associated with harmful agricultural practices should be carried out by Agricultural Extension Agents in order to keep farmers abreast of alternative opportunities.

Urban agriculture should be guided by policies that integrate political commitment, incentives and build educational and institutional capacities to promote sustainable practices. Mainstreaming environmental sustainability into urban agriculture should embrace reform of trade policies, markets, taxation, subsidies and economic incentives.

From this study, it seen that agricultural production takes place under intensive land use characterised by shortened fallow period. No rotation is practiced and without legumes. The practice deprives soil opportunity of nutrient replenishment by natural process of nitrogen fixation. The findings reveal that clearing of land has led to high soil temperatures, erosion of particles and silting of water resources in the area. Stubble burning destroys soil fauna and flora and leads to loss of nutrient elements through evaporation and volatilization. While intensive cultivation has destroyed soil structure, fertilizer accumulation has caused soil acidity, toxicity and reduced nutrient uptake. There is reduced yield and quality of produce every year. Agricultural extension service within the area is inadequate. Farmers' sensitization on environmentally friendly techniques

through demonstration should be intensified. Effort toward implementing the recommendations will effectively protect the urban environment from degradation.

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