An analysis of the profitability and choice of metropolitan waste-use in urban agriculture of the Federal Capital Territory, Abuja, Nigeria

Analýza rentability a možností využití komunálního odpadu v městském zemědělství na území hlavního města Abuja, Federal Capital Territory, v Nigérii

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Abstract: The study attempts to analyse the profitability of urban agriculture using metropolitan organic waste in Abuja, the Federal Capital Territory of Nigeria. The results show that the enterprise is profitable, and that output price is the most important determinant of the maximum variable profit. Other price factors, specifically planting materials, labour, and metropolitan waste (organic manure), account for less. Further analysis shows that level of education, age of farmers, per capita farm income, and household size are important determinants of choice of urban agriculture for food security and improvement of environmental quality. The chances of farmers willing to pay for urban agriculture will increase when their level of education and per capita income increase, while the chances of not willing to pay for such venture will increase when their ages and household size increase. The creation of more market outlets for urban produced foods is recommended, among others.

Key words: profitability, metropolitan waste-use, urban agriculture, Nigeria

Abstrakt: Studie se zaměřuje na analýzu rentability využití organického komunálního odpadu v městském zemědělství v hlavním městě Abuja, Federal Capital Territory, v Nigérii. Výsledky studie ukazují, že takový podnik je rentabilní a že hlavním prvkem determinujícím maximální variabilní zisk je cena outputu, tedy výsledného produktu. Ostatní cenové faktory, jako je zejména osivo a sadba, práce a cena městského komunálního odpadu (organické hnojivo), mají menší význam. Další analýza ukazuje, že úroveň vzdělání, věk farmářů, příjem na osobu a velikost domácnosti jsou významné determinanty pro rozhodování o provozování městského zemědělství z hlediska potravinové bezpečnosti a životního prostředí. Ochota zemědělců investovat do městského zemědělství se zvyšuje s růstem jejich úrovně vzdělání a příjmu na osobu, zatímco neochota k tomuto typu podnikání roste se zvyšujícím se věkem a velikostí domácnosti. Doporučuje se mj. vytváření většího počtu tržních příležitostí pro tento typ produkce.

Klíčová slova: rentabilita, využití městského komunálního odpadu, městské zemědělství, Nigérie

Today's cities operate on a throughput model, in which resources are imported and wastes are exported. Urban agriculture can help to close the loop between inputs and outputs by converting what are traditionally viewed as waste products into food and fuel, thus lowering the size of the city's ecological footprint. For example, sewage sludge from treatment plants can be added to other organic by-products such as leaf litter, garden trimmings, and food scraps. When composted, this mixture yields rich mulch which can be used as fertilizer to nurture the growth of quality organic edibles in urban gardens (Laurence 1996). The convergence of producers and consumers which occurs with localized food production also reduces the need for intakes from the larger resource stream, lowers the amount of pollution generated by long distance transportation, and conserves energy normally lost to the system. This is achieved when the processing, packaging, transporting, and storing activities of the traditional agricultural model are bypassed for the growing and harvesting of produce in a single location by a few individuals (Nugent 1997).

The urban agriculture referred to in this study is defined as an industry that produces food and fuel, largely in response to the daily demand of consumers within a town, city or metropolis, on land and water disposal throughout the urban and peri-urban areas, applying intensive production methods, using and re-using natural resources and metropolitan wastes, to yield a diversity of crops and livestock.

Urban agriculture is presented as a large and growing industry that uses urban waste water and urban solid waste as inputs which close ecological loops when processed on idle land and water bodies (Smith, Nasr 1992). The positive impact of this neglected industry include: (a) improved nutrition and health (b) improved environment for living, (c) increased entrepreneurship (d) improved household food security of the urban poor (e) reduced food insecurity as it increases access to food, especially fresh nutrient-rich foods, among population suffering from food insecurity (the poor, temporarily or permanently vulnerable). They do this through their own self-provisioning that directly provides food, or by using what they grow to reduce market expenditure or to increase income. As the urban poor are found to be spending 60–80% of their income on food, any of these actions can have a major impact on household well-being, and (f) available evidence suggests that urban agriculture enhances quantities of food for the urban farmer and other low-income families and supplements income for the urban farmer.

Urban agriculture takes place in all regions of the world, but is most prevalent in Asia (Smith et al. 1996). Usually vegetables and fruits are grown on land unsuited for building purposes and on undeveloped public and private lands (IDRC 1993). In addition, intensive livestock production systems for milk, meat, and poultry or egg production are operational around and within city limits, with a trend to zero grazing. In Kenya and Tanzania, two out of three urban families are engaged in farming (Mara, Caincross 1989). In Taiwan, over half of all urban families are members of farming associations. Large Chinese cities produce 90 percent and more of their vegetable requirement within their urban regions. In the United States, for instance, 70 percent of fruit, vegetables and ornamental plants are grown on urban land (Rabinovith, Schmetzer 1997).

The benefits of urban agriculture extend beyond better nutrition, poverty reduction and jobs for the poor. Agricultural methods make the most out of scarce land, water and other natural resources, and often make use of wastes and industrial by-products as well. From the environmental and economic point of view, waste reduction is interesting. Finally, reducing environmental pollution in towns contributes to poverty alleviation because the urban poor are mostly exposed to, and constrained by bad environmental conditions (Songspore, McGranahan 1993). The metropolitan waste being referred to in this work is the organic aspect of the metropolitan waste that the farmers have sorted into an exclusively organic fraction for utilization in the farm.

Large cities have been perceived as mushrooming out of control and representing a major problem for humankind. If urbanization is indeed out of control, then the emergence of a new generation of very large cities may undermine any progress towards sustainable development. The challenge of supplying nutritionally adequate and safe food to city dwellers is substantial. Accomplishing this task under conditions of growth and congestion demands that policy-makers seize opportunities for integrating resource management and planning efforts, understanding potential linkages between rural and urban areas, and anticipating the changing needs of a country's citizens in both rural and urban settings. The need to address issues associated with urban agriculture is a pressing one, as urban populations in both developed and developing countries continue to increase.

An important visible manifestation of the increasing ecological problems in African cities relates to the problem of collection and disposition of solid wastes. Domestic sewage is released untreated or only partially treated into the waterways in many countries. A 1986/87 survey of 660 households in Dar-es-salaam (Tanzania) revealed that only 15 percent of the dirty water and sewage was being regularly disposed of while the municipal sewage system in Khartoum (Sudan) served about 5 percent of the city. Another survey found that about one-sixth of the human solid wastes is dumped outside proper toilet facilities (United Nations Centre for Human Settlement 1989).

While the growing cities are likely to get the water that they need, whatever the cost, they face the world-wide serious problems in disposing the wastewater. The wastewater contains a variety of pollutants of biological origin depending on the level of industrial development, and chemical pollution control. In such circumstances part, more often, all of these pollutants find their way into the nearest water body, be it a river, canal, lake or the ocean. As a result, a number of the rivers, lakes and aquifers in these countries are being severely contaminated. Many studies have detected bacteriological contamination of water resources, which contribute to the high morbidity and mortality rates, especially among infants through diarrhea and other gastro-intestinal infections. Urban agriculture is viewed as a veritable option to the disposal of these natural wastes, as it can convert urban wastes into resources, put vacant and under-utilized areas into productive use, and conserve natural resources outside the cities while improving the environment for urban living (Mbata 2005).

In Nigeria, prior to the implementation of the economic reform measures in 1986, the immense urban boom in the early 1980s attracted people into cities and towns to seek employment in more buoyant sectors than agriculture. But the implementation of reforms has affected the socio-economic and ecological environment of the cities and towns. For instance, following the mass retrenchment of workers in both the public and private sectors in a bid to restructure these sectors of the economy, and with the government's reluctance to increase wages and salaries to match the inflationary trend, poverty became the hallmark of the urban dwellers, and the stage was set for all to go back to land in order to survive. To avoid being crushed by the depressed economy, almost all family units in most Nigeria urban areas were compelled to become "emergency" farmers cultivating every piece of idle and vacant land within and at the periphery of the metropolis. As a result of this conversion, the cultivable area of land available to these farmers has reduced drastically resulting to over-exploitation of land resources by the "emergency" farmers who are strangers to soil conservation techniques (Arene 1995). From all indications, this exploitation will surely attain a suicidal proportion if appropriate measures are not taken to "renew" the soil. The core of this research focuses on the resource aspect of urban agriculture. The relationship between urban agriculture and resources can be described as being three pronged. First, some urban by-products, such as waste water and organic solid waste, can be recycled and transformed into resources or opportunities for growing agricultural products within urban and perio-urban areas. Second, some areas of cities such as idle lands and bodies of water can be converted to intensive agricultural production. Third, some natural resources, such as energy for cooking, can be conserved through urban agriculture.

At present, there is no information on the commercial potentials of urban agriculture in the Federal Capital Territory. The closest attempt to this study is the work of Ughenu (2001), which addressed urban farming in Onitsha but did not estimate the economic implication of metropolitan waste-use in a bid to evaluate the profitability and sustainability of urban agriculture in the area. This study, therefore, attempts to fill the gap.

RESEACH METHODOLOGY

The study area

The Federal Capital Territory (FCT), Abuja, is the study area. The territory is located within the savanna zone, occupies an area of 800 000 hectares out of which 274 000 hectares are available for agricultural activities, 270 000 hectares under forest reserves, and 250 000 hectares earmarked for the Federal Capital Cities developments, and the remaining 6 000 hectares account for rocks, hills and rivers (FCT ADP 1992).

The territory has an estimated population figure of about 5 million inhabitants. The growth rate of the territory's population has been increasing at a fast rate since the scat of government was shifted to Abuja in 1990. There are over 70 000 regular farming families in the FCT (FCT Agricultural Development Programme Village Listing Survey 1998).

The territory was carved out of the middle belt states of the then Niger, Kwara and Plateau states. It is situated in the heart of the nation lying within latitudes 7°25' and 9°20' North and longitudes 6°45' and 7°39' East.

The territory was chosen because the growth rate of the city population has been increasing at a fast rate and commercialization activities have been on the increase placing the environment under stress with the attendant growth in variety of by-products of urban life such as liquid and solid wastes and their limits to disposal.

Simply put, the city is currently having increasing difficulty dealing with the problems of liquid and solid wastes; hence some farmers make use of these wastes for urban agriculture.

Sampling procedure

The FCT has 6 area councils, namely: Abaji, Kwali, Kuje, Gwagwalada, Bwari, and Municipal. The FCT is divided into two agricultural zones – the Eastern zone and the Western zone. The Eastern zone comprises the Municipal, Bwari, and Kuje area councils; while the Western zone comprises Gwagwalada, Kwali and

Abaji area councils. The population of this study consists of all farmers using metropolitan waste in the area. 50 farmers were randomly drawn from each agricultural zone, making a total of 100 farmers.

Data collection

Data for the study were collected from both primary and secondary sources. Primary sources of data collection, which were cross-sectional, comprise the use of structured questionnaire items which were administered to farmers. The primary data collection was conducted in three parts.

Part A involved a broad characterization of the physical, social and economic environment of urban agriculture. Farmers were interviewed using both structured questionnaire and memory recall approaches, the objectives being to ascertain common practices on crop mixtures, crop rotation systems, land tenure systems, crop processing and marketing. Part B dealt with farm level details on farm use history, location, farm size, crops grown, use of purchased and non-purchased inputs, other cultural practices, and labour utilization for different farming operations. Part C was concerned with the household level information on household size and composition, income, labour supply, and other non-farm aspects of household activities that may affect urban agricultural practices.

Secondary sources of data collection were from the Federal Ministry of Agriculture and Rural Development, the Ministry for Federal Capital Territory, the Federal Capital Territory Agricultural Development Programme Office, the National Population Commission, and the Urban Planning Office of the study area. The data collected were helpful in analyzing the results.

Data analysis

Gross margin, profit function, and logit regression analytical techniques were employed to analyse the data and achieve the objectives.

The gross margin represents the contribution made by individual farm enterprises to the overhead cost. It also shows the gains or losses that can be expected if the enterprise increased or reduced in size (Sturrock 1982).

The average prevailing market prices of the various crops were used to derive the relevant monetary values of output, whereas the average prevailing prices of inputs were used to derive the relevant monetary values of inputs.

The gross margin formula is given as:

$$GM = TR - TVC$$

Where:
GM = gross margin (₦)
TVC = total variable cost (₦)
TR =.total revenue (₦)

The gross margin is estimated for a single unit of each enterprise and is the difference between total income and total variable costs.

Profit function analysis was employed to estimate the profitability levels of individual resource inputs on crop production enterprises. These inputs include variable and fixed capital (planting material, organic manure (metropolitan waste), labour, matchet, and wheelbarrow). The profit function was used because of its importance in diagnostic analysis reflecting marginal resource profitability at mean levels of input price (Arene, 2002).

The profit function model is specified as follows:

$$\pi^* = \pi^* (Py, P_1, P_2, P_3, Z_1, Z_2)$$

Where:
π^* = amount of maximum variable profit (₦)
Py = price of output (₦)
P_1 = per unit price of planting material (₦)
P_2 = per unit price of metropolitan waste (organic ma nure) (₦)
P_3 = per unit price of labour (₦)
Z_1 = value of farmland (₦)
Z_2 = value of matchets/wheelbarrows (₦)

Note: Z_1 and Z_2 are fixed cost items, and are therefore, not included in the analysis since the analysis is based on the short-run effect of input prices.

Logit regression procedure was used to determine the effect of socio-economic characteristics of the farmers on their choice of or willingness to pay for metropolitan waste-use in urban agriculture and improved environmental quality. The parameters of the model were estimated with the maximum likelihood estimation technique. A binary response model "willing to pay" and "not willing to pay" was specified and estimated logistically. The logit specification is suited to models where the dependent variable is dichotomous, which in this case are the farmers who are willing to pay and those not willing to pay. Willingness-To-Pay was measured using a bid value of zero or one, where one represents Willing-To-Pay, and zero otherwise. The logit specification then provides a model of observing the probability of a farmer choosing or being willing to pay for metropolitan waste-use in urban agriculture and improved environmental quality. The logit model is specified explicitly as follows:

$$Yi = \beta_0 + \beta_i X\beta_i + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + c$$

Where:
Yi = willingness to pay (1 if willing, 0 otherwise)
X_1 = level of education (in years)
X_2 = age (in years)
X_3 = per capita household income (₦/per annum)
X_4 = household size (Number of dependants)
β_I = unknown parameters to be estimated
e = error term

RESULTS AND DISCUSSION

Gross Margin Analysis Result: This analysis evaluates the gross profitability of a given enterprise. It is useful where the value of the fixed costs is negligible as it is the case with urban agriculture which is operated at small scale level. The revenue items include yam, maize and okro, while the variable cost items include labour, metropolitan waste (organic manure), yam seedlings, maize seeds, and okro seeds (Table 1).

Profit Function Analysis Result: Profit function reveals and diagnoses the price factors that make for profit. The result of the profit function analysis is presented in Table 2.

Table 1. Gross margin estimates

Items	Qty/ha	Price/unit (₦)*	Revenue/variable cost (₦)*
Revenue			
Yam	1 144 tubers	120	137 280.00
Maize	1 104.6 kg	100	110 460.00
Okro	1 998.5 kg	20	39 970.00
Total revenue (TR)			287 710.00
Costs			
Labour	21	1 000	21 000.00
Organic manure (metropolitan waste)	438 kg	200	87 600.00
Yam seedlings	647 tubers	60	38 820.00
Maize seeds	20.5 kg	100	2 050.20
Okro seeds	4.97 kg	160	795.20
Total variable costs (TVC)			150 265.20

GM = TR – TVL = ₦ 287 710.00 – ₦ 150 265.20 = ₦ 137 444.80
The gross margin result of ₦ 137 444.80 implies that urban agriculture is profitable in the area.
*(₦) 140 = 1 US Dollar ($)

Note: Output was computed without adjustment for home consumption.
Livestock was not included because metropolitan wastes are not direct inputs to their production.

Table 2. Profit function estimation

Parameters	Coefficient	Standard errors	*t*-values
Price of output	1.020	0.080	12.75**
Price of planting materials	9.233E-03	0.039	0.024
Prince of labour	–7.526E-02	0.040	0.188
Price of metropolitan waste (Organic Manure)	–3.715E-03	0.048	0.0077
Intercept	–1.3971-02	0.479	0.00029
R^2	0.737		
F-statistic	66.637*		

Source: Calculations from the Field Survey Data, 2005

*significant at 10% level of probability; **significant at 5% level of probability

The result shows that the overall model is statistically significant implying that the variable price items contribute significantly to profit.

Also, the combined effects of the variable price items in the function explained about 74 percent of the variation in maximum variable profit. The *t*-statistic shows that the price parameters for planting materials, labour and metropolitan waste have no significant effect on profit, while the output price parameter accounts for more. This implies that high output price enhances farmers income and profit. The result also shows that the farmers are profiteering in the rational area of profit function, using all the variable price items.

Logistic Regression Result: Binary logistic regression procedure was used to estimate the effects of socio-economic variables of the farmers on their choice of or Willingness-To-Pay for metropolitan waste-use in urban agriculture and improved environmental quality. The result is shown in Table 3.

Education level, per capita income and household size were found to significantly affect the choice of or Willingness-To-Pay for metropolitan waste-use in urban agriculture and improved environmental quality. Education level has positive relationship with choice of or Willingness-To-Pay for urban agriculture with its consequent improvement on environmental quality. This means that the more educated the farmers are, the higher is the probability of their Willingness-To-Pay for a better environment by adopting metropolitan waste as a resource input in urban agriculture. Farmers who had higher education indicated greater Willingness-To-Pay and this was because they recognized the importance of cleaner environment to health and productivity.

Per capita income has a positive relationship with Willingness-To-Pay for or choice of metropolitan waste-use in urban agriculture and improved environmental quality. This implies that the higher the farmers' income, the higher is their probability of Willingness-To-Pay for metropolitan waste-use and good environment. This makes some sense because, with increased income, farmers can afford to pay for a venture that can improve their living and working conditions.

Household size was found to be inversely related to Willingness-To-Pay for urban agriculture and improved environmental quality. This means that the probability of their Willingness-To-Pay decreases as household size increases. As consumption needs increase, household income reduces, thereby, leaving little or no disposable income for other expenses. Environmental degradation has been known to be associated with poverty (Salau 1992).

The co-efficient of determination, R^2, was found to be 77 per cent implying that the variation in Willingness-To-Pay is due to the stated socio-economic characteristics of the farms. The mean Willingness-To-Pay was about ₦ 9 967, implying that the farmers attach value to metropolitan waste management as this improves environmental quality, increases urban food production and income. The result further showed that the overall logistic model was significant based on the chi-square, thus, implying that the socio-economic variables are significant determinants of choice or Willingness-To-Pay for metropolitan waste-use to increase urban food production and improved environmental quality.

CONCLUSIONS AND RECOMMENDATIONS FOR POLICY

Closing the nutrient loop is one of the main objectives of a more ecological approach to environmental

Table 3. Logistic result for the determinants of Willingness-To-Pay

Explanatory variables	Coefficient	Standard errors	*t*-values
Education level (X_1)	1.860	0.558	3.333**
Age of farmers (X_2)	–0.061	0.500	0.122**
Per capita farm income (X_3)	0.050	0.010	5.000**
Household size (X_4)	–0.171	0.096	1.781*
Intercept	0.251		
–2 log likelihood ratio	52.822		
Chi-square	85.447*		
R^2	0.77		

Source: Calculations from the Field Survey Data, 2005

*significant at 10% level of probability; **significant at 5% level of probability sanitation. Re-use of waste water and organic waste in urban agriculture may contribute to closing this nutrient loop. In addition to food security and income generation, urban agricultural activities can help to improve public waste resource management, and uplift the savings and employment potentials of marginal and low-income urban dwellers.

Based on the results of the study, the following recommendations are made:

(1) More market outlets for urban produced foods should be created since urban agriculture has been shown to be profitable as revealed by the gross margin and profit function analyses.

(2) Since urban agriculture is low in capital-use and high in labour-use, and thus well suited to low-income urban families, family labour-use should be encouraged to reduce the cost of hired-labour, and enhance profit and income.

(3) Since education was found to be positively related to Willingness-To-Pay for improved environmental quality and choice of urban agriculture, training in metropolitan waste management for urban farmers should be mounted by the Federal Capital Territory Agricultural Development Programme on regular basis to enhance efficient utilization of the organic waste component.

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