RESOURCE PRODUCTIVITY AND FARM INCOME IN FADAMA LAND CULTIVATION IN SOKOTO STATE: A CASE STUDY

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ABSTRACT

Using crop yield, profitability and resource use efficiency as yard sticks, this paper examines the productivity level of fadama land in Sokoto State. A field survey conducted in the Kandoli Shela fadama in Dundaye District of Sokoto State revealed that most farmers obtained profits from fadama land cultivation although crop yields were generally low. In addition, most resources were inefficiently utilised, which suggests that higher yields and profits could be obtained through reallocation of resources.

INTRODUCTION

In the semi-arid agroclimate of north-western Nigeria, upland cultivation is restricted to the short rainy season because of inadequacy of soil moisture. This usually results in under-utilization of most agricultural resources. To circumvent this problem, some farmers engage in fadama land cultivation as a means of earning some income during the dry season.

Fadama is a Hausa word which refers to low-lying relatively flat areas either in streamless depressions or adjacent to seasonally or perennially-flowing streams or rivers (Kolawole and Scoones, 1994). Striking features of the fadama land are its relatively high moisture retention within the rhizosphere, and fertility. Due to these characteristics, the fadama is cultivable throughout the year. This identifies it as a critical resource in the vast drylands of not only Sokoto State, but also of others within the semi-arid northern Nigeria.

The problem in Sokoto State is that the fadama lands are small, relative to the total land area. For example, Singh (1997) has observed that the fadama lands constitute only about 11% of the total cultivable land area in the erstwhile Sokoto State. This implies that efforts to increase agricultural production on fadama lands may have to concentrate more on increasing their productivity rather than on extensification of production *per se*. It is, therefore, important to examine the extent of resource productivities in the fadama and determine whether opportunities exist for increasing them. Using the Kandoli Shela fadama in Dundaye District of Sokoto State as a case study, this paper examines resource use, crop yield, farm income, and resource use efficiency in fadama land cultivation.

MATERIALS AND METHODS

The Study Area

The area of study was the Kandoli Shela fadama in Dundaye District, Wamakko Local Government Area, Sokoto State. The fadama is along the flood plains of Kandoli Shela stream and it is cultivated by small-scale farmers who irrigate small plots using traditional water lifting devices such as calabash, bucket and shadouf. With the cultivation of surrounding upland restricted to the short rainy season (about three months per year), the Kandoli Shela fadama is the "life-line" of the several communities in Dundaye District which depend on it. The fadama is cultivated all-year-round for the production of vegetable crops (including pepper, tomato, onion, garlic, sweet potato and egg plant), sugar cane, as well as fruits.

The Kandoli Shela stream cuts across various scattered settlements in Dundaye District and flows north-south across the Usmanu Danfodiyo University Permanent Site, although it changes course due east near the University Library Annex before resuming its southerly course. It eventually drains into the River Rima near Kwalkwalawa. An earlier study in the area by Singh *et al.* (1996) revealed that the soils of

Kandoli Shela valley are predominantly sand to sandy loam, with slightly acidic to alkaline (6.1-8.2) pH. They found that the surface soils contained an average organic carbon of 0.44% and had a C.E.C. of 15.66 mmol/100g. Their study and others in Dundaye District (Singh and Babaji 1989, 1990), suggest that the fadama soils are texturally finer and nutritionally richer than the adjacent upland ones.

Sampling and Data Collection

From the sampling frame prepared on the basis of a preliminary survey conducted to identify fadama farmers in the area, a random sample of 40 farmers was drawn. Data using questionnaires from the selected farmers were collected on a weekly basis between December, 1995 and September, 1996. The collected data were mostly demographic and those related to inputs and outputs, as well as their prices.

Data Analysis

The data were analysed using descriptive statistics, farm budgeting and a production function model. Descriptive statistics were used to describe resource use and crop yield while farm budgeting was used to analyse farm incomes. The marginal productivities of the various inputs used in fadama farming were determined by estimating a production function using multiple regression. The production function estimated was of the general form:

$$Y = f(X_1, X_2, X_3, X_4) \quad \text{.................................} \quad (1)$$

where: Y = Crop yield (kg/ha)
X_1 = Fertilizer input (kg/ha)
X_2 = Labour input for all operations except watering (man-hours/ha)
X_3 = Seed input (kg/ha), and
X_4 = Labour input for watering (man-hours/ha)

Equation (1) was estimated in the linear, quadratic and double-log (Cobb-Douglas) forms, through multiple regression and the double-log form was selected for further analysis because it gave the best fit. The estimation was made only for sole tomato as an example.

RESULTS AND DISCUSSION

Resource Use

Resources employed by the fadama farmers include land, labour, capital and irrigation water. Majority (82.5%) of the respondents inherited, while none purchased the fadama lands. A few farmers (12.5%) acquired their lands through gifts while only 5% rented. These results suggest that commercial transactions in fadama land is not yet common in the area. Discussion with farmers in the area generally indicated that expansion of fadama cultivation is restricted by, among other factors, inadequate supply of such land. This problem is probably worsened by the predominating land tenure by inheritance which does not permit easy transfer of land to non-family members. Another disadvantage often cited against inheritance method of land acquisition is that it often leads to sub-division and fragmentation of land holdings. This sub-division probably accounts for the very small sizes of holdings recorded in this study as can be seen in Table 1. It is evident from Table 1 that majority (more than 77%) of the respondents cultivated less than 0.02 ha of land. Such small size of holding is not easily amenable to mechanization and it limits the scale of operation of the farmer, thus, denying him the benefits associated with large-scale production.

Table 1. Distribution of respondents according to the farm size (ha)

Farm size group	Number of respondents	Percentage
0.00-0.02	31	77.50
0.03-0.05	7	17.50
0.06-0.08	2	5.00
Total	40	100

The family and non-family labour use according to farm operation is presented in Table 2 which shows that watering alone consumed more than 77% of the total labour input. The high proportion of labour utilization for watering is probably attributable to the fact that water lifting is accomplished through manual labour. Another striking finding revealed from Table 2 is the low utilization of non-family labour which was used only in harvesting for which it accounted for less than 12%. In addition, only communal (non-family) labour was employed and this was by 12.5% of the farmers. Hired labour was not utilized by any of the respondents. Communal labour was used in harvesting to quicken the process so as to avoid the loss of products which are highly perishable. The proportion of non-family labour recorded in this study is lower than those reported by Adedibu (1994) in the Wurno area of Sokoto State and Baba (1989) in the Bauchi State.

Table 2. Type and amount of labour used in the vegetable production

Operation	Hours of family labour	Hours of non-family labour	Total labour hours	Percent of total
Land preparation	70	0	70	2.60
Watering	2113	0	2113	77.50
Weeding	122	0	122	4.50
Manure application	46	0	46	1.70
Fertilizer application	49	0	49	1.80
Harvesting	294	33	327	12.00
Total	2693	33	2726	100

The non-durable capital inputs employed by the respondents were seed, fertilizer and manure. Majority (77.5%) of the farmers used seeds saved from the previous harvest, while 12.5% obtained them as gift. Only 10% of the respondents bought seeds. The seeds of various crops used were of local varieties. All the respondents used chemical fertilizers. The distribution of respondents according to level of fertilizer use is presented in Table 3 which shows that 70% used less than 400 kg/ha of fertilizer. The mean fertilizer use was 332.58 kg/ha which is less than the 500 kg/ha recommended for vegetable crops in the fadama in this part of the country (AERLS, 1985; Baba and Okosun, 1996). The relatively low level of fertilizer utilization is probably attributable to inadequate supply and high cost of the commodity as reported by majority (65%) of the farmers. However, to augment the short-fall in inorganic fertilizer application, all farmers used manure at an average rate of 1.11 ton/ha. None of the farmers used either herbicides or pesticides.

Table 3. Inorganic fertilizer use by the farmers

Fertilizer (kg/ha)	Number of respondents	Percentage
1-200	15	37.50
201-400	13	32.50
401-600	8	20.00
>600	4	10.00
Total	40	100

The durable capital inputs used by the respondents were simple farm tools such as cutlasses and hoes, and *guga* (the calabash used for lifting water). Others include baskets used in packing the produce and irrigation canals constructed by the farmers.

The foregoing discussion suggests that farmers in the area still rely on traditional inputs, as fertilizer was the only improved input employed. Furthermore, it would appear that the operations are not commercialised as all resources were either owned or produced by the farmers.

Cropping Systems and Crop Yields

All farm operations including nursery, land preparation, planting, fertilizer application (and manuring), weeding, irrigation and harvesting were accomplished manually for all the crops. Crops grown by the sampled farmers included tomato, hot pepper, egg plant and onion. Both mixed and sole cropping were practiced although the latter predominated. Tomato and hot pepper were mixed by 10% of the farmers while tomato and onion by 7.5%. Tomato, onion and egg plant were grown sole by 40%, 37.5% and 5% of the farmers, respectively (Table 4).

Table 4. Distribution of respondents according to the crops grown in the fadama

Type of crops	Number of respondents	Percentage
Tomato/hot pepper	4	10.00
Tomato/onion	3	7.50
Sole onion	15	37.50
Sole tomato	16	40.00
Sole egg plant	2	5.00
Total	40	100

The analysis of average yield obtained for each crop revealed that the yield of sole tomato was 7,939.97 kg/ha while that of sole onion was 7,844.47 kg/ha. Hot pepper yielded 5,852.66 kg/ha in mixture with tomato. The yield of egg plant was 4,500 kg/ha.

In this study, the yields recorded for all crops appeared to be low. For instance, the yield of tomato is lower than the 13,924 kg/ha reported for Bauchi State by Baba (1993) and 12,345 kg/ha reported as Nigerian average by FAO (1990). The onion yield also fell below the 10,575 kg/ha reported by Baba (1993). A possible reason for the low yields could be non-utilization of improved inputs by the farmers occasioned by their non-availability. To increase the productivity of the fadama, therefore, it may be necessary to bring improved seeds and other inputs within the reach of farmers. This would most likely increase yields and farm incomes in the area.

Table 5. Costs of vegetable production

Expenditure item	Cost (N/ha)	Percent of total cost
Variable costs (VC)		
Labour	50236	50.30
Seed	2424	2.40
Fertilizer	10863	10.90
Manure	4470	4.50
Harvesting	6276	6.00
Transportation	7261	7.00
Total Variable cost	81530	82.00
Fixed costs (FC)		
Depreciation on capital assets	18403	18.40
Total fixed cost	18403	18.40
Total cost	99933	100

Farm Income

Since most of the inputs were not purchased, the costs had to be imputed. The cost structure in fadama cultivation is presented in Table 5 whichahows that a major proportion (50.27%) of the production cost was accounted for by the imputed cost of unpaid family labour, while fertilizer (the only major purchased-input) accounted for 10.87%. Labour cost, in turn, was dominated bv the operation of water application.

The distribution of respondents according to net farm income (profit) is presented in Table 6 which shows that all, except three of the farmers, earned profit in fadama cultivation. Most (75%) of the farmers, however, realised less than ₦10,000/ha.

Table 6. Distribution of respondents according to net farm income

Net farm income (₦/ha)	Number of respondents	Percentage
< 0	3	7.50
0-10000	30	75.00
10000-20000	5	12.50
> 20000	2	5.00
Total	40	100

Marginal Productivities and Resource Use Efficiency

To determine marginal productivities for resources used in fadama farming and the efficiency of their use, a production function was utilised using the ordinary least squares procedure. The production function was initially estimated in linear, quadratic and double-log functional forms. The double-log form was ultimately selected for further analysis as it gave the best fit. The regression results of the double-log function are presented in Table 7 which shows the parameter estimate (regression coefficient) and t-ratio, with respect to each of the inputs included in the model, as well as the F-ratio and R^2.

The regression coefficients in the model represent the output elasticities for the respective inputs. As can be seen from Table 7, all the inputs except irrigation labour, had positive "signs" indicating a direct relationship between each of them and tomato yield. For example, the coefficient of 0.556 for fertilizer implies that a 1% increase in the use of the input, holding other inputs constant, will increase tomato yield by 0.556%. The interpretation is similar for seed and labour for all operations minus irrigation. The negative sign for irrigation labour shows a negative relationship between this input and tomato yield. The sum of the output elasticities, which represents returns to scale, was 0.996 indicating decreasing returns to scale in fadama farming.

Table 7. Results from the estimated double-log function

Input	Regression coefficient	t-value
Intercept	0.370	1.100^{ns}
Fertilizer	0.556	4.095^{***}
Labour for all operations minus irrigation	0.436	2.930^{**}
Seed	0.173	1.398^{ns}
Irrigation labour	-0.169	-1.905^{*}

R^2 = 0.898; F-ratio = 24.079^{***}; *, **, *** = significant at P<0.10, P<0.05, and P<0.01, respectively.

The R^2 also presented in Table 7, is a measure of degree to which the variables in the model jointly explained variation in the yield. The results show that 89.80% of the variation in the yield was explained by the inputs included. The joint explanatory power of the inputs was further confirmed by the F-ratio which was highly significant (P<0.01).

The results of the estimated production function were further used to compute the marginal value productivities of the inputs. The computed marginal value products and the unit acquisition costs of the inputs are presented in Table 8 which shows that fertilizer, labour for all operations except irrigation, seed and labour for irrigation had marginal value products of 7.37, 0.90, 0.30, and -0.11, respectively. This implies that a one unit increase in any of the inputs, holding others constant, will change the monetary returns by a value corresponding to the marginal value product of that input. It is also evident from Table 8 that with the exception of fertilizer, the marginal value products of all the inputs were lower than their unit costs. This suggests that all the inputs were inefficiently allocated with fertilizer being under-utilised and the remaining inputs being used above their economic optimum levels.

Table 8. Marginal value products and acquisition costs of inputs

Input	Marginal value product	Acquisition cost
Fertilizer (₦/kg)	7.37	5.45
Labour for all operations minus irrigation (₦/m-hr)	0.90	13.33
Seed (₦/kg)	0.30	11.42
Irrigation labour (₦/m-hr)	0.11	13.33

POLICY IMPLICATIONS

The results of the study have shown that the sizes of fadama land holdings in the area were small with the average farmer cultivating less than 0.02 ha. The small sizes could be attributed to two factors. Firstly, the widespread practice of land tenure by inheritance characteristically led to fragmentation of holdings. Secondly, the small size of fadama land area relative to the total cultivable land precludes ownership of large plots by individuals. The small size of holdings probably encouraged overutilization of resources, particularly labour, by farmers to avoid being idle. Such resources would have been spread over larger plots if more suitable lands were available.

The study further revealed that fertilizer was used below the recommended level. This was further confirmed by the results of the production function analysis which identified fertilizer as the only underutilized input in the area. The low level of fertilizer utilization could be attributed to the inadequate supply of the input to farmers in the area. Furthermore, no respondent used improved varieties of the crops, and the local varieties were used above economic optimum level. The underutilization of fertilizer and the non-use of improved varieties may have contributed to the relatively low yields obtained. It appears that higher yields and income could be obtained if farmer accessibility to fertilizer, high-yielding varieties and other improved inputs is increased. One way to do this could be by organizing farmers into water users' associations and providing the inputs through the associations to avoid the difficulty of reaching individual farmers. Such associations may also play a major role in assisting farmers to market their produce. In addition, adequate extension advice is needed in the area to train the farmers in the use of the improved inputs to avoid their under or over utilization.

It appears that a replacement of the manually-operated traditional water-lifting devices with modern types (such as pumps) would reduce the cost of labour, which looms large in the cost structure of the farms. This could further increase profit, depending, of course, on whether the additional cost of acquiring and operating the pump is more than off-set by the reduction in labour use. Studies elsewhere in Nigeria (Baba, 1989, 1993; Adedibu 1994), and in neighbouring Niger Republic (Baba and Alassane, 1997), show that the replacement of traditional water lifting devices significantly increased the net farm income. Such replacement might also enable farmers to increase their size of holding as more distant plots can be reached with water. The purchase of pumps might be beyond the reach of some of the farmers as individuals. However, if they operate in groups as earlier suggested, they could pool their resources together to purchase the pump.

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