Economic evaluation of investments in pump irrigation systems in Bauchi State, Nigeria

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ABSTRACT

A major constraint to increased agricultural production in Nigeria, is inadequacy of rainfall in the northern states. This problem has led to heavy government investment in the development of irrigated agriculture involving both large and small-scale irrigation systems. The recent government intervention in the small-scale irrigation systems has been mainly through the fadama development activities of the Agricultural Development Projects (ADPs). This study evaluated the performance of the small-scale irrigation system within the Western Zone of Bauchi State ADP comprising four local government areas (Bauchi, Dass, Tafawa-Balewa and Toro) during the 1987/88 dry season cropping year. The data generated were projected over a five year period (1988-1992) using the annual growth rate of the consumer price index. Discounted cash flow measures were used for analysing the profitability of the investments. The findings of the study showed that investment in small-scale irrigation farming was profitable when family labour was assumed to have a very low or zero opportunity cost. The NPV and the IRR obtained were ₦15,582.64/ha and 159%, respectively, under this scenario. On the other hand, NPV and IRR dropped to ₦502.44/ha and 24%, respectively when family labour was costed. A number of factors were identified as contributors to the rather low returns obtained. These included water shortages, unavailability of improved seeds, and low product prices during the peak harvest period.

INTRODUCTION

A major constraint to increased agricultural production in Nigeria is inadequate supply of water. Rainfall, the most important source of agricultural water, is inadequate and highly variable in supply. Nwa (1976) reported that the annual rainfall in Nigeria was less than 500 mm in some parts of the north and greater than 2,300 mm in some parts of the south. It was also reported that about three-fourths of the north received less than five months of rainfall in a year (FAO, 1966; Federal Republic of Nigeria, 1976; Nwa, 1981). There are several implications of these rainfall characteristics. First, large areas of land are left uncultivated, especially in the Sahel region of the north. In addition, the intensity of land use is low because cropping is restricted to the short rainy period. Furthermore, only crops that are quick-maturing and/or drought-tolerant are grown—a situation which prevents diversification into the production of new and high-value crops. And, quite often poor harvests are recorded in years of late arrival, early cessation and/or frequent breaks of the rains. All these constitute major constraints to increased agricultural production. Irrigation is therefore, considered necessary to alleviate these problems, in order to increase agricultural production in the country.

Government involvement in irrigation development in Nigeria has a relatively long history dating back to 1918 when flood waters were impounded along the Sokoto and Rima Rivers for agricultural production by the (then) Northern Nigerian Government. However, organised federal government involvement in irrigation development began in 1973 when the Chad Basin and Sokoto-Rima Basin Development Authorities were established (Erhabor, 1982). Later on, in 1976, nine additional River Basin Development Authorities (RBDAs) were created and the existing two reconstituted. These authorities are still in existence and are charged with a range of responsibilities including the harnessing, management and exploitation of the country's water resources for agricultural production and other purposes. Nwa and Martins (1982) have adequately documented the various irrigation schemes established by the RBDAs in their respective areas of operation.

The irrigation projects established by the RBDAs and other government agencies in Nigeria are mostly large-scale schemes which have been characterised by many problems (Wallace, 1979; Palmer-Jones, 1980; Idachaba, 1980; Etuk and Abalu, 1982; Kolawole, 1982). In apparent recognition of these shortcomings, emphasis seems to be shifting to small-scale irrigation based on ground water development by hand-operated

and small motor-driven pumps (Eicher and Baker, 1982). Considering the relatively low level of capital requirement and the simplicity of the technologies involved, small-scale irrigation might be more beneficial to a developing country like Nigeria, than the large-scale schemes.

The Research Problem and Objectives

To successfully develop small-scale irrigation in Nigeria, empirical information on the economics of crop production under the existing small-scale irrigation schemes is essential. Such information would highlight the potentials and constraints of the schemes. Policy makers, irrigation development planners, as well as research and extension workers would then recognise the specific aspects of small-scale irrigation systems on which to focus their attention.

Presently, there is a dearth of empirical information on the worth of investments in small-scale irrigation systems. The very few studies on the economics of small-scale irrigation in Nigeria determined costs and returns, as well as productivities of resources in the year of study (Orewa, 1978; Erhabor, 1982; Olukosi and Ofojekwu, 1983). But, since investment in small-scale pump irrigation is a strategic investment, with costs and returns spread out over many years, it is necessary to study the schemes over their entire life span.

This study, therefore, aimed at evaluating the profitability of investment in small-scale irrigation based on small motor-driven pumps, with particular reference to Bauchi state of Nigeria. The specific objectives of the study were to:

(1) determine the costs and returns of crop production under the pump irrigation system;
(2) estimate the net present value (NPV) and the internal rate of return (IRR) on investments in the systems;
(3) identify the constraints to increased returns under the systems; and
(4) derive from the result of the study, implications for policy and research and extension work on small-scale irrigation development in the country.

METHODS OF DATA COLLECTION AND ANALYSIS

The study area

The study area is the Western Zone of the Bauchi State Agricultural Development Programme (BSADP). This Zone, as at the time of this study consisted of four Local Government Areas (LGAs), namely, Bauchi, Dass, Tafawa-Balewa, and Toro LGAs, and had an estimated population of 483,878 people. Annual rainfall in the area ranges from 1,000 mm to 1,300 mm, with a duration of about five months (usually beginning in May and ending around October)(BSADP, 1983). This leaves a period of dry season of about seven months during which little or no rainfall is received. The area is, however endowed with a few streams, along the flood plains, which some small-scale farmers use to irrigate their plots. Motorised pumps are used to lift water from the streams, ponds, wells, and more recently, from washbores. Crops grown are mostly vegetables, including tomato, pepper, eggplant and onion.

Data collection

Data collected were of two types. The first set of data were the "fixed point" and/or "registered" information which were not expected to change during the research period. They included information on size of households, and type, number, age and value of tools and equipment used in irrigation farming.

The second set of data were the "continuous" and "non-registered" types which included input-output data such as hours of family labour and non-family labour input, tasks undertaken, wages paid and number, sex, and age of persons involved. Other types of data included in this category were type, quantity, source and cost of seeds and fertilizers used on each plot; frequency and length of water application, quantity of crops harvested, quantity consumed at home or given out as gifts, quantity sold, prices received, cost of transportation, frequency of pump breakdown and cost of repair, as well as expenditure on fuel and lubricant. Data were collected from forty-five farmers in four villages selected purposively to include only those that were known to use pump for irrigation. The villages selected were Juga and Tundunwada-ribina, in Toro LGA, Dajin in Tafawa-Balewa LGA and Dass in Dass LGA. The selection of the villages was based on their relative prominence in small-scale pump irrigation and accessibility. Data collection, by means of observations and interviews using a structured questionnaire, was undertaken between December 1987 and June 1988 by four enumerators stationed in the selected villages throughout the survey period.

The analytical model

The data collected were analysed using a net farm income (NF) model to determine the costs and returns of pump irrigation farming projected over a five year period, 1988-1992. These costs and returns formed the basis for estimating the NPV and IRR of investment in pump irrigation. The NPV was defined as:

$$NPV = \left[\sum_{t=1}^{5} A_t (1+i)^{-t}\right] - C \quad \text{.............. (1.0)}$$

while the IRR was obtained by solving the following equation for: y:

$$\left[\sum_{t=1}^{5} A_t (1+r)^{-t}\right] - C = 0 \quad \text{.............(2.0)}$$

where;

A$_t$ = net returns for period "t",

C = initial investment in pump irrigation (defined as cost of capital items such as pumps, water hoses, washbores, hoes, cutlasses, etc., which the farmers needed to begin irrigation in 1988),

t = time periods in years (t = 1, 2.....5), and

r = Internal rate of return.

Assumptions

To facilitate data analysis, the following assumptions were made:

(1) The cost of pump, washbore, water hose, cutlasses, and hoes, together, constituted the initial investment requirements for dry season farming using motorised pumps.

(2) While pumps and washbores have a life span of 5 years water hoses, hoes and cutlasses were assumed to last only 3 years.

(3) The costs of production increased at an annual rate of 49.27%, while returns increased at an annual rate of 25.74% (FOS, 1990; Baba et al., 1990).

(4) The discount factor was 19.50%, which was the ceiling lending rate in 1988 (CBN, 1988).

(5) The first year of investment is 1988, which was when the survey was conducted.

RESULTS AN DISCUSSION

Costs

The estimated costs for the 1987/88 season are presented in Tables 1 and 2. The total variable cost was 3,601.76/ha (Table 1). However, about 65% of this was accounted for by unpaid family labour. When hired labour was included, labour input accounted for about 71% of the variable cost. This result identifies labour as the single most costly input in operating an irrigated farm. This situation is not unexpected since all farm operations, including land clearing, ploughing,

Table 1: Variable costs under pump irrigation for the 1987/88 season.

Item of cost	Amount (N/ha)	% of total variable cost
Seeds	182.78	5.08
Fertilizer	207.33	5.76
Repairs and maintenance	122.70	3.41
Fuel	245.65	6.82
Hired labour	225.45	6.26
Family labour	2,358.85	65.49
Marketing and others	258.70	7.18
Total variable costs	2,601.76	100.00

levelling, channel construction, planting, weeding, watering, digging of wells, and harvesting, were accomplished through manual labour. The cost of fuel, repairs and maintenance, fertilizer, seeds, and marketing were relatively low. In this study, initial investment was defined as the acquisition costs of a unit of pump, water hose, washbore, and hoe and cutlass, in 1988. These constitute the durable capitals items which a farmer may require to begin dry season farming using small motorised pump. Data in Table 2 show that the major proportion (89.96%) of the initial investment was accounted for by pump, while washbore, water hose, cutlass and hoe constituted 6.82%, 2.09%, 0.84%, respectively. To obtain the fixed costs attributable to 1988, the costs of the above-listed items were depreciated over their useful life using the straight line method, assuming zero salvage value (Table 2).

Returns

Gross returns were computed for each farmer over five years, which was the assumed productive life of the investment. The annual production costs were then deducted from the gross returns to obtain annual net incomes. Thereafter the annual net incomes were discounted to obtain the NPV. The aggregate NPV for all farmers was N22,610/ha and N70,1218.75/ha when family labour was costed, respectively. The distribution of farmers according to NPV, when family labour was costed, and when it was not, are presented in Tables 3 and 4. About 53% of the farmers obtained negative NPV, when the imputed cost of family labour was taken into consideration (Table 3). This implies that more than half of the farmers produced at a loss. The average farmer obtained an NPV of N502.44/ha. Further analysis revealed that close to 69% of farmers incurring losses were in Dajin village where water shortage was most acute. In this area, the streams,

Table 2: Fixed investments in pump irrigation.

Item	Unit cost at 1988 prices (N)	% of total initial invest-ment	Length of use-ful life (years)	Annual depreciation (N)	% of total depreciation	Replacement cost after 3 years (N)	Remaining after 5 years (N)
Pump	2,150.00	89.96	5	430.00	87.76	0.00	0.00
Water hose	50.00	2.09	3	16.67	3.40	166.30	55.43
Washbore	150.00	6.28	5	30.00	6.12	0.00	0.00
Cutlass	20.00	0.84	3	6.67	1.36	66.51	22.17
Hoe	20.00	0.84	3	6.67	1.36	66.51	22.17
Total	2,390.00	100.00	-	490.00	100.00	299.32	99.77

and, indeed, the washbores, dried up midway into the season and irrigation was barely sustained through manual digging and re-digging of shallow wells in the river beds. Labour for digging of wells was mostly supplied by the farmer and family members. This tended to increase family labour input which explains the low NPV in this village, when family labour was costed. The severe water shortage also reduced yields, culminating in low returns in the area.

The situation was, however, remarkably different when family labour was not costed. In this case only 11% of the farmers produced at a loss. The average NPV was N15,582.64/ha with more than 33% of the farmers obtaining an NPV of N20,000.00 or more, as compared to only 13% of farmers falling into this income group, when family labour was costed. The IRR on investments was found to be 24% and 159% for the average farmer, when family labour was costed, and when it was not costed, respectively. Thus, the IRR, when family labour was costed, did not exceed the cost of capital of 19.50% (in 1988) by a wide margin, which further underscores the low returns in the study area.

Table 3: Distribution of respondents according to NPV when family labour was costed.

NPV range (N/ha)	Frequency	Percent of total
<0	24	53.33
1-5,000	2	4.44
5,001-10,000	5	1.11
10,000-15,000	6	13.33
15,001-20,000	2	4.44
20,001-25,000	1	2.22
25,001-30,000	2	4.44
>30,000	3	6.67
Total	45	100.00

Table 4: Distribution of respondents according to NPV when family labour was not costed.

NPV range (N/ha)	Frequency	Percent of total
<0	5	11.11
1-5,000	4	8.89
5,001-10,000	9	20.00
10,000-15,000	7	15.56
15,001-20,000	5	11.11
20,001-25,000	2	4.44
25,001-30,000	2	4.44
>30,000	11	24.44
Total	45	100.00

Constraints to Increased returns

The findings in the preceding section indicate that investment in small-scale pump irrigation was generally not profitable, especially when family labour was costed. This is certainly discouraging considering the efforts currently being made to obtain widespread adoption of irrigation farming as a means of attaining increased agricultural output and farm incomes in the country. Dry season farming is essentially a commercial activity with profit as the main motivating factor and failure to attain this objective would discourage farmers from investing in irrigation systems. In view of this, it is important to examine some of the factors of responsible for the low returns. One of the most important constraints to increased returns was shortage of irrigation water. In view of this, it is important to examine some of the factors responsible for the low returns.

One of the most important constraints to increased returns was shortage of irrigation water. Early in the season, there was relatively abundant water in the stream, ponds and washbores, from where water was pumped to farm plots. With time, however, water from these sources dried up, forcing farmers to manually dig wells in the rivers. These wells, in turn, dried up and the well-digging was

repeated several times. Yet, the water obtained was generally inadequate, causing serious water stress on crops. This, most likely, reduced yields and returns on the farms.

To achieve widespread adoption of small-scale irrigation, government would have to go beyond providing only pumps to farmers at subsidised rates, and provide also reliable sources of water for dry season farming. Bauchi State Agricultural Development Project (BSADP) sank washbores, at subsidised rates, for some of the farmers, the effects of this effort was not felt because most of the washbores dried up in the dry season. In view of this, it would be considered that as far as ground water development strategy is concerned, the sinking of boreholes and tubewells would be more reliable than washbores which easily dry up. The erection of small-scale dams could also enhance water availability in the area. It should also be noted that availability of reliable water sources would reduce labour consumption and production costs since manual digging of wells would become unnecessary.

Another constraint was non-availability of improved seeds of the crops grown. None of the respondents indicated using improved seeds. Seventy-five percent of them attributed this to lack of access to such seeds. A major challenge to research and extension work, therefore, is to develop and extend to farmers, high-yield varieties of crops grown.

Farmers also complained of low prices for their products. An attempt was made to monitor price movements during the season. The results indicated that prices of the four crops (tomato, pepper, eggplant and onion) fluctuated widely during the irrigation season. They were generally highest at the beginning of the season but decreased rapidly until they reached their lowest values at the middle of the season (around February and March), after which they began to rise again. The period of low prices featured untimely evacuation of the products and the concomitant losses.

Although there is a vegetable and fruits processing plant (VEGRU) in the neighbouring (then) Borno State, no farmer indicated selling his product to the Company. This implied that the impact of the company was not being felt. The company, however, could provide a good opportunity for farmers to dispose of their produce easily, in order to reduce glut and post-harvest losses, and to ensure that they receive remunerative prices for their products. This would further increase farmers' incomes and incentive to invest more in dry season irrigation farming.

CONCLUSION

Although the results of the analyses indicated that, under the assumptions made, investments in pump irrigation was, on the average not very profitable when family labour was costed, their interpretation would depend on how the opportunity cost of labour in the dry season is measured. In imputing the cost of family labour it was assumed that if a farmer refuses to work on his farm, he could hire out his labour at the going wage rate. Hence, one hour of family labour was weighted as one hour of hired labour. But this needs not be the case. In fact, if most farmers choose not to engage in dry season farming they may not find profitable employment on other people's farm or elsewhere. Hence, the opportunity cost of family labour in the dry season may not necessarily be up to the cost of hired labour.

Regardless of the manner in which the family labour is costed, however, the fact is that certain constraints, including water shortage, unavailability of improved seeds and low prices of products, have been identified as contributing factors to farmers' depressed incomes and their alleviation could greatly improve returns in the area.

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