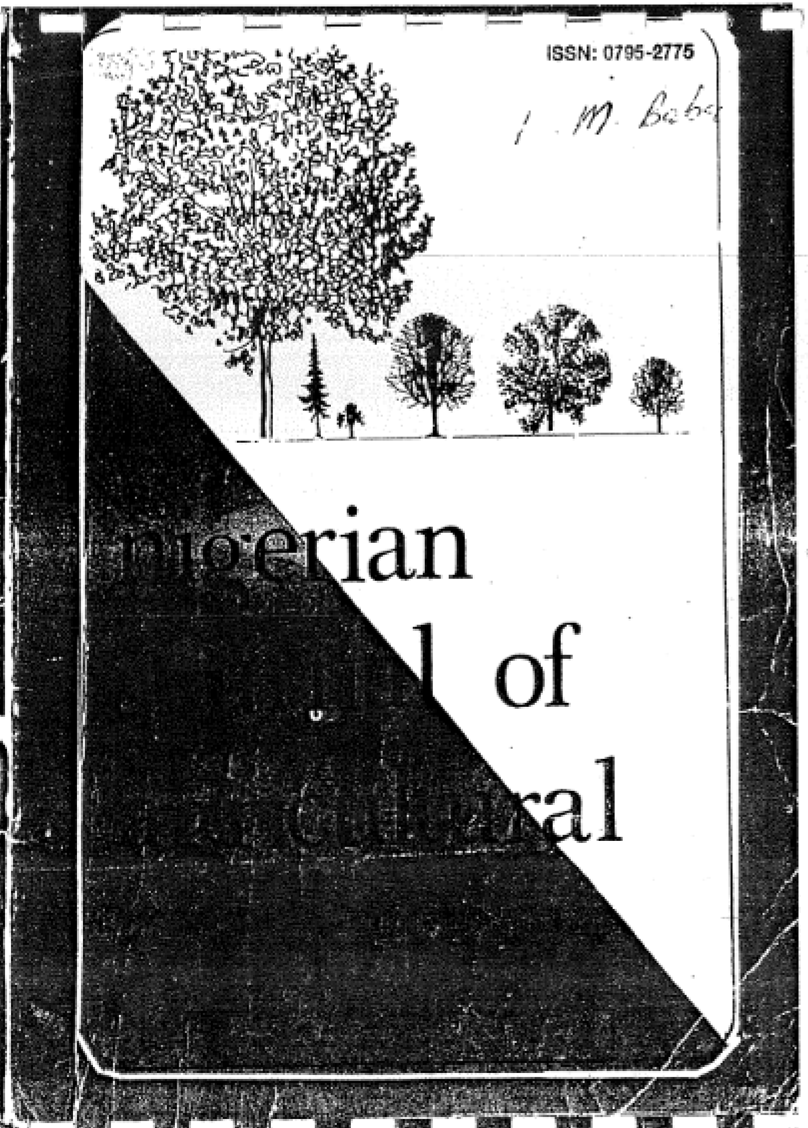
NIGERIAN JOURNAL OF AGRICULTURAL TECHNOLOGY
VOL. 3 (1991).

CONTENTS

PAGE



(iii)

NIGERIAN JOURNAL OF AGRICULTURAL TECHNOLOGY VOL.3 (1991) 10-21.

RESOURCE-USE EFFICIENCY AND CONSTRAINTS IN IRRIGATED AGRICULTURE: EMPIRICAL EVIDENCE FROM BAUCHI STATE, NIGERIA

K. M. BABA and E. G. ETUK*

School of Agriculture,
Abubakar Tafawa Balewa Univeristy,
P. M. B. 0248, Bauchi.

ABSRACT

Although the practice of small-scale irrigation, using pump and shadoof water lift devices, has many important advantages, successive Nigerian governments have emphasised large-scale schemes in the development of water resources for agriculture. This has been due largely to the lack of an adequate knowledge base for the development of small-scale irrigation in the country.

Using cross-sectioned survey data from the Western Zone of the Bauchi State Agricultural Development Programme, this paper identifies the contraints to crop production under small-scale irrigation and examines the possibility of improving incomes on small irrigated farms. Shortage of irrigation water, inadequate supply of fertilizer, absence of credit facilities and low producer prices were found to be some of the major constraints on the study farms. The results of the study indicate that opportunities exist for raising profitability through resource re-allocation under the exising small-scale irrigation systems, and through the alleviation of the constraints identified in the study.

* Late Dr. E. G. Etuk was formely with the Deparstment of Agricultural Economics and Rural Sociology, IAR, Ahmadu Bello University, Zaria.

INTRODUCTION

Policy statements and the huge financial allocations made to water resources development in the Fourth National Development Plan tend to portray irrigation as the cornerstone of agricultural development in Nigeria. These policies have been implimented through the establishment of large-scale irrigation schemes in many parts of the country. These schemes have many shortcomings that make them ineffective as instruments for achieving the desired objectivies of increased agricultural output and higher farm incomes [Idachaba et al., 1980; Palmer-Jones, 1980; Etuk and Abalu, 1982; Makarfi, 1987].

Many small farmers in Northern Nigeria successfully irrigate their fadama land with water from streams, ponds and wells using pump and shadoof water lift devices. The capital requirements of these lift systems are low and the technologies involved, apart from being simple, allow the farmers the best control over the time and rate of water application. Furthermore, high returns to crop production have been reported under such simple and relatively cheap systems [Erhabor, 1982].

Despite these potentials, there are no empirically grounded strategies for the development of small-scale irrigation in Nigeria. This lack of well-articulated long-term small-scale irrigation development strategies can be attributed to the inadequacy of research information on crop production under the existing systems. This paper seeks to broaden the empirical basis for the effective development of small-scale irrigation systems in Nigeria. especially in the northern parts of the country. It identifies the constrainsts to increased crop production under pump irrigation systems in the Westhern Zone of the Bauchi State Agricultural Developemnt Programme [BSADP]. The paper also estimates the productivities of resources and determines the efficiency of resource-use under the systems. Implications of the results of the study for irrigation development strategies are discussed.

METHODOLOGY

The data for this study were obtained from a purposive sample of forty-five farmers from four villages [Dajin, Dass, Juga and Tudun-Wada Ribina] in the Western Zone of the BSADP. The purposive sampling technique was used because only dry season farmers using pumps for irrigation were relevant to the study. Furthermore, since the study involved continuous monitoring of the activites of the farmers for severn months, only those who indicated willingness to co-operate throughout the period were included in the sample. The sampling frame was a household list obtained from BSADP. Input-output data such as size of plots cultivated, family and non-family labour input, quantites of seeds and fertilizer used, water application, crop harvest and sales were collected twice weekly, from December 1987 to June 1988, through interviews using structured questionnaires.

The analytical procedure used for achieving the objectives of the study were descriptive statistics and production function analysis.

The production function model employed was of the general form:

$$Y = f[X_1, X_2, X_3, X_4, U] \quad [1]$$

where:

Y = Output [in kilograms per hectare]

X_1 = Human labour input [in man-hours per hectare]

X_2 = Plant population per hectare

X_3 = Fertilizer input [in kilograms per hectare]

X_4 = Irrigation water input [in hectare - centimeter per hectare]

U = Error term.

The above function was estimated, through multiple regression analysis, in the linear, quadratic, square root and Cobb-Douglas equation forms for tomato, pepper, onion and garden egg which were the major crops grown in the study area. For each of the crops, the Cobb-Douglas function gave the best fit in terms of the magnitude of R^2 and appropriate "signing" of the regression coefficient, and was therefore selected for further analysis. The marginal value productivites of the inputs included in the model were computed using equation [2].

$$MVP_{xi} = bi\,[Y/X_i].\,Py \quad [2]$$

where:

MVP_{xi} = Marginal value product of ith/input

Y = Geometric mean of output

xi = Geometric mean if the ith input

Py = Price of the product; and

bi = Regression coefficient [or elasticity of production] with respect to the ith input.

RESULTS

Constraints to Increased Production

The constraints to increased crop production as reported by the respondents are presented in Table 1 which shows that all the respondents identified non-availability of credit, lack of tractor for land preparation.

Table 1 Constraints to Crop production under Pump Irrigation as identified by farmers.

Constraints	No. of farmers	Percentage
Non-availability of land	0	0
Non-availability of labour	2	4.4
Non-availabity of credit	45	100
Lack of tractor for preparing land	45	100
Low produce prices	45	100
Inadequate supply of fertilizer	34	75.6
Non-availabity of improved seeds	34	75.6
Lack of extension advice	30	66.7
Shortage of irrigation water	34	75.6
Non-availability of pump	12	26.7
Pests and disease attack	10	22.2

Source: Field Survey (1988).

and low produce prices as major constraints to crop production in the study area. Majority (75%) of the respondents also identified inadequate supply of fertilizer as a constraint and reported that the prices they paid for this input were too higl.. Furthermore, non-availability of improved seeds and lack of extension advice were identified as constraints by about 75% and 66% of the respondents, respectively. Further analysis showed that none of the respondents used improved varieties of crops grown, while only 22% received extension advice on dry season farming. Shortage of irrigation was identified as a constraint by 75% of the respondents.

About 26% of respondents reported non-availability of irrigation pumps as a constraint to increased crop production. Further investigation revealed that these were farmers who did not own pumps but hired from neighbours. They generally complained of the difficulty they encountered in obtaining pumps to hire when needed.

Attack of crops (which were mainly vegetables, including tomato, pepper, onion and garden egg) by pests and diseases were considered a major problem limiting output by 22% of the respondents who also reported that they had never used pesticides or other disease control chemicals on their farms. They, however, conceded that they had never reported such pests and diseases incidents to any government agency.

There appears to be no major labour bottlenecks in dry season farming among the studied farmers since only 4% of them identified non-availability of labour as a constraint. Similarly, shortage of suitable land was not a problem in the study area as no farmer indicated this as a constraint. Infact, 51% of the respondents reported that they owned suitable land lying fallow, while the remaining 49% did not forsee any difficulty in acquiring more land, through rentage, if they were to increase area under cultivation.

<u>Results from the Estimated Equation</u>

The results or the estimated production function for tomato are presented in Table 2 which shows that the coeffeicient of determination, R2, for the model was 0.81 implying that 81% of variation in tomato output was explained by variation in the inputs (labour, fertilizer plant population and water) included in the model. The high F-ratio, which is significant at 1% level, further confirms the strong explanatory power of the inputs. Also presented in Table 2 are the regression coefficient (i.e elasticites of production) and t-values with respect to the inputs. It should be noticed that the production elasticities of all the inputs, except labour, are positively "signed". Hence, a percentage increase in any of

the inputs, holding other inputs constant, would increase tomato output by a proportion corresponding to the value of the production elasticity of that input. The negative production elasticity for labour implies that this input has been over-utilised resulting in a decline to output for additional units of labour input.

Similar results of the estimated production function for pepper, onion and garden egg are presented in Tables 3, 4, and 5, respectively. For all the crops, the inputs except labour had positive production elasticites. Labour had positive production elasticity in garden egg and negative elasticity for the remaining crops.

Return to scale (i.e the sum of production elasticites) were 0.853, 0.934, 1.530, and 1.486 for tomato, pepper, onion and garden egg, respectively, implying that there were decreasing returns to scale in onion and garden egg production.

Table 2: Results of regression analysis for tomato.

Variables	Regression coefficients	t-values
Constant term (A)	0.072	0.124 n.s.
Labour (X_1)	-0.146	-1.069 n.s.
Plant Population (X_2)	0.522	5.667***
Fertilizer (X_3)	0.072	0.442 n.s.
Irrigation water (X_4)	0.406	3.372***

R2 = 0.81
F-ration = 30.73***
*** = Significant at 1 percent level
n.s. = not significant

Source: Field Survey, 1988.

Table 3: Results of regression analysis for Pepper.

Variables	Regression Coefficients	t-value
Constant term (A)	1.725	2.451**
Labour(X_1)	-0.127	-0.991 n.s.
Plant Population (X_2)	0.290	1.825*
Fertilizer (X_3)	0.351	2.100***
Irrigation Water (X_4)	0.120	2.308**

R2 = 0.80
F-ratio = 29.17***
* = Significant at 10 percent level
** = Significant at 5 percent level
*** = Significant at 1 percent level
n.s. = not significant

Source Field Survey, 1988.

Table 4: Results of regression analysis for onion.

Variables	Regression	t-values
Constant term (A)	1.256	0.845 n.s.
Labour (X_1)	-0.305	-1.649 n.s
Plant Population (X_2)	0.206	0.773 n.s.
Fertilizer (X_3)	0.457	2.680**
Irrigation Water (X_4)	0.867	4.703***

R2 = 0.67
F-ratio = 10.58
** = Significant at 5 percent level
*** = Significant at 1 percent level
n.s. = not significant

Source: Field Survey (1988).

Table 5: Results of regression analysis for garden egg

Variable	Regression Coefficients	t-values
Constant term (A)	0.366	0.523 n.s.
Labour (X_1)	0.160	1.511 n.s
Plant Population (X_2)	0.375	1.771*
Fertil;izer (X_3)	0.392	2.842**
Irrigation Water (X_4)	0.559	2.524***

R2 = 0.75
F-ratio = 18.90***
* = Significant at 10 percent level
** = Significant at 5 percent Level
*** = Significant at 1 percent level
n.s. = not significant

Source Field survey (1988).

Marginal Value Productivities and Resource-Use Efficiency

The computed marginal value productivities and acquisition costs (prices) per unit of the inputs are presented for each of the crops in Table 6. The marginal value products for all the inputs, except labour, were higher than the products for all the inputs, in all the crop enterprises. This implies that these inputs (plant population, fertilizer and irrgation water) were used below economic optimum levels and profits could be increased through an increased use of the inputs. The marginal value product of labour was however lower than wage rate in tomato, pepper and onion enterprises, indicating that this input was used above economic optimum in producing these enterprises and that profits could be raised by reducing labour employment in these enterprises. In the case of garden egg, labour was used below economic optimum level.

DISCUSSION AND POLICY IMPLICATIONS

This study has revealed that variable resources were inefficiently allocated in the study area. For all crops, the inputs were used below their economic optimum levels, except labour which was over-utilised in tomato, onion and pepper production. The overutilization of labour is probably due to the low opportunity cost of the input during dry season in the study area. Most (about 90%) of labour input in the area was provided by family members who would have probably remained idle, in the absence of irrigated farming, during the dry season. It appears absence of more profitable economic activities encourages farmers to spend longer time on fadama operations, than necessary.

Table 6: Acquisition Costs and Marginal Value Products of Inputs by Crops.

Inputs egg	Acquisition costs/(N/unit)	MVP xi by Crop Enterprises (N/unit)			
		omato	Pepper	Onion	Garden
Labour (X_1)	0.99/man-hour	-0.74	-0.40	-0.37	1.34
Plant Population (X_2)	0.003/stand	0.11	0.10	0.01	0.16
Fertilizer (X_3)	0.29/kg	1.07	6.02	5.53	18.45
Irrigation water (X_4)	8.00/ha-cm	148.25	200.77	109.10	363.99

Source: Field Survey (1988).

Plant population was under-utilised probably because farmers were not aware of recommended population density for thecrops grown. This explanation is further supported by the fact that a large proportion (66%) of farmers identified lack of extension advice as a major problem inthe study area. To increase production and profitability, agricultural extension agencies in the state would have to step up their activities to ensure that their impact is felt, not only in rainfed agriculture, but also in irrigated farming. Extension efforts should focus on (among other things) the use of optimum plant population by farmers.

Majority (75%) of respondents identified inadequate supply and high price of fertilizer as constraints in crop production. This, most likely, explains the under-utilization of this input

at affordable prices. To achieve this, it is suggested that the present fertilizer distribution system in the country which appears to favour only rainy season farming should be reorganised. Fertilizer sales should be undertaken in two phases – the rainy season sales and the dry season sales. The latter should be for the sole benefit of farmers engaged in irrigation farming.

The under-employment of irrigation water in the study area is most likely due to shortage of this input, identified as a constraint to increased production, by majority (75%) of the respondents. Presently, the farmers depend mainly on natural sources of irrigation water supply such as rivers, stream and pond, which usually dry up in the irrigation season, leaving the farmer with the only alternative of digging shallow wells which, in turn, dry up within short periods of time. To enable the farmers to benefit from the opportunity that exists for increasing profits through increased water use, efforts should be made to increase water availability through the construction of small dams and the development of groundwater. The BSADP, through its Fadama development unit, is already engaged in ground water development through the sinking of tubewells, borehores and washbores. However, this effort would have to be seriously intensified for its impact to be felt by majority of irrgation farmers. For instance, in the study season, only few of the sampled farmer (13%) have benefitted from the ground water development scheme of the BSADP and other agencies responsible for irrigation development in the State. Furthermore, out of the targeted, 45,000ha expected to be brough under irrigation through ground water development by BSADP, only 15ha (or 33%) have been developed as at August, 1991 (Pal et al., 1991). These potentials should be urgently developed to enable farmers to increase production and earn more profits.

None of the sampled farmers indicated obtaining credit from any lending agency for the purpose of dry season farming. In planning for effective small-scale irrigation development, based on pumps, provision of credit to farmers should be considered an integral part of the strategy. As indicated earlier, some of the dry season farmers do not own pumps, while majority of those who do complain of the inadequacy of the pumps they own and blamed this on lack of funds. It is belived therefore, that provision of credit would enable farmers to purchase the right sizes of [illegible] to even increase their purchase and use of fertilizer, improved seeds and other improved inputs.

All the sampled farmers prepared their land manually and identified this as major constrain limiting expansion of cultivation. It appears the Tractor Hiring Service of the state government hase no effect on dry season farming in the study area. To reduce drudgery and to enable farmers to expand cultivation and increase profits, they should be assisted in preparing fadama land using tractors, and the possibility of introducing work-animals into the area for dry season farming should be explored.

Finally, all the studied farmers identified low prices or their products as a major constraint. Since these crops are mainly fruit vegatbles, it is suggested that irrigation development planners should encourage govenment or private enterpreneurs to establish small-scale fruit processing plants which could purchase produce at reasonable prices. This will also minimise the high post-harvest loss caused by untimely evacuation of surplus produce.

CONCLUSION

It has been demonstrated in this study that, as far as crop production, under small-scale irriation in the study area is concerned, variable inputs were inefficiently allocated. While fertilizer, plant population and irrigation water were under-utilised, labour input was used above economic optimum level. Increased use of the first three inputs would most likely increase profits in the study area and should be encouraged. In addition, the farmers identified shortage of irrigation waster, lack of credit, lack of extension advice, low produce prices, inadequate supply of fertilizer, lack of improved seeds and lack of mechanised land preparation, as the major constraints to increased production and profits in dry season farming. In planning small-scale irrigation development, therefore, these constraints must be clearly brought into focus and strategies designed to alleviate them. Some of the strategies that might be of help have been suggested in the proceeding section.

REFERENCE

ERHABOR, P.O. (1982). Efficiency of resource use under small scale irrigation technology in Nigeria. Indian Purdue University, Tech. Rep. No. 148.

ETUK, E.G. AND ABALU, G.O.I. (1982). River basin development in Nigeria: A case

study of Bakolori project. Fourth, Afro-Asian Regional Conference of ICID, Lagos, Nigeria 2 (26:356.)

FEDERAL MINISTRY OF NATIONAL PLANNING (1985). Fourth National Development Plan, (1981-85).

IDACHABA, F.S. (1980). The green revolution: A food production plan for Nigeria. A study by the Food and Strategies Mission, Federal Ministry of Agriculture. Vol.1 Main Report.

MAKARFI, A.M. (1987). Rural development through irrigation. A case for small-scale approach. Paper presented at the Fourth National Conference of Rural Sociological Association of Nigeria, A.B.U., Zaira, 17th-20 May, 1987.

PAL, U.R., BABA, K.M. AND HALIRU, Y. (1991). A re-assessment of agricultural potentials of Bauchi State. Paper presented at a public lecture organised by the Farm Managment Asssociation of Nigeria, Bauchi, 9 August, 1991.

PALMER-JONES, R.W. (1980). Why irrigate in the North of Nigeria. Paper presented on change in rural Hausaland, Kano, 29th-30th February, 1980.