Impact of the National *Fadama* Development Project on Profitability and Organisation of Small Irrigated Farms in Zamfara State, Nigeria

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Abstract

The study examined the impact of the National Fadama Development Project (NFDP) on resource use, enterprise combination, income and optimum organization of small irrigated farms in Zamfara State. To achieve the objectives of the study, data were collected from 40 farmers participating in the Project and 40 non-participants who were selected through a combination of multi-stage and stratified sampling methods. Descriptive statistics, farm budgeting and linear programming were used to analyse the data. The results showed that participating farmers used more resources and earned higher incomes than the non-participants. Furthermore, they produced more crop enterprises. The linear programming analysis revealed that opportunities exist for increasing profit through resource reorganization. It also showed that such reorganisation would yield more income to the participants than the non-participants. It was concluded that the NFDP had made positive impact on fadama farming in the area. To increase participation, it was suggested that the usual requirement for farmers to deposit some money before benefiting from the Project should be waived for farmers who are unable to pay. Furthermore, continuous monitoring of soil and water quality as well as ground water table was advocated, in order to ensure sustainability of fadama irrigation in the area.

Introduction

Recognising that the full potentials of Nigeria's agriculture could not be realised without the development of her water resources for irrigation, governments in Nigeria have adopted various irrigation development policies. One of the most recent irrigation policy thrust of the government is small-scale *fadama* (in-land valley lands which are low-lying and seasonally flooded) development. This policy is being implemented by the World Bank-assisted Agricultural Development Projects under the National Fadama Development Project (NFDP). The loan for the execution of NFDP was signed in 1991, but the Project took off effectively in 1994, three years behind schedule. The Project was to be executed in two phases of four years each. Thus phase I was to end in 1998 and phase II was to follow immediately after. However, phase II could not commence until 2001(Ribe, 2001). Zamfara is one of the core states implementing the Project through the Zamfara Agricultural Development Project.

As a radical departure from previous irrigation development policies (such as the river basin development drive), whereby irrigation schemes were designed and managed by government agencies for farmers, the NFDP focuses on assisting farmers to develop fadama lands which are owned and managed by the farmers. The objectives of the Project were to be achieved through: (i) simplifying of drilling technology for shallow tube wells (ii) construction of fadama infrastructure such as access roads, fadama roads, go-down stores and other marketing infrastructure (iii) organising farmers into viable associations (Water Users' Associations) for effective irrigation management, cost-recovery and better access to credit, marketing and other services and (iv) conducting aquifers studies and monitoring environmental impacts, water harvesting methods and upgrading irrigation technologies, including market development for fadama crops.

Problem Statement and Objectives

The apparent aim of the NFDP is to increase resource utilization by farmers in order to increase agricultural production and farm incomes in a sustainable manner, through small-scale irrigation development. But the question is: to what extent is this goal being achieved? It is important to investigate this question in order to evaluate the impact of the policy of small-scale fadama development on farmers. In pursuing the answer to this broad question, several specific research questions need to be answered. Those addressed by this study include: (i) how has the policy affected resource-use by farmers? (ii) how has it affected farmers' choice of enterprises? (iii) are farmers obtaining the highest possible income under the project? (iv) how has the project affected fadama farm plans? Using Zamfara State as a case study, this study aims at providing answers to these questions. The study pursued the answers to these, using the "with and without" approach, through the following specific objectives:

(i) to compare levels of resource-use between farmers participating in the NFDP and non-participants,
(ii) to compare the types of enterprises produced by the participants with those of non-participants,
(iii) to compare the income of participants with those of non-participants and
(iv) to compute and compare optimum farm plans for participants and non-participants.

Methodology

The Study Area

The study was conducted in Zamfara State which lies in north-western Nigeria within latitudes 10° 40'- 13° 40' N and longitudes 4°30'- 7° 06' E. The State has a relatively short rainy season (June - October) and fairly long dry season (November - May). Upland crops are grown rainfed during the rainy season. To avoid idleness of their resources during the dry season, farmers undertake dry season irrigated farming especially in the fadama lands which are found in the flood plains of Rivers Sokoto and Rima and their tributaries such as Rivers Bunsuru, Gagare, Ka and Zamfara. Crops grown in the fadama include rice, tomato, pepper, onion, sugarcane, sweet potato, eggplant, cassava, maize, okra and green vegetables.

Sampling Procedure and Data Collection

A combination of multi-stage and stratified sampling techniques were used to select the respondents. First, the State was divided into two zones following the same boundaries as the two zones of the Zamfara Agricultural Development Project (ZADP). Then two local government areas (LGAs) were randomly selected from each zone. Two villages were then randomly selected from each LGA. In each village, a sampling frame of dry season fadama farmers was established. Farmers in the list were then stratified into two, based on whether or not they benefitted from the NFDP/ZADP package (which includes supply of tube well, pump, technical advice, improved inputs, etc.). Five respondents each were then randomly selected from the lists of those who have benefitted (participants) and those who have not benefitted (non-participants). Thus, a total of 40 participants and 40 non-participants were sampled for the study.

Data were collected from the selected farmers for the 2000/2001 irrigation season by one of the authors assisted by trained enumerators, using questionnaire. The data collected include input-output, demographic and price data.

Data Analysis

The first and second objectives of the study were achieved through descriptive statistics. In addition, student T test was used to test for significant difference in resource use between the participants and non-participants in objective one. The third objective was achieved by a combination of farm budgeting and student T test, while the fourth objective was achieved through linear programming.

The Farm Budgeting Model

The farm budgeting model used is of the form:

$$GM = GI - VC \quad \ldots\ldots (1)$$

Where GM = gross margin
GI = gross income
VC = variable cost

The Linear Programming Model

Linear programming is often helpful in decisions requiring a choice among a large number of alternatives. It has been employed in several studies for determining the optimal organization of peasant farming systems in Nigeria (Ogunfowora, 1970; Abalu, 1975; Ogungbile,1980).

The linear programming model employed in this study is specified as:

Maximise $Z = \sum c_j X_j \quad \ldots\ldots (2)$

Subject to:

$\sum a_{1j} X_j \leq b_1$ (hectares of land) $\ldots\ldots (3)$

$\sum a_{2j} X_j \leq b_2$ (man-days of labour) $\ldots\ldots (4)$

$\sum a_{3j} X_j \leq b_3$ (operating capital) $\ldots\ldots (5)$

and $X_j \geq 0$ (non-negativity constraint) $\ldots\ldots (6)$

only eight crops which were grown in 13 patterns. The crops that the non-participants did not produce include rice, sweet potato, maize, wheat, cabbage, sweet pepper and cassava. Some of the most popular crops or cropping patterns in the zone include tomato, onion, tomato/hot pepper mixture, hot pepper and sugar cane.

The foregoing results indicate that participants grew more crop types than the non- participants. This could probably be attributed to the fact that the participants had larger farm holdings and easier access to farm inputs than the non-participants. This enabled them to accommodate more crops and even experiment with new ones, such as cabbage and wheat, which are relatively new in the area. It could therefore, be inferred that by making it possible for farmers to cultivate larger plots and facilitating their access to inputs, the NFDP may have increased the ability of fadama farmers to diversify their production base.

Impact on Costs and Returns

Table 4 shows that the non-participants in either of the zones incurred higher (but statistically insignificant) variable cost per hectare than the participants. When expenditure on the whole farm is considered, however, it is evident that the average participant incurred significantly higher ($P<0.05$) variable cost than the non-participant. This is expected since the participants used significantly higher quantities of purchased inputs than the non-participants (Table 1). Although they obtained these inputs at lower prices through their water users' associations, it appears that the differences in quantities more than off-set the price differences.

Table 4 also shows substantial differences in gross margins obtained by participants and non-participants. In Gummi zone, the average participant obtained a gross margin of above N137,000, compared to just slightly above N25,000 obtained by the average non-participant. This difference is highly significant ($P<0.01$). A similar wide and significant difference was also observed in Kaura Namoda zone. Part of these differences is accounted for by the larger farm holdings of the average participant over the non-participant. When the effect of farm size is removed (by obtaining the gross margin on per hectare basis) (Table 4), the gap in the gross margins narrowed, but was still highly significant in Gummi zone. Perhaps, in addition to the benefits of extensification, participation in the NFDP enabled the farmers to obtain better prices for their products through group marketing.

Optimum Farm Plans

Table 5 shows the summary of the optimum farm plans, obtained through linear programming, for fadama farmers participating in the NFDP and the non-participants. It can be seen that out of the various crops and crop combinations earlier listed, only very few of them entered the optimum plans. For instance, in the Gummi zone, only hot pepper and sweet pepper/hot pepper/tomato mixture entered the final plan for participating farmers. Similarly, only onion and sweet pepper were competitive enough for the optimum plan of non-participants. In the Kaura Namoda zone, only tomato and maize/cassava mixture entered the optimum plan for the participants, as against onion and sugarcane/okra mixture for the non-participants. If profit maximisation is the objective of the farmers, these are the enterprises in which they should specialise.

The results further show that land was exhausted in all the plans while labour was exhausted in all but one plan. This suggests that land and labour may be important constraints for further expansion of cultivation in the area. Capital was, however, used up completely only in the optimum plan for non-participants in the Gummi zone, suggesting that capital may not be a major factor limiting fadama cultivation in the area.

Table 5 also shows major differences between the total net returns achievable through the reorganisation of resources in line with the optimum plans and what farmers obtain under the existing plans. These differences are further underscored when the returns are expressed on per hectare basis. Specifically, there would be increases in net revenue per hectare of 77 to 133% if farmers adopt the optimum plans in place of the existing plans. These results show that there is substantial room for increasing returns to fadama farming through reorganization of resources in the area. This contrasts with the notion that

allocative efficiency is high in traditional African agriculture (Shapiro, 1973; Cisse, 1987).
The study also reveals major differences in net revenue of the optimum plans between participating farmers and non-participants. For instance, the optimum-plan net revenue per hectare for the participants in Gummi zone was about ₦139,852 compared to only ₦60,439 for the non-participants. This is an increase of about 131%. In the Kaura Namoda zone, there was also an increase of about 28%. This suggests that the NFDP in Zamfara State has increased not only the existing profit levels but also the potential profitability that could be obtained through optimum allocation of resources.

Conclusion and Recommendations

The study examined the impact of the National Fadama Development Project (NFDP) on resource use, enterprise choices, income and organization of irrigated farms. The results revealed that the NFDP has substantially increased the sizes of land cultivated by fadama farmers. It has also raised the level of input of other factors such as labour, fertilizers and chemicals. The higher level of resource employment has significantly increased the income of participating farmers. The Project has also increased the scope of crop enterprises produced by the farmers. Furthermore, the optimum farm plans computed showed that reorganisation of the farms would yield more income for the participants than the non-participants. It could be concluded therefore, that the NFDP has made positive impact on fadama farming in Zamfara State.

To further improve on its performance, it is suggested that the Project should review its criterion for participation. One of the requirements for participation is for farmers to deposit some specified amount of money before the fadama farming package is delivered to them. This has excluded farmers who are unable to pay this deposit from benefiting from the Project. Perhaps, instead of requesting for deposits upfront, indigent farmers could be allowed to start paying for the package only after they start realising returns from the package.

Furthermore, this study has shown that there is room for higher profits through reorganisation of resources and appropriate choice of enterprises. There is the need for extension agents, in collaboration with researchers, to assist farmers in allocating farm resources optimally. Profits in the area could also be increased through elimination or reduction of post-harvest losses, which are currently high. Most fadama crops are highly perishable and when there is glut in the market, which is frequent in the area, farmers lose substantial parts of their harvests. This could be checked if the Project, in partnership with the private sector, establishes processing firms in the area.

Finally, there is the need for the Project to monitor soil and water quality as well as the ground water table at various fadama irrigation sites in the State. This will ensure early detection of such problems as soil salinity and declining water table, which could endanger sustainability of fadama irrigation.

References

Abalu, G.O.I. (1975). Optimal investment decisions in perennial crop production: A linear programming approach. *Journal of Agricultural Economics*, 26: 383-398.

Baba, K.M. (1993). Irrigation development strategies in sub-Saharan Africa: A comparative study of traditional and modern irrigation systems in Bauchi State of Nigeria. *Agriculture, Ecosystems and Environment*, 45 (1993): 47-58.

Baba, K.M. and B.R. Singh (1998). Sustainable development of the *fadama* lands in northern Nigeria: A review of the potentials and challenges. *Nigerian Journal of Rural Sociology*, 2 (Special edition): 95-105.

Banard, C.S. and J.S. Nix (1976). *Farm Planning and Control*. London: Cambridge University Press.

Cisse, Y. (1987). Resource use and productivities: A comparative study of intensive and non-intensive farming systems in "Mali-Sud" Rural Development Project. Unpublished M.Sc thesis, Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University, Zaria, 160pp.

Frick, G.E. and R.A. Andrew (1965). Aggregation bias and four methods of summing farm supply functions. *Journal of Farm Economics*, 47: 696-700.

Nwa, E.U. (1981). An evaluation of small pump and shadoof systems of irrigation in northern Nigeria. Samaru J. Agric. Res., 1(2): 191-201.

Ogunfowora, O. (1970). A linear programming analysis of income opportunities and optimal farm plans in peasant farm. *Bulletin of Rural Economics and Sociology*, 5: 223-249.

Ogungbile, A.O. (1980). An evaluation of improved sole crop production technology on small farms in northern Nigeria under different farm power sources: A multi-period linear programming approach. Unpublished Ph.D thesis, Iowa State University, USA.

Ribe, I.A. (2001). The role of dry season farming in poverty alleviation: A case study of the Zamfara Agricultural Development Project Fadama Development Programme in Zamfara State. Unpublished postgraduate diploma project report, Department of Agricultural Economics and Extension, Usmanu Danfodiyo University, Sokoto, 56pp.

Shapiro, K.H. (1973). Efficiency and modernisation of African agriculture: A case study in Geita district, Tanzania. Unpublished Ph.D thesis, Standford University, Standford C.A.

Singh, B.R. (1997). Potentials and challenges of *fadama* farming in the erstwhile Sokoto State, Nigeria. In: Singh, B.R. (ed.) *Management of Marginal Lands in Nigeria*. Proceedings of the 23rd Annual Conference of the Soil Science Society of Nigeria, Usmanu Danfodiyo University Sokoto, pp.119-129.

Singh, B.R. and G.A. Babaji (1990). Characteristics of the soils in Dundaye District. II. The *fadama* soils of University Farm. *Nigerian J. Basic Appl. Sci.* 4: 29-30.

Singh, B.R., G.A. Babaji and S.A, Ibrahim (1996). Characteristics of the soils in Dundaye District. III. The soil and water quality along Kandoli Shela Stream valley. Nigerian *J. Basic Appl. Sci.* 5(1&2): 77-84.

Table 1: Levels of resource use by participating and non-participating farmers

Resource	Per resp. or per ha[a]	Participants		Non-participants		
		Mean	SD[+]	Mean	SD	t-value
Gummi Zone						
Land (ha)	-	1.77	1.09	0.97	0.83	2.63**
Labour(man-days)	1	82.55	58.56	64.05	56.27	1.02ns
	2	47.17	16.75	74.07	64.70	-1.80*
Fertilizer (kg)	1	296.25	294.50	138.75	122.06	2.21**
	2	150.95	82.92	183.90	126.13	-0.98ns
Chemical (naira)	1	89.25	174.40	40.00	123.12	1.03ns
	2	87.60	176.42	90.00	278.91	0.03ns
Kaura Namoda Zone						
Land (ha)	-	2.16	0.87	0.45	0.33	7.13***
Labour(man-days)	1	114.89	51.41	36.86	38.87	4.69***
	2	56.50	21.13	72.87	24.80	-1.95*
Fertilizer (kg)	1	194.40	122.41	15.63	10.21	5.64***
	2	91.67	42.34	41.83	27.37	3.83***
Chemical (naira)	1	580.67	1118.36	26.00	45.99	1.92*
	2	215.54	338.31	50.65	59.12	1.86*

[a] 1, per respondent; 2, per hectare per respondent

[+] SD, standard deviation

*, significant at P<0.10; **, P<0.05; ***, P<0.01; ns, not significant

Source: Survey data, 2001

Table 2: Crop enterprises produced by participating and non-participating farmers in Gummi Zone*

Enterprise	Participants		Non-participants		Total	
	Freq.	%	Freq.	%	Freq.	%
Rice	7	35	5	25	12	30
Sweet Potato	5	25	2	10	7	17.50
Onion	7	35	8	40	15	37.50
Sugar cane	1	5	1	5	2	5
Tomato	8	40	10	50	18	45
Amaranths	3	15	3	15	6	15
Hot pepper	2	10	1	5	3	7.50
Sweet pepper	1	5	1	5	2	5
Garlic	2	10	1	5	3	7.50
Okra	1	5	0	0	1	2.50
Garden egg	2	10	0	0	2	5
Maize	0	0	2	10	2	5
Lettuce	3	15	3	15	6	15
Okra/garden egg	1	5	0	0	1	2.50
Hot pepper/sweet pepper	1	5	0	0	1	2.50
Lettuce/okra	1	5	0	0	1	2.50
Garlic/garden egg	1	5	0	0	1	2.50
Hot pepper/sweet pepper/tomato	3	15	0	0	3	7.50

* n = 20 for each category of farmers

Source: Survey data, 2001

Table 3: Crop enterprises produced by participating and non-participating farmers in Kaura Namoda Zone*

Enterprise	Participants		Non-participants		Total	
	Freq.	%	Freq.	%	Freq.	%
Rice	2	13.33	0	0	2	6.67
Sweet potato	1	6.67	0	0	1	3.33
Onion	6	40	1	6.67	7	23.33
Sugar cane	3	20	1	6.67	4	13.33
Tomato	7	46.67	0	0	7	2333
Amaranths	1	6.67	0	0	1	3.33
Hot pepper	4	26.67	0	0	4	13.33
Garden egg	0	0	1	6.67	1	3.33
Maize	1	6.67	0	0	1	3.33
Lettuce	1	6.67	2	13.33	3	10
Wheat	3	20	0	0	3	10
Sugar cane/tomato	1	6.67	2	13.33	3	10
Lettuce/Amaranths	2	13.33	1	6.67	3	10
Lettuce/cabbage	1	6.67	0	0	1	3.33
Hot pepper/sweet pepper	1	6.67	0	0	1	3.33
Tomato/onion	1	6.67	2	13.33	3	10
Cassava/okra	1	6.67	0	0	1	3.33
Cassava/maize	2	13.33	0	0	2	6.67
Tomato/lettuce	1	6.67	0	0	1	3.33
Tomato/hot pepper	1	6.67	4	26.67	5	16.67
Tomato/okra	0	0	2	13.33	2	6.67
Sugar cane/okra	0	0	1	6.67	1	3.33
Sugar cane/garden egg	0	0	1	6.67	1	3.33
Sugar cane/tomato/okra	0	0	1	6.67	1	3.33
Hot pepper/lettuce/Amaranths	1	6.67	0	0	1	3.33
Hot pepper/onion/tomato/Amaranths	0	0	1	6.67	1	3.33

* n = 15 for each category of farmers
Source: Survey data, 2001

Table 4: Costs and returns of participating and non-participating farmers (₦)

Cost/return	Per resp or per ha[a]	Participants		Non-participants		t-value
		Mean	SD[+]	Mean	SD	50.44
Gummi Zone						
Variable cost	1	24,930.59	16,813.01	13,452.65	12,414.74	2.44**
	2	14,518.68	6008.19	15,179.40	8,954.30	-0.27ns
Gross margin	1	137,481.10	69,879.10	25,179.65	15,784.70	7.01***
	2	94,105.99	57,074.03	38,044.44	30,198.75	3.88***
Kaura Namoda Zone						
Variable cost	1	29,428.33	10,505.93	8,710.33	10,647.24	5.36***
	2	14,682.04	4,280.38	16,883.63	5,951.80	1.16ns
Gross margin	1	78, 509.40	43,202.99	9,393.27	6,574.10	6.13***
	2	37,896.93	19,259.26	29,263.20	21,601.46	1.16ns

[a]; 1, per respondent; 2, per hectare per respondent
[+]; standard deviation
**, significant at P<0.05; ***, P<0.01.
Source: Survey data, 2001

Table 5: Summary of optimum farm plans for participating and non-participating farmers

		Gummi zone		Kaura Namoda zone	
Item	Unit	Participants	Non-participants	Participants	Non-participants
Onion	Ha	0	0.309	0	0.132
Tomato	Ha	0	0	1.034	0
Hot pepper	Ha	0.521	0	0	0
Sweet pepper	Ha	0	0.661	0	0
Maize/cassava	Ha	0	0	1.126	0
Sugarcane/okra	Ha	0	0	0	0.318
Sweet pepper/hot pepper/tomato	Ha	1.249	0	0	0
Total land used in optimum plan	Ha	1.77	0.97	2.16	0.45
Total land used in existing plan	Ha	1.77	0.97	2.16	0.45
Total labour used in optimum plan	Man-day	83	58.20	115	37
Total labour used in existing plan	Man-day	83	64	115	37
Total capital used in optimum plan	₦	21,941.55	13,453	29,237.14	1,441.21
Total capital used in existing plan	₦	24,831	13,453	29,428	8,710
Shadow price of land	₦	138,920	58,461.37	28,734	43,070.55
Shadow price of labour	₦	20	0	629.17	68.31
Shadow price of capital	₦	0	0.14	0	0
Total net returns from optimum plan	₦	247,539.40	58,625.60	134,420.15	21,909.18
Total net returns from existing plan	₦	137,481.10	25,179.65	78,509.40	9,393.27
Net returns per ha from optimum plan	₦	139,852.77	60,438.76	62,231.55	48,687.07
Net returns per ha from existing plan	₦	77,672.94	25,958.4	36,346.94	20,873.93
Increase in net returns per ha of optimum plan over existing plan	%	80.05	132.83	71.22	133.24

Source: Survey data, 2001