Irrigation Projects Reform Case Studies: An Assessment of Projects' Performance[1]

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ABSTRACT

In Nigeria, the 1995-97 Corporate Plan mandated River Basins to generate funds internally from various water uses. Subsequently other services have been competing unfavourably with irrigation services. This motivated the assessment of the economic, social and financial performances of the Ogun-Oshun River Basin and Rural Development Authority's (O-ORBRDA) irrigation projects.

A structured questionnaire was used to gather primary data from 73 participating farmers. Documented primary data (records) on projects' activities from the 1995/96 to 2001/02 seasons were summarized into social, economic and financial performance indicators.

In the Sepeteri project, service payment is enforced at a cost recovery level of about 96 percent However, the project is not financially viable, because only 29 percent of the expenditure is covered. Furthermore, the farmers do not have much stake in determining the project's success, with a 67 percent social capacity level. The relative profit level of irrigated cropping is 1:1.13, and does not present sufficient evidence that farmers demand (or prefer) irrigated cropping to rain-fed cropping.

The Itoikin Project records a slightly greater problem regarding the enforcement of irrigation charges, with a 75 percent cost recovery level. The project covers about 50 percent of its total expenditure. The farmers do not have much stake in determining the project's success, with a 33 percent social capacity level. The relative cropping profit levels of 1:0.79 shows some evidence of higher demand or preference for irrigated land compared to rain-fed cropping.

For these two projects, inadequate funding and deteriorating infrastructures hamper the level of irrigation supply. Furthermore, the projects are not financially self-sufficient due to insufficient funding and the low level of demand for irrigation services by farmers.

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1. INTRODUCTION

1.1. Background Information

Irrigation in Nigeria was considered feasible through the development of the nation's water resources. This informed the establishment of 11 RBRDAs, (Ogun-Oshun River Basin and Rural Development Authority [O-ORBRDA] inclusive), between 1973 and 1979 to cover every part of the country (O-ORBRDA, 1998). The RBRDAs were set up to carry out a number of functions, particularly the development of irrigation infrastructure in the respective areas of operation. Smallholder and commercial farmers under irrigation schemes cultivate thousands of tons of crops by means of irrigation facilities (Alexander, 1996).

However, the overall performance of the existing irrigation facilities had declining, owing to a combination of technical, socio-economic and institutional factors (Nwa, 1993; Thaboni, 1997). One of the recent research recommendations to avert this trend is commercialization and eventual privatization of the RBRDAs. This move could jeopardize the River Basins Authority irrigation service and its primary statutory role, which is a planned agricultural development programme.

1.2. Problem Statement

The impact of project funding and management procedures on the level and distribution of a project's benefits has been one of water management questions facing policy makers in developing countries (Jensen, Rangeley and Dieleman, 1990).

Nigeria has invested in irrigation projects to counteract seasonal food shortages due to drought. Besides, the national goal of food self-sufficiency, the high cost of private water extraction and market distortions necessitated a huge investment on large-scale and public irrigation projects across the country. However, large-scale irrigation projects that have been developed so far have not been self-sustaining. This phenomenon is not peculiar to Nigeria.

Research efforts into this problem led to a proposal that government should shift attention from large to medium and small-scale irrigation projects (Thaboni, 1997; African Development Bank, 1998) in order to relieve governments of cost, administrative and maintenance burdens, which are much greater for large-scale projects than for small-scale projects. In response to this, the state's Agricultural Development Projects (ADPs) and Irrigation Departments diverted attention to small- and medium-scale irrigation projects.

Despite these attempts to develop irrigation projects, the irrigation potential remains largely untapped, because farmers' participation has declined, and the projects irrigate only small percentages of the land acquired or secured. For example, Adegbola and Akinbode (1986), in a review of O-ORBRDA irrigation projects, reported that the Itoikin, Mokoliki and Eyinwa communities did not participate in the projects within their communities. O-ORBRDA, at the outset in 1974, irrigated only 10 ha of land. This increased to 7 198.5 ha in 1984/85. However, by 1999, despite planning to irrigate 39,693 ha over its area of operation during the period, only 285 ha was actually irrigated. Only 6 ha and 41 ha were under irrigation for Sepeteri and Itoikin projects respectively during the 1999/2000 season (O-ORBRDA, 2000).

Recent development efforts have been directed at the institution of water market and economic incentives by commercialization and eventual privatization of the River Basins. The 1995-97 Corporate Plan mandated O-ORBRDA to generate funds internally to cushion the dwindling funds from budgetary allocations in order to meet substantial portions of its recurrent costs. According to Pingali (1997) a guided increase in agricultural commercialization should lead to increase in farm size, among other things. However, this move, if not guided, could expose the O-ORBRDA to a shift in priorities, from being a service provider to an enterprise unit, whereby it would be more concerned with activities that return the most internally generated revenue and less concerned with meeting the irrigation needs of the intended beneficiaries, which is the statutory role of the O-ORBRDA. The reason for this shift is that unguided pursuit of profit leads to inefficient and unfair services, since such projects are natural monopolies. For example, O-ORBRDA commenced producing drinking water in 1999, with revenue of N574 450 while revenues from sales of irrigation services in 1997, 1998 and 1999 were N175 200, N352 105 and N126 850 respectively (O-ORBRDA, 1997, 1998, 1999).

This situation could result into devastating consequences, including food insecurity in the command area and rural-urban migration. Most of the projects' staff could become redundant, and most of the land acquired and secured for the projects tied down and unutilized. Consequently the communities will become skeptical about future public development projects.

While most research efforts aiming to improve the performance of irrigation projects have focused on the structure, technology and environmental issues, some have investigated the socio-economic impact of formal irrigation projects on their command areas. This research aimed to prepare ground for an analysis of the impact of commercializing irrigation services on the projects' performances. The present focus is assessing projects' socio-economic and financial performance. The question is, how viable are the irrigation projects socially, economically and financially with respect to their irrigation services?

The aim of this paper is to provide information about the trends relating to the social, economic and financial status of O-ORBRDA farmer-based irrigation projects by characterizing trends in their operational and strategic performances. Studies on the performance of irrigation projects are essential prerequisites for well-informed commercialization decisions and eventual privatization.

This paper hopes to provide information to the donors/prospective stakeholders, the government, the project managers and the farmers. The indicators will inform each of the stakeholders the trend of performance and provide an indication of the correct course of action to improve the services. Specifically, this paper will give an indication of affordability and ease of enforcement of the irrigation services, profitability of irrigated cropping, the incentives for demanding irrigation services and possibility of financial sustenance.

1.3 Conceptual Framework

To quantify the socio-economic and financial viability of irrigation projects, the perspective of this paper is the economics and management of projects. The performance assessment is based on the policy at the sector level, the statutory role of public irrigation projects and their eventual privatization. According to Bos (1997) the performance indicators should show (i) how efficiency project management uses the resources (land, irrigation water and funds) and (ii) the degree to which the irrigation services respond to the need for irrigation services need by the intended beneficiaries. Upton (1997) recommends technical improvements, introduction of economic incentives through a system of water charges and organizational modification to enhance greater farmer participation as broad approaches to overcome poor performance and improve management scheme in bureaucratically operated irrigation systems.

Certain concepts should be borne in mind when evaluating the efficiency of irrigation projects in an economy where agriculture is the mainstay. Public irrigation projects in developing nations such as Nigeria seldom meet the conditions for competitive market analysis, because its outputs are natural resources (i.e. land and water), which are developed for national economic efficiency and development. According to Schreiner, Badger, Welsh and Suprato (1989), such projects are characterized by natural monopoly, derived demand, project externalities, non-market valuation and government interventions.

Therefore, it is quite possible for agencies managing projects to record negative returns because of the high cost of capital, while farmers make profits consistently. Consequently, the rational irrigation policy should ensure that the sound reason for fixing irrigation rates is the net additional benefits it offers. These benefits accrue to the region and the society as a whole. The major impacts of these benefits will be found in land use, employment, cropping patterns, farm inputs and so on. Hence, these benefits always receive priority above financial returns accruing to the government from irrigation rates. Therefore, to develop the social and economic capacities of intended beneficiaries to ensure a projects' success, the value of irrigation should be reflected in additional profit to farmers, because demand for irrigation services depends on the additional gain farmers expect from their uses (Jha, 1984).

To this end, the profits from irrigation services should play roles such as (i) payment for capital invested in projects; (ii) reward for innovation i.e. finding a new ways of developing and sustaining the projects and (iii) reward for efficiency in the supply and delivery of irrigation services such that lower costs lead to lower prices.

1.3.1 Performance indicators

Socio-economic and financial performance indicators for Research Programme on Irrigation Performance (See Bos, 1997) were constructed to assess the operational and strategic performances of the projects relevant to this paper. The indexes are highlighted below.

(a) $$Fee\,Collection\,Index = \frac{Irrigation\,Fees\,Collected}{Irrigation\,Fees\,Due} \qquad (1)$$

where

Irrigation fees collected = total revenue collected on irrigation service during an irrigation season (₦).

Irrigation Fees Due = total revenue collectible on irrigation services during an irrigation season (₦).

The Fee Collection Index reveals the level of acceptance of irrigation delivery as a public service to the farmers i.e. the ease of enforcement of an irrigation charge or how affordable the charge is among the intended beneficiaries.

(b) $$User's\ Stake\ Index = \frac{Number\ of\ Active\ project\ farmers}{Total\ number of\ project\ farmers} \quad (2)$$

where:

Number of Active project farmers = number of farmers in attendance.

Total number of project members = number of project farmers informed and expected to be in attendance.

The Users' Stake in Irrigation Project Index reveals the social capacity of intended beneficiaries and organization in managing and sustaining the project i.e. level of acceptance of responsibility for the project's success. The "involvement" of members was quantified using data on the attendance of farmers at the last five consecutive regular meetings called by management for a task agreed upon, such as water distribution, conflict resolution, plot maintenance, etc.

(c) $$\text{Re}lative\ Irrigation\ Service\ Cost\ Index = \frac{Irrigation\ \cos t\ per\ ha}{Total\ production\ \cos t\ per\ ha} \quad (3)$$

where:

Irrigation Service Cost per ha = cost of irrigation service per ha (₦/ha)

Total production cost per ha = average total cost of irrigated cropping per ha (₦/ha)

The Relative Water Cost Index will reveal the tendency of farmers to abandon or continue with irrigated cropping i.e. the farming system. It is computed on the average. However, the Relative Water Cost Index is perceived to be inadequate for measuring the tendency of farmers to abandon or continue irrigated cropping since, for most farmers in the developing nations, ends justify the means i.e. they consider profit to be far more important than cost. It is then modified to incorporate the ends, profits from irrigated and rain-fed croppings, as specified below:

(d). $$\mathrm{Re}\,lative\ \ Irrigation\,\mathrm{Pr}\,ofit\ Index = \frac{\mathrm{Pr}\,ofit\ \ from\ Irrigated\ Cropping}{\mathrm{Pr}\,ofit\ \ from\ Rain - fed\ Cropping} \qquad (4)$$

(e). $$Financial\ Self - sufficiency\ \ Index = \frac{Actual\ Income}{Total\ MO + M\ Expenditure} \qquad (5)$$

where:

Actual Income = total internally generated revenue from irrigation related services.

Total MO + M Expenditure = total expenditure on irrigation related services.

Financial Self-sufficiency Index will provide an indication of the financial viability of the project.

The Financial Self-sufficiency Index is admittedly subjective because "requirements" depends largely on the number of staff employed by the project agency per unit of irrigation area. However, O-ORBRDA irrigation projects have regular permanent employees who earn monthly salaries, irrespective of the level of services provided. Consequently the indicator seeks to capture the specific conditions obtainable in the irrigation services. The modified index is specified as follows:

(f) $$Financial\ Self - sufficiency\ \ Index = \frac{Actual\ Income}{Total\ MO + M\ Expenditure} \qquad (6)$$

2. LITERATURE REVIEW

2.1. O-ORBRDA and irrigation development

O-ORBRDA, one of the 11 RBRDAs established by the Federal Government of Nigeria under Decree Numbers 25 and 31 of 1976 and 1977 respectively, is a parastatal of the Federal

Ministry of Water Resources and Rural Development. The twelfth RBRDA was created in 1994. After to the start of the commercialization programme and the addition of the rural water supply function in January 1995, the River Basin Development Authorities (RBDAs) became River Basin and Rural Development Authorities (RBRDAs). Under this programme O-ORBRDA is responsible for developing and managing water resources in Osun, Oyo, Ogun and Lagos states. The command area has an estimated land area of 66 264 km^2. It is drained by two main rivers, the Ogun and Osun Rivers (after which the River Basin is named) and a number of tributaries and small rivers such as the Sasa, Ona, Ibu, Ofiki, Omi, Oba and Yewa rivers.

Since 1976 the original operational functions of the Authorities have been amended several times. Today, the O-ORBRDA operates under Decree No. 35 of 1987 and the Privatization and Commercialization Decree No. 25 of 1988 in its undertaking of comprehensive development of both surface and underground water resources for a variety of uses, with particular emphasis on the provision and maintenance of irrigation infrastructure and the handing over of all land to be cultivated under irrigation schemes to farmers (O-ORBRDA, 1998).

Therefore, O-ORBRDA is an irrigation management agency and bureaucracy whose roles include controlling water resources and working with farmers who are involved in private and commercial farming enterprises. To achieve these statutory roles, the Authority established and operates both small scale and large-scale farmer-based irrigation projects.

2.2. O-ORBRDA farmer-based irrigation projects

O-ORBRDA secured land for its irrigation projects by motivation strategies and only acquiring land for permanent structures after assuring the previous owners of the land of its willingness to pay crop compensation. The management and administration of these irrigation projects have been adjusted over time in response to changes in political regimes and their respective priorities.

Formerly, settled farm plot owners only paid in part for capital expenses, but paid fully for recurrent and operating inputs supplied. The farmers followed O-ORBRDA's management planned cropping pattern, which involved the authority ploughing, harrowing, planting and harvesting crops, the farmers only weeded and applied fertilizers to their plots. The authority would then take over the produce, process and market, deduct the costs of services and pay the balance to the farmers.

Currently, all farming operations are carried out directly by participating farmers. They only pay for water release expenses, tractorisation and other inputs supplied to them by the authority. Farmers own the proceeds from their irrigated farm plots. Each project is managed by a group of professional/technical staff headed by a project manager. The farmers are selected on the basis of traditional entitlement to land ownership in the given locality and proven commitment to farming as a career.

O-ORBRDA recommends a plot size of 2.5 ha per participant farmer. However, farmers are allocated plots ranging from 0.5 ha to 4 ha based on the project's peculiarities and farmers' capacity. The charges are N3 300/ha (N2 500 for irrigation water and N800 for technical advice) per irrigated plot and N200/ha for a dryland plot. The irrigation projects spread across the areas of operation. These include Igboijaiye, Ilero, Ofiki, Sepeteri, Oyan River Dam, Abeokuta Headquarters, Lower-Ogun, Asa, Iwo, Okuku, Igbonla, Eyinwa/Odogbolu/Aiyepe, Itoikin, Oogi, Ipetu-Ijesa and Oke-Odan Irrigation Projects. Of these only six projects, namely Igboijaye, Ofiki, Sepeteri, Abeokuta Headquarters, Itoikin, and Oke-Odan irrigation projects, supplied irrigation servicesin the 1998/99 dry season, while only Itoikin and Sepeteri supplied irrigation services in the 2000/2001 dry season (NRBDA, 1979; O-ORBRDA, 1997; 1998; 1999).

2.3. Water pricing problems in irrigation projects

Smith and Tsur (1997) and Tsur and Dinar (1997) conclude that public intervention is called for because of the presence of externalities, the small number of participants, various types of uncertainties and economies of scale that limit metering water for sale. Interventions range from price setting, quantity/quota setting or a combination of the two measures. For example, unmetered irrigation water is often priced by imposing per-acre fees on cultivated acreage, or by charging per-unit fees on observable inputs or outputs. However, where water is unmetered, regulation may not be directly applicable, therefore, for effective pricing, asymmetric information and transaction costs are required. These empirical studies reveal that, beyond a certain level of transaction cost, the economy is better off without regulation.

Bhatia, Rogers and De Silva (1999) examined the efficiency, equity and sustainability implications of perceiving water as an economic good in India, and concluded that water pricing should reflect social, political and economic goals in different situations and that integration of all water uses in its pricing is crucial.

Tsur and Dinar (1997) identified and rated different methods of pricing irrigation water. Their empirical results reveal that welfare is affected markedly by the effect of water pricing on choice of crop. Water pricing is sensitive to implementation costs; an inefficient but simple method such as per acre pricing may outperform an efficient but complicated method, taking implementation costs into account. They concluded that (i) efficient use of irrigation water requires that the pricing method affects demand and (ii) pricing methods that do not influence water input directly, such as area pricing, lead to inefficient allocation. The preferred pricing method gives the highest social benefit and should be the one with lowest implementation cost.

A study by Jha (1984) on irrigation and agricultural development in India revealed that pricing of irrigation services in bureaucratic irrigation projects are characterized by the following problems:

i. farmers (intended beneficiaries) are unwilling to share the financial burden of irrigation facilities;

ii. farmers are unwilling to share the responsibilities of operating and maintenance of irrigation facilities;

iii. high rent of irrigated land virtually negates project participation incentives;

iv. uncertainty about both prospectivefarmers' demand for irrigated land and irrigation agents' supply of irrigated land (i.e. farmers are not certain of the supply and irrigation agents are not certain of the demand); and

v. difference in crops and cropping pattern planned the projects' agents and the prospective farmers.

In a world-wide survey of irrigation water pricing methods Bos, Murray-Rust, Merrey, Johnson and Snellen (1994) discovered that more than 60% of pricing method was based on unit area; less than 15% on a combination of per unit area and volumetric method and about

25% on volumetric method. They found that methods are determined by implementation costs, ease of enforcement and the institutions responsible for water delivery. However, the authors did not explore the success of various methods.

In a study of four regions in the Western United States Moore, Gollehon and Carey (1994) discovered that farmers respond to increases in water prices by changing to crops that require less water, thereby reducing the acreage of crops requiring high volumes of water. This means that levying too high a charge could result in underutilization of facilities, as had occurred on the Sarda Canal in India (NCAER, 1959). However, Krishna (1963) found that an increase in general water rates increases the technical efficiency with which water is applied.

Sampath (1984) argues that an uneconomic water levy leads to wasteful use of water, since the cost of water to the farmer is not reflected in the value water to him/her. This implies that levying water should reflect the economic cost of water to farmers because, according to Smith and Tsur (1997), the farmers themselves take into account the true cost of water in their input-output decisions.

Using Bakalori Irrigation Projects as a case study, Kwanashie, Togun, Ajobo and Ingawa (2000) investigated the extent to which the problems of poor pricing, poor planning, lack of good management and poor project monitoring and evaluation have affected water resource use in Nigeria. They conclude that these problems undermine water resource management in Nigeria, and recommend market-based strategies for allocating water between competing users for efficient and cost effective use of water resources.

Johnson, Svendsen and Zhang (1998) studied the way organizational reforms affect changes in system performance of the Bayi and Nanyao Irrigation Projects. They report that the irrigation fee collection rate increased from 30% to 70% nationally and that total collections increased four-fold as a result of the organizational reforms. The reforms included development of multipart fee structures, which include flat collection charge coupled with variable volumetric and energy-based charges, along with the development of a variety of sideline enterprises by the irrigation agency to absorb redundant staff, thereby augmenting irrigation fee collections by almost 14%.

2.4. Ownership and cropping pattern problems in natural resource projects

The problem of access to land is an age-old problem that has plagued every nation of the world at one time or another. Herrera, Riddell and Toselli (1997) state that technology applied to food production, including irrigation, can improve the productive capacity of land. However, when application of technology is characterized by unequal power relationships, it only leads to greater profits for those with a combination of land, financial resources, creditworthiness and political influence.

When farmers own land and work for themselves, they have the motivation to work hard to make the land more productive. This was found among the irrigators at Kano River Irrigation Projects in Nigeria (Omotesho, 1981). Similar results were reported by Fabiyi and Idowu (1997). They examined the impact of land and tree ownership on the adoption of an alley farming system in Southern Nigeria and found that, while technology is relatively cheap for the smallholder farmers, level of adoption is only high among those that have primary access to land. Johnson (1986) reports that in Thailand lack of clear land title significantly constrains investment among farmers. Ohene-Yankyera (1980) found that the tenure status of farmers and the number of holdings per farmer significantly affect the rate of adoption in agro-forestry projects in Ghana.

Quasem (1994) studied the impact of irrigation on household income and employment in Bangladesh. He observed that households with larger farm sizes but less irrigation services have greater household income compared to their counterparts' income in more irrigated villages but with smaller farm sizes

Toulimin and Quan (2000) report that governments have been forced to recognize the relatively limited role they can play in direct allocation and management of land resources, because they have been systematically neglecting resources and some tenure systems do not fall into the clear categories of conventional land law. Hence common property resource management by which people gain access to resources, among other measures, usually appears to be instituted as an afterthought to debates on irrigation land policy, if at all. This despite the importance of the commons for securing rural livelihoods, to many African countries. Economic analysis supports the view that the contribution of land to economic growth depends on the security, duration and enforceability of property rights, since these provide the incentives for agricultural investment.

2.5. Knowledge gained from the literature review

From the foregoing review of literature, it is clear that irrigation could serve as a government intervention measure that can assist to effect income distribution to the poor and attain national objectives. These objectives can be achieved by supporting community-based water resource development. While some governments provide or regulate irrigation water services, others encourage concessional agreements or full privatization as a means of water resource development. The premise on which this policy is based remains controversial. Some argue that water should be viewed as an economic good to ensure efficiency, others are of the opinion that it should remain a social good due to market failure.

The methods employed by various nations and regions of the world vary according to, among others, national economic goals, regional goals, political ambition, specific socio-economic conditions within the nation, institutions, location of projects, irrigation districts, geographic location, the system of irrigation i.e. technology, crops grown, season, nature of agreement (long lease or short lease), the procedure used to impose penalties for unauthorized use, availability of water and preferred cropping patterns. Hence it is appropriate for water to graduate from being a social good to an economic good in response to a particular market situation. However, a number of management strategies on pricing method, physical structure, cropping pattern, farm size and others need to receive attention to ensure sustainable privatization.

3. METHODOLOGY

3.1. Area of study

Of the 17 farmer-based irrigation projects under the O-ORBRDA, only the Sepeteri and Itoikin Irrigation Projects that supplied irrigation services until the 2001/2002 cropping periods are covered. The Sepeteri Irrigation Project is one of the Upper Ogun Irrigation Projects, located near Saki, in the Saki-East Local Government Area of Oyo State. The intention was to irrigate 2000 ha with a sprinkler system. The Itoikin Irrigation Project is one of the Lower Oshun Basin Irrigation Projects located in the Epe Local Government Area of Lagos State.

3.2. Data sources and collection

A set of structured questionnaires was used to gather primary data from the project farmers (44 and 29 farmers in Sepeteri and Itoikin respectively). In total the farmers cultivated 22,35 ha and 95,5 ha in Sepeteri and Itoikin respectively. The data include irrigated farmland sizes, production costs and returns, and attendance and participation at Water User Association (WUA) meetings and activities. Records of irrigation activities and transaction records over the 1995/96 to 2001/2002 growing seasons were also collected. In addition, personal observations were made on the project sites, and some project personnel were interviewed.

3.3. Analytical techniques

3.3.1. Indices construction

An index number is used to summarize series of figures over years. It shows how much the figure for one-year differs from that of another. Usually, a fairly typical year's figure is taken as base-year figure and others are compared to the base-year figure. The commonest application of index numbers is for comparing a series of annual figures.

In this paper, the 1995/96 irrigation season was taken as base year, meaning that subsequent figures were compared to 1995/96 figures. This year was chosen as a base year in order to examine how projects have been performing regarding irrigation services since commercialization started in 1995. The year was assumed to be a logical base year for evaluating performance of a formerly public irrigation project. To explore the rate of change in the indices over years, a chain index was computed by using the previous period as base for each current year's index computation. Chain index shows whether the rate of change is rising (rising numbers), falling (falling numbers) or constant (constant numbers) as well as the extent of the change from year to year. The formula to compute the chain index is as follows:

$$Chain\ Index = \frac{index_1}{index_0}, \frac{index_2}{index_1}, \ldots, \frac{index_n}{index_{n-1}} \quad (7)$$

where n = number of years over which the indices were compared. Furthermore, to observe the average annual percentage change over the years, the average annual percentage change was computed as follows:

$$Average\ Annual\ percentage\ Change = 100(\sqrt[n]{Index_l \div Index_i} - 1) \tag{8}$$

where indexi = base year index; indexl = last year index and n = number of years over which the trend is studied (Harper, 1991).

3.3.2. Paired-samples t-test procedure

The relative cropping profit index was constructed from empirically quantified data collected. A paired-samples t-test procedure was carried out to compare the means of costs and returns to irrigated and rain-fed cropping for same group of project farmers. The differences between values for the costs and returns to irrigated and rain-fed croppings were computed for each farmer and the average was tested to determine whether it was different from 0.

Noted that the total population of farmers was included in the analysis. The data on the cross-sectional costs and returns for both irrigated cropping and rain-fed cropping for the same farmers during 2001/2002 cropping sessions were used. A T-test was conducted to examine the difference in average costs and returns to irrigated and rain-fed cropping realized by the same set of farmers in the same project. The farmers grew the same crops. The formula for the T-distribution is given below.

$$t^* = \frac{\mu_i - \mu_r}{\sqrt{\frac{\sigma_i^2}{N_i} + \frac{\sigma_r^2}{N_2}}} \tag{9}$$

where

t* = t calculated

μi = average cost of (or returns from) irrigated cropping

μr = average cost of (or returns from) rain-fed cropping

$\sigma i2$ = variance of cost of (or returns from) irrigated cropping

$\sigma r2$ = variance of cost of (or returns from) rain-fed cropping

ni = population size (irrigated farmers)

nr = population size (rain-fed farmers)

4. RESULTS AND DISCUSSION

4.1. Project characteristics

4.1.1. Farm characteristics

Table 1 provides a summary and descriptive statistics of data collected from the farmers and by personal observation. The statistics and summary show some of the project/farm characteristics.

In Sepeteri Project, farmers are permitted to pay for services after their crops have been sold. Average farm size is 0,51 ha. At least 64% of farmers have been participating in the project for at least six years. About 77% of the farmers acknowledged credit availability as a limiting factors for irrigated plot size. The project does not usually organize social welfare for participants. Crops are restricted to vegetables. Farmers complained of high risks associated with site of the project.

At Itoikin, payment is made before services are rendered. Average farm size is 3,29 ha. The project occasionally organizes social welfare programmes for participants, such as field days. At least 76% of farmers have been participating in the project for at least six years. About 55% of farmers attributed limited demand for services to lack of credit facilities, while the rest considered the irrigation charges to be too high. Farmers complained of floods, especially during raining seasons.

Inadequate funding and a deteriorating infrastructure limit irrigation supply in the two projects.

Table 1: Farm Characteristics of Sepeteri and Itoikin Irrigation Projects

Item	*Sepeteri*	*Itoikin*
Payment for irrigation services	After service	Before service
Average irrigated plot size(ha)	0,51	3,29
Social welfare programme	None	Field days
Cumulative % of farmers who have participated consistently for at least six years	64	76
Factors that limit irrigation demand:		
Lack of credit	77%	55%
high cost of irrigation	11%	45%
Other non-farm engagement	12%	
Risk associated with the project	Harsh harmattan between January and February Monkey pest invasion in February Occasional invasion by cattle owned by nomadic Fulani	Floods
Factors that limit irrigation supply	Inadequate funding Deteriorating infrastructure	Inadequate funding Deteriorating infrastructure

Source: Field survey, 2002

4.1.2. Sources and costs of farm inputs

Table 2 shows the sources of farm inputs and average unit costs. At Sepeteri, hired labour cost N500/man-day on the average. Other inputs were supplied by management of the irrigation projects at the rates stated in the table. Credit facilities in the form of institutional loans were not available to farmers at Sepeteri. At Itoikin, management only supplied the irrigated and dryland plots. Tractorisation and seed were sourced from the Lagos State Agricultural Development Project (Lagos ADP) agent, at a rate of N4500/ha and N150/kg respectively. Farmers bought fertilizer jointly from the Lagos State Agricultural Input

Supply Agent (LAISA) at the subsidized rate of N1,200/bag. Those who had access to cooperative loans paid average of 1.5% interest. Hired labour cost as much as N3 000/ha.

Table 2: Sources and cost of farm inputs

Inputs	*Sepeteri*		*Itoikin*	
	Source	*Average unit cost*	*Source*	*Average unit cost*
Irrigation services (₦/ha)	O-ORBDA	3 300	O-ORBDA	3 300
Upland rain-fed) (₦/ha)	O-ORBDA	200	O-ORBDA	200
Transportation of produce to market	O-ORBDA	750	Not available	-
Hired labour (₦/ha)	Market	500	Market	3 000
Fertilizer (₦/50 kg)	O-ORBDA	1 200	LAISA	1 200
Herbicides (agrochemicals) (₦/liter)	O-ORBDA	700	Market	800
Seeds (₦/kg)	O-ORBDA	500	LAGOS ADP	150
Tractor/disc plough (₦/ha)	O-ORBDA	1 500	LAGOS ADP	4500
Loan (%)	Not available	-	Cooperative	1,5

Source: Field survey, 2002

4.1.3. Average cost and return per ha

From Table 3 the costs and returns to irrigated and rain-fed cropping were compared within each project. For Sepeteri, total revenue per ha was estimated to be N41 569,91 and N30 990,21 for irrigated and rain-fed croppings respectively. Total costs were estimated at N10 698,47/ha and N3 633,24/ha for irrigated and rain-fed croppings respectively. The cost of irrigated cropping was significantly higher (1% level of significan) than that of rain-fed cropping. However, the estimated net revenues for irrigated cropping (N30 841,44/ha) and rain-fed cropping (N27,357.07/ha) do not differ statistically because of higher costs of irrigated cropping. Furthermore, farmers spent less on variable inputs under rain-fed cropping compared to irrigated cropping.

On the other hand, at Itoikin project, total revenues per hectare were estimated at N49 229,31 and N44 486,74 for irrigated and rain-fed croppings respectively. Total costs were estimated to be N26 321,15/ha and N15 526,34/ha for irrigated and rain-fed cropping respectively. The costs of irrigated cropping are significantly (5% level of significance) higher than that of rain-fed cropping. The estimated net revenues (N22 908,16/ha and N28 960,40/ha) for the two types of cropping do not differ statistically.

Table 3: Average costs and returns per ha of irrigated and rain-fed croppings

	Sepeteri		*Itoikin*	
Cost and returns	***Irrigated***	***Rain-fed***	***Irrigated***	***Rain-fed***
Total Revenue *(₦/ha)*	41 569,91*	30 990,21*	49 229,31	44 486,74
Cost of Irrigated plot *(₦/ha)*	3 300,00	-	3 300,00	-
Total cost *(₦/ha)*	10 698,47**	3 633.14**	26 321,15*	15 526,34*
Net return *(₦/ha)*	30 871,44	27 357.07	22 908,16*	28 960,40*
Relative irrigation costs (%)	20		13	
Relative cropping profit index	1,08		1,26	

** significant at 1%; * significant at 5%

Source: Field survey, 2002

4.2. Socio-economic and financial performance of the projects

Table 4 provides a summary of the socio-economic and financial performances of the projects. Each item is discussed in the following subsections.

4.2.1. Irrigation fee collection performance

Table 4 reveals that the average index for irrigation fee collection performance is 96 percent for Sepeteri Project. This implies that enforcement of the irrigation service charge is successful, despite the fact that the payment is delayed until after produce has been sold. It could also be inferred that the irrigation service charge is affordable in this project and that cost recovery is possible. The chain index reveals an increase in performance (rising numbers from 81 percent in 1996/97 to 100 percent in 1997/98, at an average rate of 4,3%).

At Itoikin project, the average index is 0,75. i.e. as much as 75% of the total revenue was collected. This implies success regarding fee collection, that is the pricing method and cost recovery are 75% effective. However, the chain index reveals dwindling movement in the rate of change. The performance decreased at the average of 2,28% annually.

4.2.2. Relative irrigation service cost and cropping profit performance

The cost of an irrigated-plot as a percentage of total cost is 20% and 13% for Sepeteri and Itoikin respectively. However, it should be noted that the percentages of irrigation service cost to total production cost are high enough to make farmers abandon irrigated cropping for rain-fed cropping, since most of the respondents mentioned lack of credit as a limiting factor for demand for irrigated plots. Paired sample T-tests reveal that the irrigated and rain-fed cropping costs differ significantly at the 1% level for both projects. Yet the net profits of the two types of cropping are not significantly different from that at Sepeteri. The ratio of profit from irrigated cropping to profit from rain-fed cropping is 1:1.08 and 1:1.26 at Sepeteri and Itoikin respectively.

Costs of and net returns for both cropping systems are statistically significantly different at the 5% level for the Itoikin Project, but total revenues are not statistically significantly different. The costs of irrigation services could have brought about the marked difference in the net returns. On average, identical profit levels accrue to both croppings. Consequently, farmers may tend to prefer rain-fed cropping to irrigated cropping if they are credit constrained. They could also seek off-farm employment during the dry season.

4.2.3. Users' stake performance

Among the Sepeteri project farmers, the Users' Stake Performance Index is 0.67. This may be interpreted to mean that about 67 percent of farmers were actively involved in the last five obligations required of them for running the project. The chain index reveals inconsistent response regarding farmer participation. The performance declined at an average rate of 8 percent over the period

For Itoikin, the average index is 33 percent. This means that about 33% of the farmers responded to the last five call to assist in running the project. The chain index shows a rise in performance from the first to the fourth meeting, followed by a dramatic decline for the last meeting. This may signal a loss of interest in the success of the project among the intended beneficiaries.

4.2.4. Financial self-sufficiency performance

At Sepeteri, the average index is 29 percent, implying that only about 29% of the expenditure on irrigation services rendered to farmers is recovered. The chain index reveals a decline in cost recovery at an annual rate of 25 percent.

However, at Itoikin the project recovered 51 percent of the cost of operation, but recovery declined an annual rate of about 8 percent. This means that neither project could not cover the total expenditure on irrigation related services from the revenue generated and are therefore not viable.

Table 4: Socio-economic and financial performance indices of the projects

Index	*Sepeteri Project*		*Itoikin Project*	
	Average index (%)	**Average annual % change in index**	**Average index (%)**	**Average annual % change in index**
Fee collection	96	4,3	75	-2,28
Users’ stake	67	-8	33	-5,26
Financial self-sufficiency	29	-25	51	-7,94
*Relative cropping profit	1,08		1,26	

Source: Field survey, 2002

5. CONCLUSION

At the Sepeteri Project, lack of credit facilities limits most of farmers' demand for irrigation services, while a few considered the services expensive. The irrigation service is acceptable to farmers. The cost of irrigated cropping is so high that the effect of higher returns from irrigated cropping is not reflected in the net returns. This higher cost per hectare of irrigated cropping meant some farmers preferred rain-fed cropping to irrigated cropping. As a result the farmers do not readily accept responsibilities for ensuring the success of the irrigation project.

For the Itoikin project, about half of the farmers attribute their low demand for irrigation services to lack of credit, while the other half considers the cost of irrigation too high. Compared to the other project, enforcing irrigation charge is more difficult among Itoikin farmers. Farmers tend prefer rain-fed cropping to irrigated cropping because they have higher net returns per hectare from rain-fed cropping. This is exacerbated by higher cost per hectare of irrigated cropping. As observed among Sepeteri farmers, farmers do not accept responsibility for making the project a success.

Inadequate funding and deteriorating infrastructure hinder the level of irrigation water supplied at the two project sites. The projects are not financially self-sufficient due to insufficient funding for operations and low levels of demand from the intended beneficiaries (i.e. the farmers).

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