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EVALUATION OF THE PERFORMANCE OF THE SATA SMALL-SCALE IRRIGATION SCHEME IN GHANA AFTER ITS INCEPTION AND POST-REHABILITATION PERIODS

Kotei R.[1], Kyei-Baffour N.[2], Agyare W. A.[2], Korankye O.[1], Adarkwa T. A.[3] and Amartey J. N. A[1].
[1]Department of Agriculture Engineering and Mechanization, College of Agriculture Education, University of Education, Winneba, Mampong-Ashanti, Ghana
[2]Department of Agricultural Engineering, School of Engineering, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[3]Department of Agricultural Engineering, University of Energy and Natural Resources, Sunyani, Ghana
E-Mail: richstarnaa@tahoo.co.uk

ABSTRACT

The evaluation was carried out on the Sata Small-Scale Irrigation Scheme built, to ensure food security, create employment for the youth, alleviate poverty and improve the living conditions of farmers, in 1994. Questionnaires, interviews and observations were used to collect the data. The poor performance and low patronage by farmers stimulated this study. The non-involvement of farmers on the management of the scheme, lack of repairs and maintenance of the infrastructure, ineffective irrigation management committee, incorrect irrigation frequencies, lack of marketing strategies were some of the major reasons identified for the inability of the scheme to fulfill its primary objectives. Five years after its rehabilitation the scheme was far from its objectives. The scheme's physical system was poorly rehabilitated and there was no comprehensive revitalization. It is recommended that for the scheme to achieve its objectives, a framework based on understanding the physical, cropping, economic and social-organizational components of the scheme is developed. Also, extension work to identify the socio-economic effects of the irrigation scheme for effective management and implementation of future schemes needs to be carried out.

Keywords: revitalization, rehabilitation, small-scale irrigated agriculture, social-organization.

INTRODUCTION

Africa, according to Hillel (1997), has promoted small-scale irrigated agriculture as a means of ensuring food security as well as improving the standard of living of the rural people for many years. Irrigation has a multi-facetted role in contributing towards food security, self-sufficiency, food production for the local market and exports. It encompasses a wide range of interventions that enhance productivity and results in profitability for rural farming populations and the nation as a whole. When approached holistically, with equal levels of support for both the software and hardware aspects, irrigation has major positive impacts at household and village level and contributes significantly to Poverty Reduction Strategy (PRS) objectives (Chiza, 2005). Various studies have shown that small-scale irrigation improves food security and livelihoods of rural farmers in Africa (Oni *et al*., 2011; Chazovachii, 2012).

Irrigation development in Ghana, according to Regassa *et al.* (2011), has been justified as a way to achieve food security, poverty reduction, and rural employment. Again, they stressed that though agriculture is a key part of the country's economy, the structure of the sector is vulnerable because it relies on rainfed agriculture during approximately six-month rainy season (Regassa *et al.*, 2011).

According to GIDA and JICA (2004), an irrigation project is not only a system of producing crops but also, and perhaps even primarily, a place for a community of people and families to live healthy lives while working, cooperating and contributing to the food security of their nation. As in other human activities, the first requirement for success in small scale irrigation is that the workers engaged in the scheme be strongly motivated and committed to the task (FAO, 2000). Again, farmers on small scale irrigation schemes should be properly informed not merely trained in the performance of routine operations but enabled to understand the fundamental principles of proper irrigation management. The focus on small scale irrigation has shifted, since 1970s, to user participation and the irrigation world has now realized the need to reform irrigation management if performance is to be improved (FAO, 2000). According to the experts even low input irrigation is more productive than high input rain fed agriculture (Spore, 2001).

Furrow system should be maintained regularly; the field channels and drains should be kept free from weeds, uniform flat or gentle slopes are preferred for furrow irrigation. These should not exceed the maximum recommended furrow slope of 0.5% to avoid soil erosion. Ultimately, irrigated agriculture produces substantially higher yields than dry land agriculture (FAO, 2000).

Government small holder irrigation schemes (SIS) are now facing various serious challenges and an uncertain future, owing to low yields, deteriorating infrastructures, limited access to services, weak and unclear institutions regarding access to water and land, and lack of support which have resulted in failure of some of such schemes (Perret, 2002).

Irrigation in some areas failed to achieve its potential benefits and the challenges, according to Norman (1992), were not inherent in the principle of irrigation but

in inappropriate practices of it; unmeasured and excessive application of water to land with little regard either for the real cost of extracting the water from its source and delivering it to the farm, or for the cost of restoring the water resource after it has been depleted or polluted. According to the International Programme for Technology and Research in Irrigation and Drainage (IPTRID) of FAO (1997), the application of too little water is an obvious waste, as it fails to produce the desired benefit. Excessive flooding of the land is, however, likely to be still more harmful, as it tends to saturate the soil for too long, inhibit aeration, leach nutrients, induce greater evaporation and salinization, and ultimately raise the water-table to a level that suppresses normal root and microbial activity (FAO, 1997).

Market outlets for agricultural products are imperative for successful small-scale irrigated horticulture to occur. Relative proximity and reliable physical linkages to a market must exist. Regardless of the other investments, farmers will require expanding markets to increase their incomes. For Perry (1997), without sufficient market for the produce, increased agricultural production through irrigation will not have the desired effect of increasing household incomes. Fruits and vegetables which are mostly produced in small holder irrigation schemes are usually more difficult to market than to produce: due to, sometimes longer distances to market centres, poor quality and packaging and farmers' inability to determine prices of their goods. A producer may need several years to establish a sustainable marketing programme. FAO (1997) gave some principal recommendations that can improve the management of smallholder irrigation schemes and enhance the benefits to farmers.

A World Bank study indicated that about 30% of the irrigation infrastructure assets in sub-Saharan Africa need revitalization (Briceño-Garmendia *et al.*, 2008). There is great potential, according to (Inocencio *et al*., 2005 and Briceño-Garmendia *et al*., 2008), for revitalising existing irrigation systems and that the costs of such interventions are generally lower than constructing new systems. The concept of Podmore (1983) describes an irrigation system as composed of interrelated mutually dependent components: physical component, a cropping component, economic component, and a social-organisational component.

Rehabilitation of an irrigation scheme is an engineering-centred approach while revitalisation is a people/systems/market-centred approach (Denison and Manona, 2007). According to Wijayaratna (1988) rehabilitation is the restoration of a scheme's physical structure to original specification in which case it is also viewed as an extended maintenance activity which takes place periodically and involves high costs than routine maintenance. Revitalisation is a more comprehensive approach, encompassing the development of both physical capital and social capital that provide complex systems to use irrigation water (Denison and Manona, 2007). Rehabilitation involves minimal engagement with the organisational dynamics of water apportionment, the agricultural production system, farmer learning process, financing and markets.

Revitalisation emphasizes human capital development both individually and organisationally, empowerment, access to information, marketing and business strategy development, alongside repair and re-design of existing infrastructure (Denison and Manona, 2007). In this proposed framework, revitalisation refers to complete revamp of the hardware and software components of the irrigation system while rehabilitation refers to the process of revamping the hardware of the irrigation schemes.

Various parameters and variables are involved in the surface irrigation process which can be classified according to whether they are field parameters, decision variables, or evaluation variables. Field parameters are situational data so the irrigation designer or farmer cannot assign them another value. Decision variables are those parameters or variables that an irrigation designer can adapt to find the best irrigation performance for given or selected field parameters. Evaluation variables are basically indexes for determining the irrigation performance. The outputs of the study are believed to highlight the challenges faced by the scheme before and after its rehabilitation and show future direction for planning, design and operation of irrigation projects.

Objectives

The objectives of this study were to determine the challenges and the causes that led to the poor performance of the Sataso Irrigation scheme 15 years after its inception and its unsuccessful rehabilitation.

MATERIALS AND METHODS

Study area, scheme design and objectives

The scheme is located in Sataso and Adidwan communal areas in the Sekyere West District of the Ashanti Region. It is about 24 km North-West of Mampong on the Mampong-Ejura trunk road. It is located within the transitional zone, a region in which agriculture in recent years is severely limited by inadequate and unreliable rainfall. Meanwhile, the main occupation of the people is farming, producing crops such as maize, yam, cassava and vegetables. The irrigation project was meant to serve people living within a radius of 10 km with a target population of about 600 farmers. The topography of the site is fairly flat with a sandy loamy soil condition. The scheme utilizes a weir and the furrow irrigation system. The project was designed purposely for the cultivation of rice, maize and vegetables but at the time of the study, the envisaged plot for rice had not been developed.

The targeted population was made up of farmers operating on the scheme at the time, farmers living within the communities designated to benefit from it but not using the facility, farmers who have opted out and the technician on the scheme. Twenty (20) out of the 50 registered farmers, provided by the Irrigation Management Committee (IMC), Chairperson of the scheme were

interviewed 15 years after the take-off of the scheme. Fifteen (15) former users of the scheme were also interviewed. Background information on the scheme and its operation was gathered from the project manager engaged on the scheme and available scheme's documents. At the beginning of this study, four (4) out of the 20 farmers had abandoned their farms for good. These were also interviewed.

Structured questionnaires and interviews interpreted in vernacular were used to gather information for this study. The questionnaires solicited information on age of user, educational background, perceptions, experience, assistance received, users' contributions, challenges associated with the physical infrastructure and users' competence. Mixed qualitative and quantitative approaches of data collection were employed in this study. The primary data were collected through scheduled interviews, focus group discussions, and direct observation of the irrigation scheme.

Methods of data analysis

Texts and narrative data collected were categorized into study themes and analyzed qualitatively through description or narrations. Content analysis was also employed to compare the provisions in the scheme's bylaws, and the basis of agreement concerning handing over of the scheme from government (GIDA) ownership to users' ownership. The quantitative results obtained in the analysis of descriptive statistics and interviews were used to support the findings from the qualitative approach.

RESULTS AND DISCUSSIONS

Irrigation development and history of water management in the scheme

The Sata scheme started operation in 1994 as one of the six pilot irrigation schemes in Ghana based on the recommendation of the World Bank to test for the beneficiary participatory approach in project planning and management. The construction cost of the Sata scheme was covered by the government, and the community provided land and some labour. The scheme lies in the forest-savannah transitional zone and takes its water from the perennial Sata Stream by means of a weir. The total land area according to the project layout was 56 ha but only 34 ha was developed out of which only 24 ha was under active cultivation due to multiple challenges until its rehabilitation in 2009. The number of plot holders in the scheme varied depending on the allocated plot size which varied from 0.2 ha to 0.6 ha. The number of beneficiaries was 50 farmers; 35 men and 15 women, at the start of operations. The number of farmers ever registered on the scheme in a year was 56 and the maximum number of farmers who have actually used the facility at a season was 50. According to the farmers and the technician on the scheme, after 15 years of operation, it had not achieved its objectives and its great potential was being curtailed mainly by technical challenges.

Six years after its rehabilitation the Sataso scheme is still battling with technical and socio-economic challenges which have, drastically, lowered its efficiency leaving it with a bleak future? Patronage has further gone down; the newly constructed canals have developed numerous cracks at the bottom and on the side wells; turnout gates were non-functional; field levels were higher than the water level in the field canals, it still takes a long time for water to get to the last plots and the fields have not been graded. The leakages from the canals have permanently flooded the rice fields (Figure-7).

Users' participation in scheme construction

The participation of users of the scheme during operational activities and in management was expected to have a positive impact on their sense of ownership and promote active involvement in all operations and activities regarding the scheme. According to the scheme's technical man, even though the government initiated the scheme's construction, the communities wholeheartedly welcomed the initiative and donated the land and some farmers gave their full participation in labour in various activities. This level of participation was not sustained and it dwindled with time. Surprisingly, the scheme users were not actively involved at design and implementation stages of the whole scheme which according to the Gambia Small Scale Water Control Project (SSWCP) (2005) is crucial to formation and sustainability of effective Water Users Association (WUA).

Initiatives and the process of WUA establishment and operations

The institutional and legal framework designed by GIDA and or Ministry of Water Resources to promote farmer-managed small-scale irrigation for schemes in operation and under development/construction, and for those which will be constructed in the future has not been successful. One of the objectives of the scheme was also to pilot beneficiary participatory approach in project planning and management. GIDA's aim was to handover the scheme to the users to manage it through the establishment of users' committee and monitor performance from time to time.

GIDA is a government organization that comes under the jurisdiction of the Ministry of Food and Agriculture. It is the only public organization linked directly to irrigation development and management and is in charge of surveying proposed sites for irrigation development, designing and constructing facilities, managing and maintaining irrigation-project districts under further development, and disseminating irrigation farming technology among farmers.

The early 1990s saw fundamental changes to the management framework of public irrigation districts. The previous "government-led management" system had become difficult to maintain, and so "Participatory Irrigation Management (PIM)" was introduced, whereby beneficiary farmers and others could manage the irrigation facilities with little supervision from GIDA. In Ghana, since the introduction of the system of PIM in early 1990, operation and management of irrigation facilities in public irrigation districts has been mostly conducted using funds

collected from Irrigation Service Charges (ISC) paid by beneficiary farmers.

The government gave the direction that small-scale irrigation schemes should be transferred to WUA. The initiatives of the process came from the government through GIDA, which is considered as the best alternative for the management of the schemes. The WUA was established with the objectives of smooth operation and maintenance of the scheme, input and credit supply, and marketing of high quality produce. The objective of smooth operation and maintenance of the scheme was expected to be instrumental in bringing equitable allocation and distribution of water among all users; maintenance of canals; resource mobilization to cover the operation and maintenance costs; and resolving conflicts.
The government (GIDA) has the responsibility for carrying out major maintenance or rehabilitation works which could be beyond the capacity of the WUA. Again, it provides technical assistance on the management of the entire scheme. However, the operation and minor maintenance activities are the responsibilities of the WUA. It came to light that both parties had not been able to translate these agreements into reality on the ground.

Organizational setup of WUA

The executive committee was responsible to supervise the implementation of the decisions made by the general assembly of the scheme. The study revealed that there was no controlling committee to, solely, supervise and control the implementation process, and ensure that they were in line with the directions of the general assembly or GIDA. A universally discharged function of WUAs, according to Joseph (2001), is the maintenance of close laision with government agencies for receiving advice from such agencies and taking decisions on matters of common interest to the body of farmers, conveying information from the farm level to the higher government agencies and vice versa. This, from the study, was the least performed function of the scheme's WUA. Joseph (2001) again, reiterated that experiences elsewhere suggest that success/failure of WUAs has much to do with the legal support systems which the local WUA did not have.

There were no effective communication between the WUA and users of the scheme. General assembly meetings were held regularly at the beginning of the scheme's operations and when necessary but attendance became poor, later degenerated until the scheme's rehabilitation in 2009. The key informants also revealed that the WUA's management committee has not been effective in conducting monthly meetings which affected their managerial authority and control of activities, especially allocation and distribution of water, mobilization of free labour for canal desilting and weeding, and in resolving conflicts among water users and penalizing offenders according to the fines prescribed by bylaws. The association failed to link farmers and organisations such as Adidwan / Sataso Farmers Union and to sustain the formally established links with GIDA, JICA, and other stakeholders associated with the scheme and NGOs in agricultural development.

Conflict resolution and enforcement of by-laws (Rules and regulations)

A universal discharge function of the WUAs, according to Joseph (2001) is the maintenance of close laision with government agencies, in this case, GIDA, MOFA and EPA. This is pertinent for receiving advice from such agencies and taking decisions on matters of common interest to the users of the scheme and conveying information from users to the higher agencies and vice versa. There were no records of performance of this linkage function by the Users Association. By-laws governing the scheme were not properly enforced and this led to the breakdown of law and order and some conflicts. There was no effective enforcement of the rules and regulations of the WUA by the committee which lacked the capacity to manage the scheme. The executive committee of the WUA was also not committed in identifying offenders and giving appropriate penalties against their illegal activities.

From the discussions held with the executive committee, current and former users, there were serious abuses of turn and conflicts among users before and after the rehabilitation which became a daily issue and which forced most of the users to leave their land fallow (idle) or go out of the scheme, especially users at the tail end of the command. The users (farmers) at the head of the command have been over utilizing the water partly due to repeated subsidence from cracks in canal beds and walls. These made the scheme unattractive to new users (farmers). Lifting irrigation water by pump is gaining grounds due to ungraded plots. There were serious conflicts among irrigators, concerning monopoly over irrigation water, which were mainly attributed to weak leadership of the WUA in resolving conflicts among irrigators. The abuses of water use, absenteeism during communal labour are the major causes of conflict among users. There is a bylaw adopted by the WUA to ensure equitable distribution of water and to manage conflicts of different reasons among beneficiaries. The bylaw is expected to be obeyed by all users whether they are members of the cooperative or not. However, the majority of the farmers do not operate according to the bylaws of the cooperative and offenders are not penalized due to ineffective leadership in the WUA to take action against the offenders.

Gender, age and educational background

A preliminary survey, by the authors, revealed that 47% of active farmers in the scheme's catchment area were females. However, only 3 (15%) worked on the scheme (Table 1). The vast difference of the proportion of males to females on the scheme was attributed to the difficult nature of the work on the scheme. An interview of former and current users (farmers) and a visit to the field revealed poor grading of the fields which made it difficult for uniform irrigation of the fields. Farmers always directed and redirected water and supplemented irrigation by hand application which took 2-4 hours to get the whole field irrigated per application. Due to house chores, the women were unable to get to the field early in the morning and could not stay into the evenings.

Table-1. Users' satisfaction on WUA performance.

Rating	Number responses	Percentage
Very poor	10	63
Poor	5	31
Satisfactory	1	6
Good	0	0
Very good	0	0
Total	16	100

Poor supervision and non-existence of irrigation schedules, by the management committee, made it impossible for a good number of users to irrigate their fields at regular intervals (frequency). Farmers mostly irrigate to their satisfaction (over irrigate) and not to their knowledge about crop water requirement. One has to be on the farm very early enough or late in the evening and sometimes in the night to have access to water and house chores would not allow the women to fit into the status-quo. These definitely affected the performance since the success of irrigation to poverty alleviation, according to Bahattarai *et al*. (2002), depends on water management, input utilization, access to potential output market and socio economic characteristics of users.

The scheme couldn't attract the youth below 30 years of age as 50% of the farmers (10) were above 50 years of age (matured). The youth under 30 years were never interested in the schemes activities or in agriculture in general since no success story had come from the scheme. They knew about the drudgery in water application on the scheme and the difficulty in keeping to a schedule. The preliminary survey revealed that the youth below 30 years have migrated to the bigger towns and cities in search of jobs other than agriculture. This situation makes the schemes future bleak and no wonder the number of users kept dwindling by the years.

Table-1 indicates that the scheme users have had some level of education (up to ordinary and HND levels) and with their wide range of experiences in agriculture (Table-3). They should be able to learn new innovations, learn and apply simple farming techniques and take and keep records of activities, inputs and yields in order for the scheme's technical team to help them evaluate their performance and compare to that of their rain-fed yields and track avenues of losses for redress. However, the technician indicated that despite the drudgery, the users were able to do three cultivations per annum and that made the difference between them and the rain-fed counterparts.

With such educational background, coupled with the wide range of experiences in agriculture, as shown in Table-2, the farmers should be capable of learning and applying new and simple farming techniques and keeping records of activities. Unfortunately, none of the farmers on the scheme kept records of activities. Standards were not used in the sale of produce; different sizes of basket are used and the final price depends on the farmer and probably his financial needs at that time. This made it difficult to compare yields on the scheme and those outside it.

Table-2. Biographical data of 20 respondents on the scheme.

Gender	Frequency	Percentage (%)
Male	17	85
Female	3	15
Total	20	100
Age distribution		
21-30 years	0	0
31-40 years	6	30
41-50 years	4	20
Above 50 years	10	50
Total	20	100
Educational level		
Middle School Leaving Certificate (M.S.L.C).	14	70
General Certificate of Examination. Ordinary Level	1	5
Higher National Diploma (HND)	5	25
Total	20	100

The response of the 16 farmers left on the scheme in 2008, 15 years after its inception (Table-2), indicated that most of them (75%) observed an increase in yield by the number of baskets and in monetary (value) terms (56%). These responses are in consonance with Rukuni (1984) that generally, yield of crops achieved through

irrigation schemes are higher than in rain fed agriculture. No wonder, most of them (82%) did see using the facility as cost effective (Table-3). What they (farmers) considered to be expensive was the drudgery in water applications under increasing temperatures and evapotranspirations. According to the older users (farmers), they apply more water and at higher frequency than at the beginning of the scheme. Nevertheless, the farmers preferred irrigation to rainfed agriculture as a result of the higher yield and profit margin obtained per ha and the absence of risk due to water security and the year round production opportunity. According to the technician on the scheme, the yields were a little above that from rain fed but not within the expected yields under proper scheduling and more efficient water distribution and application systems and approved management strategies of the scheme. According to him (technician), the design challenges as earlier and as discussed in latter pages have been the major causes of the poor performance of the scheme. It was also observed that all the women (15%) always obtained lower yields compared to that of the men due to their inability to cope well with the poor planning and management of the scheme which demanded more energy and time and sometimes a water pump to keep the field uniformly irrigated.

Table-3. Farmers' perception of profitability in irrigation to Rainfed.

Irrigation conditions	Frequency			Percentage		
	Higher	Lower	Total	Higher	Lower	Total
Yield Per ha	12	4	16	*75.0*	*25.0*	100
Profit Margin	9	7	16	*56.25*	*43.75*	100
Cost of facilities	3	13	16	18.25	81.75	100

It was observed on the field that the high difference in yield and profit (75% and 56.3%) and (25% and 43.6%) as shown (Table-3) was due to poor produce quality, post-harvest handling and losses and marketing challenges. The quality of the scheme's produce was most of the times below average and the condition got worse, by the time the produce gets to the market as a result of deplorable conditions of the farm road and lack of proper packaging. Farm produce are sold without grading them. There were no standards in the marketing of the farm produce and secondly farm gate prices are fixed by the market women without the farmers' input.

The farmers on the scheme were very experienced. Most of them had a wide range of experiences in farming. Many of them (94%) had been in farming long before the scheme was established. The minority (6.25%) of participants have had less than 10 years farming experience in various crops (Table-4). This also presupposes that they were abreast with both some old and modern agricultural practices. Armed with such rich experiences the farmers should be capable of adopting and learning the best farming practices that could give higher yield.

Table-4. Experience of farmers.

Number of years	Frequency	Percentage (%)
1 – 10	1	6.25
11 – 20	8	50.0
21 – 30	5	32.25
31 – 40	2	12.5
41 – 50	-	-
Total	**16**	**100**

All the users confirmed that they received various forms of support or assistance which included capacity building, technical advice, and extension services (Table 5). The trainings organized for the farmers by GIDA and JICA were aimed at equipping them with irrigational skills which included water management, irrigated crop agronomy, management of the scheme and marketing of farm produce. Technical advice was provided by the technician attached to the scheme on how to utilize the facilities for better results. Extension services were provided by the agronomist of GIDA and the extension officer from MOFA. There were demonstrations of nursery techniques, line transplanting, fertilizer applications and vegetable growing but there were no records of attendance. There were no trials of other labour savings equipment for women. No wonder the female participation was poor. Some demonstrations without field trials were made at the early years of the scheme. The assistance and support enjoyed by the farmers were in line with the requirement for farmer participation in irrigation schemes to fulfill its primary objectives (Perry, 1997; Meinzen-Dick, 1993).

Table-5. Assistance for farmers on the scheme.

Form of support	Responses					
	Frequency			Percentage		
	Available	Unavailable	Total	Available	Unavailable	Total
Capacity building	16	0	16	100	0	100
Extension services	16	0	16	100	0	100

Transparency in irrigation service fee collection and maintenance of the scheme

According to the technician on the scheme, the WUA has in its bylaws that the scheme service charge (ISC) which has been reviewed over the years from GHC3.50 in 1994 to GHC 65.00 per season per acre in (2008) has not been fully enforced. This fee is supposed to be paid by all water users to cover maintenance and other minor operational costs was deemed but was poorly paid until and even after the rehabilitation in 2009.

The descriptive statistics (Table-6), however, indicates that 69% of members regularly paid their ISC but there were no proper records to support this. This underscores why the management committee were described by users as inefficient. It was also revealed during the discussion with the former users of the scheme that the external stakeholder did little to ensure efficiency and transparency in leadership. There was no transparency in the scheme's financial matters (income and expenditure) which discouraged members from active participation in irrigation management and new members from joining the association. Lack of transparency in managing the scheme's finances and lack of bookkeeping on centrally managed programmes and activities are key for the failure of WUAs in discharging their duties. With regards to maintenance, according to the discussions made with key informants and focus groups, even though maintenance started on a good note in the early years it could not be sustained and canals, in most parts of the seasons were silted which reduced their capacity.

The association also failed to, regularly; mobilize farmers to desilt the canals and clear weeds along them (Figures 1 and 6) and assist in the operation and maintenance of the scheme which were very important for the success of the scheme (Perry, 1993). However, the irregular payment of the Irrigation Services Charges (ISC) by some (31.25%) (Table 6) farmers according to GIDA (2004) was attributed to attitude of some farmers who viewed the scheme as belonging to the government indicating that the handing over was not properly done and probably users were not fully involved in the development of the scheme.

Table-6. Farmers contribution to the scheme.

Farmers contribution	Responses					
	Frequency			Percentage		
	Regular	Irregular	Total	Regular	Irregular	Total
Payment of ISC	11	5	16	68.75	31.25	100
Membership of WUA	16	0	16	100.0	0	100
Helped to solve some problems	12	4	16	75.0	25.0	100

Figure-1. Heavily silted Sata scheme canal.

From the users' inference and field observation, it was established that conditions of the scheme's canal (63%), field grading and hence drainage system (94%) and the general construction quality were very poor (100%) for surface irrigation method (Table-7). These were seen in:

- The poor water distribution on the fields without supplemental hand applications using pumps with water hose and watering cans to cover the whole field. This, according to them has been the major work on the scheme (Table-7).
- Waterlogged conditions at lower parts of the fields were due to seepage through canal walls and beds attributed to the poor construction, grading and drainage conditions on the scheme. Some portions of

canal had caved in causing blockade and spillover of water onto some of the plots.

These outlined challenges according to Skutsch (1998) and Gay (1994) deteriorate irrigation systems and cause serious consequences on the performance. The challenges as published by Skutsch (1998) and Gay (1994) affected water supply to the plots and made drainage network progressively more unreliable, and the distribution of the available water increasingly inequitable as channels were blocked by sediments and weeds (Figure-1). Another challenge identified was controversial sand winning within the scheme's area. This, according to the scheme's technician reduced the irrigable area and will affect expansion.

Table-7. Technical challenges associated with the scheme.

Condition at the scheme	Responses					
	Frequency			Percentage		
	Noticed	Un-noticed	Total	Noticed	Un-noticed	Total
Seepage through canal	10	6	16	62.5	37.5	100
Waterlogged plots	15	1	16	93.75	6.25	100
Poor grading	15	1	16	93.75	6.25	100
Poor constructional work (canals)	16	0	16	100	0.0	100
Poor Soil conditions	6	10	16	37.5	62.5	100

Majority of the farmers (75%) on the scheme were not using any prescribed frequency of irrigation or scheduling which affected their yields (Table-8). From the information gathered, it could be inferred that the 25% who responded positively to the irrigation frequency were over irrigating since the conditions on the fields (both hard and softwares) do not allow for correct irrigation amounts, frequency and time (schedulings). This was one of the reasons farmers do not get the expected yield. The issue of incorrect irrigation amount, frequency and time culminating in low yield as claimed by respondents agrees with Norman (1992) that for enhancement of crop growth, farmers at irrigation sites should irrigate at the correct amount, frequency and time in to prevent water deficits and over irrigation. It was also observed that farmers on the scheme keep to the same amount of water applied irrespective of the crop's growth stage. This could result in over-irrigation during the early growth stages and under-irrigation during the advanced growth stages in all crops.

Table-8. Scheme's irrigation frequency.

Irrigation frequency	Frequency	Percentage (%)
Incorrect	12	75.00
Correct	4	25.00
Total	16	100.00

Users who have opted out of the scheme have common reasons (Table-9) which do not differ from the position of the users at the time of the study. According to them, when water is opened to the first few plots no other farmer can have access and the difficulty in getting the crops uniformly irrigated increases the irrigation time many times above the normal. This makes it difficult to keep to the irrigation frequency to maintain enough moisture within the root zone for growth and evapotranspiration (Perry, 1986).

Table-9. Reasons given by 24 farmers for opting out of the scheme.

Conditions at the scheme	Responses	
	Frequency	Percentage
Poor water regulation for farmers use	24	100
Poor grading of the fields	24	100
Lack of transparency financial administration	24	100
Other reasons	0	0

Rehabilitation of the Sataso Scheme

The Sataso Scheme was rehabilitated in 2009 due to its inability to achieve its primary objectives. The intake (weir) and the whole canal system were reconstructed (Figure 2 and 3) and that was the only rehabilitation works carried out. It focused primarily on water supply and repairing of the distribution system. There was no revitalization of the scheme since there was no human capital development both individually and organizationally, empowerment, access to information, marketing and business strategy development, alongside repair and re-design of existing infrastructure. The socio-economic challenges were not addressed since rehabilitation involves minimal engagement with the organisational dynamics of water apportionment, the agricultural production system, farmer learning process, financing and marketing.

Figure-2. Sataso Scheme canals under reconstruction (2009).

Figure-3. The rehabilitated weir wit greater intake capacity.

The conditions at the scheme, five years after the rehabilitation of the physical infrastructure

The number of users increased from 16 in 2008 to 25 (56.3%) in 2009 and dropped to 11 in 2014, 5 years after the rehabilitation. The new members were all returnees who thought the technical challenges had been addressed.

Grading and field conditions

The grading challenges were not addressed and farmers go through the same difficulties in getting their fields evenly and sufficiently irrigated as it was in 2008. For furrow irrigation a gentle slope of up to 0.5% is needed. The average slope of the scheme, by GPS, was 2.04% quite higher than the required (0.5%). According to the technician on the scheme, the plots were not graded at all, leaving it very uneven and multidirectional as it was before the rehabilitation. No proper and well-defined or constructed furrows were found on any of the fields because it was simply impossible (Figure 4 and 5).

Figure-4. A plot of Okro without well-defined furrows.

Figure-5. A Plot of Maize without well-defined furrows.

Conditions of the canals

One of the major challenges before the rehabilitation was the leakages from the canals which affected regulation of water supply and irrigation time and frequency. All the technical challenges that led to the rehabilitation were still prevailing; heavily silted and weedy canals (Figure-6), leakages and seepage (Figure- 7 and 8), nonfunctional control devices (Figures 11 and 12) and difficulty in constructing well defined furrows for uniform water application were key factors for poor patronage by the communities in the catchment and the failure to achieve its primary objectives. Significant quantities of irrigation water are lost in the main canal prior to arriving at the distribution sections. According to the key informants, the scheme has never been meaningfully used for irrigation since its inception 20 years back.

Figure-6. Silted and weed infested main canal at the Sataso Irrigation scheme.

Figure-7. One of the numerous cracks on canal floor 5 years after rehabilitation.

Figure-8. Low water level in canal due to serious seepage.

Figure-9. A turnout gate without a gate and driving wheel to control water levels.

Figure-10. Non- functional check gate.

Management challenges

Managerial challenges, according to Perret (2002), make it very difficult for decision-makers and operators to evaluate the potential for long-term sustainability, then to organise rehabilitation and transfer accordingly, owing to a context of low participation, weak local institutions, and lack of information regarding farmers' strategies, land tenure arrangements, cropping systems, household socio-economics, and so on, which eventually determine the potential for cost recovery and economic viability. The following observations were made:

- Irrigators on the scheme, everywhere in the field, do not operate with any target depth of application, a major design consideration, probably due to poor scheme design
- No field parameters and decision variables are used on the scheme and
- Farmers generally do not know the period of time required to compensate soil water deficit

Field parameters include the infiltration characteristics, the surface roughness or flow resistance, the field slope and the required irrigation depth and decision variables are those parameters or variables that a design engineer can manipulate to find the best irrigation performance for given or selected field parameters.

Sustainability of the scheme's design operations

The Sataso Irrigation Scheme's sustainability is severely threatened by the non-functional or ineffective or inappropriate water management by users. Indirectly, the scheme introduces completely new methods of irrigation farming. The scheme gradually changed from a very extensive, low-input, individual farming system, to a complex, more intensive higher-input and cooperative system (SSWCP, 2005). Water management operations become more intricate requiring coordination and synchronization of actions between scheme users. Such cooperation, according to SSWCP (2005) is a new dimension in farming tradition and needs to be gradually acquired. The scheme's WUA's progress is hinged on well trained executive staff in water management. Manuals on operations and maintenance must be available for staff and

farmers. The technical specifications for operations and maintenance must be made available to the scheme and well-disseminated to farmers.

Impact of new technology and the need for a pilot phase

When investment projects like the Sataso scheme introduce technologies which require a significant change in communities perception, way of life and agricultural practices and attitude, the uncertainties and risks of failure are high enough to justify the emphasis on simpler technologies involving the improvement of existing practices without large variations in farming and community traditions. Meanwhile a limited "pilot phase" intervention must be undertaken to fully test the implication of the new technologies and their sustainability, prior to wider replication (SSWCP, 2005).

CONCLUSIONS AND RECOMMENDATIONS

The study was carried out on the Sataso Small-Scale Irrigation Scheme which was intended to ensure food security, create employment for the youth, alleviate poverty and improve the living conditions of farmers in the scheme's catchment area in 1994. Questionnaires, interviews and observations were used to collect data. The poor performance and patronage by farmers in the catchment area of the scheme stimulated this study. The non-involvement of farmers on the management of the scheme, lack of regular repair and maintenance of the infrastructure, ineffective irrigation management committee, incorrect irrigation frequencies, lack of marketing strategies for the crops produced were some of the major reasons identified for the inability of the irrigation scheme to attract, retain and improve the socio-economic life of users and to fulfill the objective for which it was established. Five years after its rehabilitation, the scheme was still grappling with the challenges which led to its inability to attract, retain and improve the socio-economic life of the people. The scheme's physical system was poorly rehabilitated and there was no comprehensive revitalization of the scheme including training of farmers. It was recommended that for the scheme to achieve its objective a framework based on understanding the four mutually interlinked systems is developed and extension work to identify the socio-economic effects of the irrigation project for effective implementation.

The performance of the WUA toward the achievement of the intended objectives of the scheme with respect to managing the irrigation activities was low. Some of the indicators of performance according to the major themes found to be significant through key informant interviews and group discussions are discussed as:

There was no equitable water allocation and distribution among users at different locations along the main canal, the Irrigation Management Committee (IMC) on the scheme was not effective, the repair and maintenance of the scheme were viewed as GIDA's responsibility, the physical infrastructure of the scheme was not in good condition and the scheme was far from achieving its primary objectives. It has not been able to:

a) Prove its financial viability,
b) Increase the volume of water to irrigate all the 34.0 ha during the major season (April - August),
c) Reduce the time it takes for water to get to last plots,
d) Reclaim its waterlogged area (10.32 ha) and borrowed pits areas (3.3 ha) created during construction which could not be cultivated,
e) Retain and attract farmers to the scheme,
f) Address the food security situation in the catchment area,
g) Improve the economic life of the people,
h) Wean itself from government support and become self-sustainable,
i) Transfer fully, the needed irrigation technology to the farmers,
j) Develop a marketing strategy and
k) Satisfy participants on the scheme.

Also, members have lost confidence in revenue collection due to lack of transparent financial management. Several other factors have been identified to have contributed to the overall poor performance of the Scheme. Some of the important factors revealed by the study were: poor field grading, unscheduled irrigation, poor planning**,** poor design, poor maintenance of the system, poor users' cohesion, ineffective scheme management, choice of crops, poor produce quality and marketing strategies, cash flow problems, lack of a sense of ownership on the part of farmers and inability of the scheme to completely transfer irrigation technology to the farmers. The Sataso Irrigation Scheme has serious infrastructural, technical and socio-economic challenges which results in poor performance and low patronage by the inhabitants. There is the need to develop measures to reform the management and activities of the scheme.

In the light of the experiences from the Sataso scheme, the following general recommendations must be considered in future planning and rehabilitation and revitalization of small-scale irrigation schemes in the country:

- New schemes should be, gradually, handed over to the farmers and they should be guided to have a sense of ownership and take total responsibility in the operation and management of the scheme.
- The Irrigation Management Committee (IMC) should be strengthened and helped to work efficiently and effectively,
- The scheme must focus on crops of high value and of higher demand for both local and international markets and be trained on skills of marketing them,
- There should be a strong association in scheme activities like water use, maintenance of infrastructure, and payment of irrigation service charges.
- In addition to training in water management and irrigated crop production, farmers should also receive

training in leadership skills, gender issues, financial management, record keeping, packaging and marketing.

- Private sector participation in small-scale irrigations should be encouraged so that farmers can receive assistance in areas like export market.
- The road linking the site to the main Mampong-Ejura trunk road should be rehabilitated and regularly maintained.
- There is the need to provide irrigation schemes with security of land tenure
- The scheme should device a mechanism of assisting farmers to ensure minimum acceptable levels of production by each individual farmer to adequately justify the investment.
- GIDA must have clear and well defined policy on the handing-over of irrigation schemes to farmers, which should be specific on timing of hand-over, respective roles of farmers and government after handing over.
- Implementation strategies must be modified to maximize impact and patronage
- The scheme's M&E unit should be trained to consolidate and improve the existing system
- The scheme must work with an action plan
- Before handing over the project to irrigation users, technical training with practical demonstration have to be conducted by the project staff with support from the staff of front line ministries and other relevant organizations and
- Research institutions must collaborate with irrigation schemes to facilitate dissemination of correct irrigation technologies through field research and demonstration farms.

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