PERFORMANCE ASSESSMENT OF SELECTED IRRIGATION SCHEMES IN NIGER STATE USING COMPARATIVE INDICATORS

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Abstract

The study was carried out to evaluate the performance of selected irrigation Scheme in Niger State using various indicators such as output per unit cropped area and water consumed, related to production with land and water, relative irrigation supply (RIS) related to water supply from the system with crop water demand and financial self-sufficiency (FSS) related with collection of fees from water users in the command area. In this study, the performance indicators for the schemes were determined for year 2013-17. The analysis of agricultural performance indicators showed that the production value of different crops grown in command area were fluctuating upwards and downwards signifying inconsistency in management of the schemes. The analysis of water use indicators showed that not all water released from the reservoir get to the command area due to damage of the distribution canals and some of the canals have been overgrown by weeds thereby making the canal capacity insufficient to meet the peak consumptive requirement. The analysis of economic or financial indicators showed that the scheme had a serious problem about the collection of water fees i.e. revenue or irrigation charges collected from scheme were less than that of total operation and maintenance expenditures.

Keywords: command area, irrigation project, performance indicators, relative irrigation supply.

Introduction

Water resources are renewable but are limited in supply are limited. In order to therefore acquire highest efficiency from existing resources, it is necessary to make use of the resources concerned. Efficient use of limited water resources, especially for agricultural irrigation, will both enhance producer's yield per unit of water and will protect environment from problems of excess water like flash flood and bilharzia. Many developing nations may face insufficient water resources to satisfy their agricultural, domestic, industrial and environmental water demands within the next two decades (Asfaw and Admassie, 2004). The world population is forecasted to grow by about 30% by the year 2024, reaching 8 billion people (Cakmak*et al*., 2004). This means competition among the agricultural, industrial, domestic and other users will increase in unprecedented levels. Therefore, water management in irrigated agriculture is important in meeting the food requirement of the increasing world population (Takeshi and Abdelhadi, 2003).

Irrigation is important in terms of agricultural production and food supply, the incomes of rural people and public investment for rural development. Yet dissatisfaction with the performance of irrigation projects in developing countries is widespread. Despite their promise as engines of agricultural growth, irrigation projects typically perform far below their potential (Small and Svendsen, 1992). A large part of low performance may be due to inadequate water management at system and field level, poor structural maintenance and failure to stick to design specifications during construction. (Cakmak*et al*., 2004).

To complement a rain-dependent farming system, irrigated agriculture was thought to be one of the solutions to enhance food security in the country. Since its initial promotion, irrigated agriculture in Nigeria still comprises a small fraction of total cultivated area; water development by constructing small earthen dams in the country is believed to bring changes in the way of life of the local communities in the area. Irrigation projects have the potential to degrade the land, the soil and waste the valuable resource-water if they are mismanaged. Performance evaluation of irrigation projects is not common in the country.

Niger State has made tremendous progress in development of its irrigation potential. However, only about two-third of the created irrigation system is actually being utilized and overall project irrigation efficiencies are very poor. Though, applying water to crop through irrigation increases yield and production in agriculture, inappropriate management of irrigation schemes might lead to environmental problems such as a high water table and poor drainage and thus salinization and pollution in addition to low quality of water. The performance of many agriculture systems is significantly below their potential due to number of shortcomings, such as poor design, construction, operation and maintenance. The system performance, agricultural productivity and financial aspects are the domain provides an idea about performance indicators. The system performance providing facility of water for irrigation and other purposes. The water distribution system is influenced by physical, climatic, economic and other factors. The prevailing climatic condition largely determines both, the available water resources and the crop water requirements in any season.

The agricultural productivity shows that, in Niger State, more than 85 percent population depends on agriculture, thus production per unit area as well as per unit water is vital for state's economy. Government has intervened by coming up with irrigation schemes through construction of about ten earth dams across the state but record has shown that none of the schemes has been utilized to maximum capacity. Adequate records are however lacking to ascertain the optimum and current performance of these irrigation schemes. Also, Lack of knowledge and tools used to assess the performance of projects adds to the problem. There is therefore a need to conduct a holistic performance assessment of these irrigation schemes using standard indicators with a view to recommending appropriate measures to improve their performance. This study is therefore carried out to evaluate the performance of three, Tungan-kawo, Kontagora and Lapai/Agaiesmall scale irrigation schemes in Niger State.

Materials and Methods

There are ten irrigation schemes in Niger state (Figure 1). However, this study will be limited to carrying out performance evaluation of three of them. These include Wushishi, Lapai, and Kontagora local government areas.

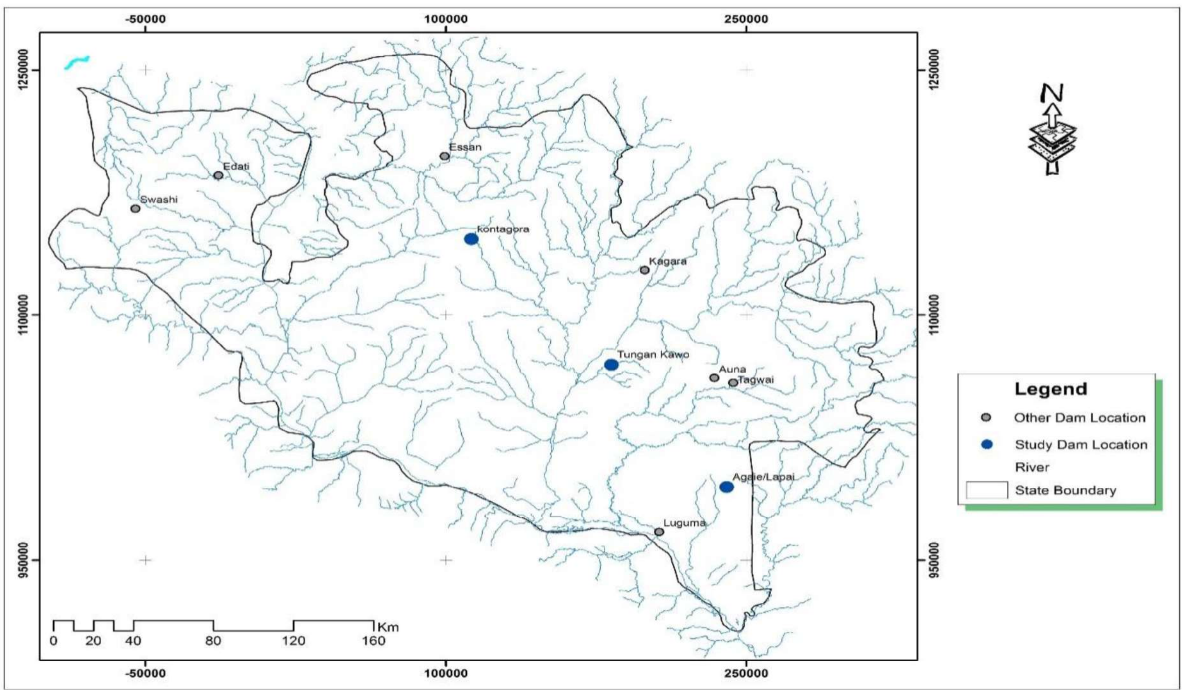

Figure 1: Existing Agricultural Dams in Niger State and the Study Area.

These dams have contributed to national income, and to the communities involved. The main aim of these dams is for crop irrigation and fishing. TungaKawo Irrigation dam was constructed in 1988 and located about 7.5 km from Wushishi town. It has a dam height of 11.75m, width of 6 m with a length of 3.3km. It has a design capacity of $23x10^6m^3$covering a land area of average of $900m^2$. It has presently employed a total of 264 people. Kontagora Irrigation dam was constructed in 1991 and located about 4.5 km along Kontagora – Yahuri road in Kontagora Local Government of Niger state. It has a dam height of 20m, width of 4 m with a length of 1km. It has a design capacity of $1.77x10^6m^3$covering a land area of average of $105m^2$ and has presently employed a total of 105 people. Lapai/ Agaie Irrigation dam was constructed in 2004 and located at about 6 km from Paiko town along Paiko – Lapai road in Paikoro Local Government of Niger State. It has a dam height of 16 m, width of 6.9 m with a length of 1.2 km. It has a design capacity of 2.8 $x10^6m^3$covering a land area of average of $600m^2$. It has presently employed a total of 495 people.

Data collection

For the study some necessary data were collected from Upper Niger River Basin Development Authority office. Sites of the Dams were visited and discussions also made with farmers to affirm the secondary data obtained. Data collected includes production, price of crops, area irrigated, cropping pattern, amount of water harvested and climatic data. The same data were also collected using questionnaire surveys from the water users (10% of the total water users). The questionnaires also were made to get the perception of the farmers about the water distribution within the project. The Secondary data included total yields, farm gate prices of irrigated crops, area irrigated per crop per season or per year, crop types, production cost per season or per year, and cropping pattern. Climatic data of each irrigation projects were collected from the nearby weather stations established by National meteorological agency for the purpose of monitoring weather for the dams.

Water use performance- Two types of indicators, relative water supply (RWS) and relative irrigation supply (RIS) were used for evaluation of water use performance:

$$\text{Relative water supply} = \frac{\text{total water suplied}}{\text{crop water demand}} \quad \text{(i)}$$

$$\text{Relative irrigation supply} = \frac{\text{irrigation suplied}}{\text{irrigation demand}} \quad \text{(ii)}$$

where, total water apply (m^3) is diverted water for irrigation plus rainfall, crop water demand (m^3) is the potential crop evapotranspiration (ETp), or the real evapotranspiration (ETc) when full crop water requirement is satisfied. Irrigation supply (m^3) is surface diversions and net groundwater drafts for irrigation, irrigation demand (m^3) is the crop ET minus effective rainfall. Irrigation requirement and net crop water requirement calculated by Cropwat 8 program (FAO, 1992). The reference evapotranspiration (ETo) is calculated on a monthly basis using the Penman-Monteith (Allen et al., 1998). The monthly value of effective rainfall (Pe) was calculated using the US Bureau of Reclamation's method (Smith, 1992). RWS and RIS values indicate whether there is an adequate supply done or not to cover the demand.

Physical performance- Physical indicators are related with the changing or losing irrigated land in the command area by different reasons. It was calculated using the following parameters:

Cropping intensity- is an indicator used to assess the degree to which irrigated crops are grown in the command area. It is determined as:

$$Cropping\,intensity = \frac{annually\,cropped\,area}{cultivable\,area} \qquad \text{(iii)}$$

$$Irrigation\,ratio = \frac{irrigated\,land}{irrigable\,land} \qquad \text{(iv)}$$

$$Sustainablty\,of\,irrigable\,land = \frac{irrigated\,land}{initial\,irrigated\,land} \qquad \text{(v)}$$

Where, irrigated land (ha) refers to the portion of the actually irrigated land (ha) in any given irrigation season. Irrigable land (ha) is the potential scheme command area.

Economic performance- Economic indicators deal with how much fee collected from water user, yearly maintenance and operation expenditure and whether system self–sufficient or not. The economic performance indicators used in the evaluation were calculated using the following equation:

$$Effectiveness\,of\,fee\,collection = \frac{Collected\,fee}{Total\,fee} \qquad \text{(vi)}$$

$$Financial\,self\,sufficiency = \frac{Annual\,fee\,revenue}{Total\,annual\,Expenditure} \qquad \text{(vii)}$$

Where, effectiveness of fee collection represents how portion of fee collected from water users whereas financial self-sufficiency represents the collected fee from water users either sufficient or not sufficient for operation-maintenance (O-M) cost in each year.

Results and Discussions

The results of relative irrigation supply (RIS), irrigation ratio (IR), sustainability of irrigable land (SIL) and financial self-sufficiency (FSS) are as shown in figures 2 and 3 while five years maize and rice output are as shown in figure 4.

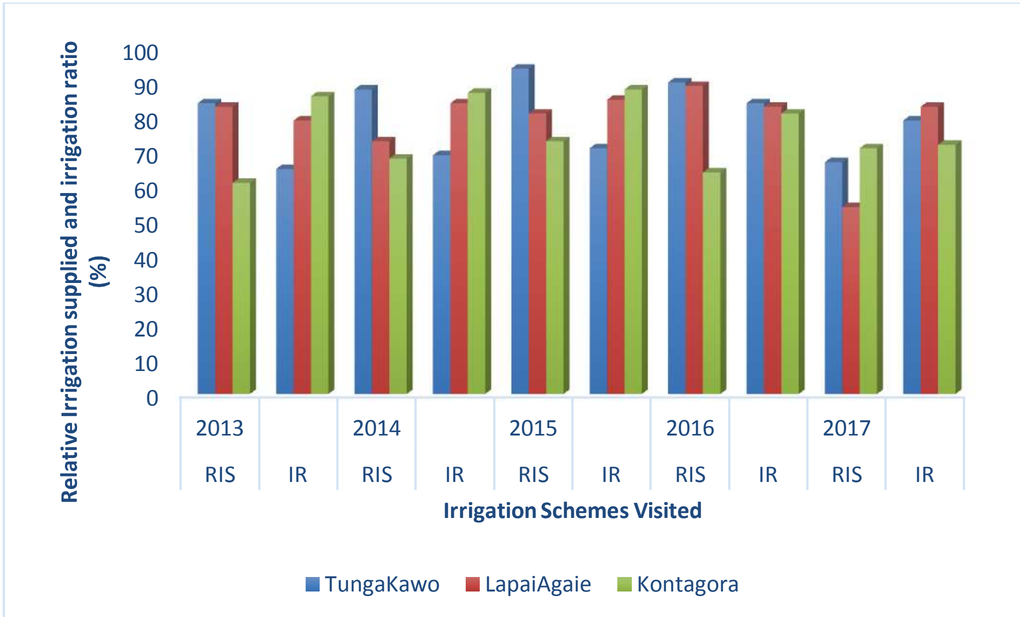

Fig. 2: Five Years Percentage performance of Relative Irrigation Supply and Irrigation Ratio

From figures two, RIS was increasing for Tungakawo scheme until 2016 when there was a slight reduction. However, there was a sharp reduction in 2017 for both Tungakawo and LapaiAgaie schemes. The only year a decrease in RIS was noticed for Kontagora dam was 2016. This may not be unconnected with failure of some sections of distribution canals which was noticed in all the schemes, siltation of the reservoir and fluctuations of weather during the period under study. There were also cases in Lapai, Agaie and Tungakawo where some section of the distribution canals have been overgrown by weeds (Figure 3). These narrowed down the width of the channels.

RIS was calculated from the ratio of irrigation supplied to the irrigation demand. It was gathered from oral interview that at times more water is released than irrigation demand but much of the water released are wasted whenever there is a canal breakage like the one noticed for Kontagora dam (Figure 4).This leads at times to localized flood and waterlogging in some places and inadequate water supply at the far downstream end of the scheme. Irrigation Ratio (IR) calculated from ratio of irrigated land to irrigable land keeps increasing for the three schemes until 2017 when much was not achieved (Figure 2). From 2013 to 2016, it was reported that farmers were requesting for more lands allocation but the reason for that reduction in 2017 could not be explained by both the farmers and the managers. The water users give less attention to water saving issues and waste significantly large amount of water resources. Farmers feel that excess irrigation water application would result in increased yield, and divert the water to the schemes as long as it is available. Lack of sound irrigation scheduling, lack of knowhow on actual crop water requirements are some of the factors contributing to wastage of water. Similar results were also obtained from many researches around the world (Ray *et al*., 2002; Bandara, 2003). These values also imply relationship between the water supply and crop water demand was poor from the point of water distribution in the schemes (Şener, *et al*., 2007).

Figure 3: Some section of distribution channel overgrown by weeds.

Figure 4: Distribution canal Failure in Kontagora scheme.

From figure 5, sustainability ratio is decreasing yearly in Tungakawo and Lapai/agaie schemes possibly due to farmers' attitude to maintenance. However, in the year 2016, sustainable ration for Kontagora scheme witnessed an increase possibly due to farmers' associations' participatory attitude in maintaining the canals and laterals. The SIL was calculated from ratio of irrigable land to initial irrigated one. The decline has made the farmers to depend more on rain fed agriculture and has made production output to be reduced in dry season. This by extension has also affected the financial self-sufficiency (FSS) of the project (Figure 5) which was also reducing from 2013 -

2016. However, in FSS in the three schemes witnessed a slight increase possibly due to farmers change in attitude to payment of water fee or due to introduction of penalties for farmers who refuse to pay the stipulated fee. Sustainability of irrigation is indicative of whether the area under irrigation is contracting or expanding with reference to the nominal area initially developed. Financial self-sufficiency indicates the revenue from the irrigation over the expenditure for operation and maintenance. The government covers the operation and maintenance of the irrigation scheme and it is considered as subsidy; and currently, attitude of farmers to water fee is poor.

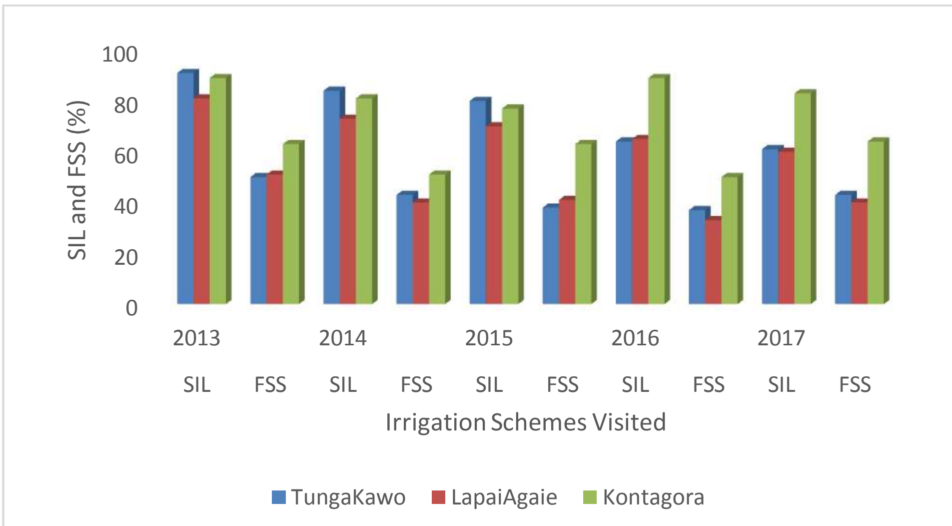

Fig. 5: Five Years sustainability of irrigable land and financial self Sufficiency

Overall output of grains in the three schemes are as presented in figure 6. Maize and rice are evaluated here because they are the two major crops being planted on the schemes and the evaluation is done with the assumption that other agronomical practices that could affect the yield are kept constant. Other crops being cultivated are cassava, pepper, okra, spinach, jute mallow etc. However, proper records were not being kept for these crops as the money realized from their sales are used to buy inputs for rice and maize. The expectation from the schemes was increase in output, however, there are fluctuations in the may be attributed to some structural failure that has been mentioned. If the schemes are completely well maintained, output can be doubled and will guarantee food security in the state.

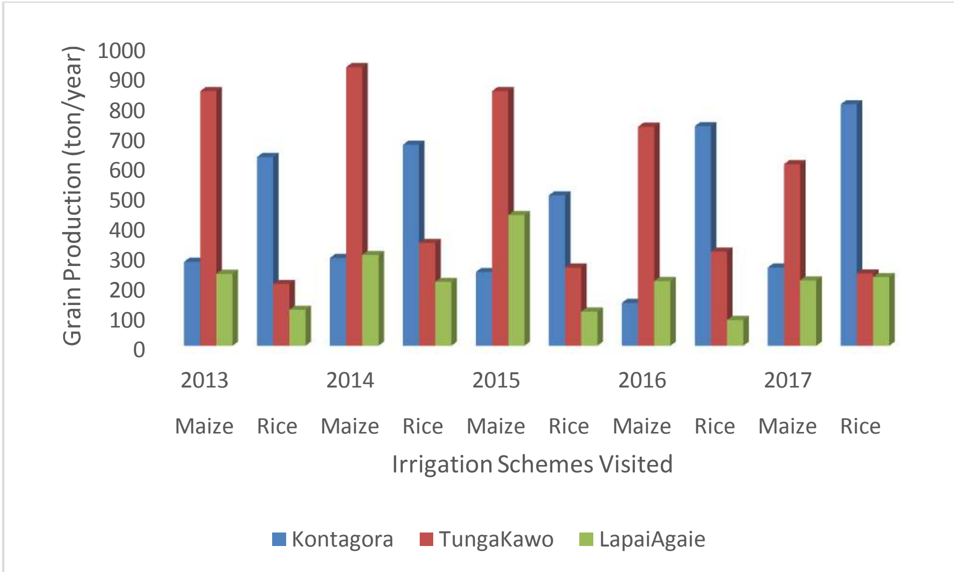

Fig. 6: Five Years Output of Maize and Rice from the irrigation Schemes

Conclusions

In this study, the performances of three irrigation were assessed using comparative indicators. This indicators used are useful to evaluate the degree of utilization of resources such as land and water in producing agricultural outputs. The RIS results indicated that excess irrigation water is supplied from the reservoir, but the water supply and crop water demand was poor from the point of water distribution in the schemes. Water users are responsible for the overall water management including maintenance of the main diversion and this has made them not to be paying irrigation water fee since. The reasons for this may be because; water fee is not collecting according to the used water amount by farmers, weak committee and delay of payments by the farmers.

Therefore for the successful fee collection the suggested solutions maybe institutional reforms for water management, install of volumetric measurement, collection of fee before irrigation and investment in infrastructure. Generally, institutional reforms for water management at the scheme are essential. The water users association (WUA) would have to be strengthened and capacitated through training for efficient water management and government should be enforce pricing policies. Comparative indicators are very good estimator and indicator of performance of irrigation projects as a whole but full, reliable and consistent documentation system is a must. And this type of study has to be adopted and practiced on some other small-scale irrigation projects in the country.

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