Evaluation of the implementation of water resource management in western part of Kano River Irrigation Project (KRIP 1), Kano State, Nigeria

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Abstract

The aim of the research was to evaluate the implementation in Kano River Irrigation Project 1(KRIP 1). Cluster, Probability proportionate, availability and purposive sampling techniques were used for the selection of sectors, farmers, respondents and Hadejia Jama'are River Basin Development Authority (HJRBDA) staff respectively. Data were obtained through self-administered questionnaire, interview and field observation. The analysis was done using descriptive statistics. Results of the study showed that the proposed aerial extent of KRIP 1 was 22,000 ha but only 77.27% was implemented. Result also revealed that the amount of water released to the project site from Ruwankanya Reservoir (3.2m) and upstream water head (0.20m) were higher than the design and was attributed to siltation in the dam. Canal design implementation was achieved to about 94%. Result further indicated that although wheat, vegetable, tomato and guinea corn were identified as the project crops specified in the design, currently, farmers cultivate rice, maize, tomato and onion in order of importance. It is recommended that water monitoring, evaluation and legal unit should be established by the HJRBDA to checkmate farmers' deviation from the specified design of the project and vandalisation of canals and waterways.

Key Words: Implementation, Water Resource, Management, Initial Design, Kano River

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Introduction

Some of the major issues that affect sustainability of large-scale irrigation scheme (LSI) are its design in terms of water management, cropping patterns, method of irrigation and water distribution. By design, it means a condition that needs an account during the planning and development of the physical works of irrigation scheme and helps for the sustenance of the scheme (Ertsen, 2012). Besides irrigation management simplicity, sustainability requires that farmers have: enough water demanded and appropriate incentives; and should normally be financial for continuing to irrigate (Kedir & Alamirew, 2013). Water management of irrigation scheme is very important in meeting the food requirement of the increasing world population (Tanriverdi, et al., 2011). Organisational requirements comprise some permanent, low intensity monitoring and evaluation procedures that could be supplemented by full-scale performance assessment investigations whenever major performance problems occur (Kedir & Alamirew, 2013).

In the semi-arid eco-climatic region of Northern Nigeria, irrigation is used to reinforce the moisture due to erratic rainfall coupled with increasing temperatures (Atedhor, 2015). Irrigation assisted in reducing seasonal constraints and crop moisture stress for effective water management. The irrigation Water Management (IWM) involves the management of water in relation to its utilization in a system called Water Productivity (Hermanowicz, 2008; United Nations Department of Economic and Social Affairs (UNDESA), 2015 & Sayed et. al., 2020). The management of the limited water resources is central to irrigation management and natural resources managers at field, on farm and at river basin level to enhance the sustainability of the water and improve producer net returns (Muazu, 2011). Evaluation of water management in irrigation schemes facilitates development in many developing African countries. In many developing countries, management of the existing irrigation schemes through evaluation of the projects will assist in solving social and environmental challenges (Peprah et al., 2015). Water demand has reached critical levels in many parts of the world. The misuse of water resources, lack of infrastructures to supply water and climate change are some of the reasons for water challenges, despite the vast amount of water in the planet (FAO, 2012). Globally there is large gap between actual irrigated area and design area in many irrigation systems, in terms of water supply, designs of irrigation systems, operation and maintenance system that amounted to disappointing performance and failures of the many schemes (Clemente et al., 2020).

The Kano River Irrigation Project Phase One (KRIP 1) was divided into two parts: Eastern and Western, the hydrology of the both parts is independent. This research covers mainly the western part, which consists of 41 sectors. The reasons for the establishment of the KRIP 1 was that the increase in the country`s population, and that there is a food shortage to feed the teaming population. It was observed that there are problems in the area relating to agricultural production such as decline in yield, soil problems and water deficiencies and wastage, which may be due to deviation or changes in the initial design of the project, which needs to be evaluated for development.

Although there have been numerous studies on the project including: Wallace (1981); Mbajiorgu and Muhammad (1997); Simon (1997); Sangari (2006); Yakubu et al., (2018), which evaluated either the impact of the project on productivity and welfare, impact of the project on the local farmers, environmental impact assessment, farmers' effort in water and land management in the area and economic potential of KRIP among others. Most of the studies were not on evaluation of the implementation of initial design by the farmers and water users, which may cause a lot of changes and setbacks in the project area and were not specifically on western Branch Region (WBR) of the project area. The aim of this study is thus, to establish the extent to which the implementation of the water resource utilsation and management has been undertaken in accordance with the design of KRIP1.

Material and Methods

Study area

The study area, which is part of the KRIP 1, is located in Kano state as shown in Figure 1. The position of the project lies between latitude $11^{\circ}3'$N and$12^{\circ}3'$N, and between longitude $8^{\circ}30'$E and $9^{\circ}40'$E (Figure 1). The total landmass is about 62,000 hectares carved out from three local government areas: Bunkure, Garun-Mallam and Kura (Sangari, 2006). The climate of KRIP area is divided into warm rainy season from June to September, cool dry from October to February and hot dry season from March to May. Rainfall is highest in July and August; the average annual rainfall is about 860mm (Sangari, 2006; Umar & Bako, 2019). The hydrology of the area composed of Kano River that originates from Riruwai highlands and its tributaries (Rilwanu, 2019).

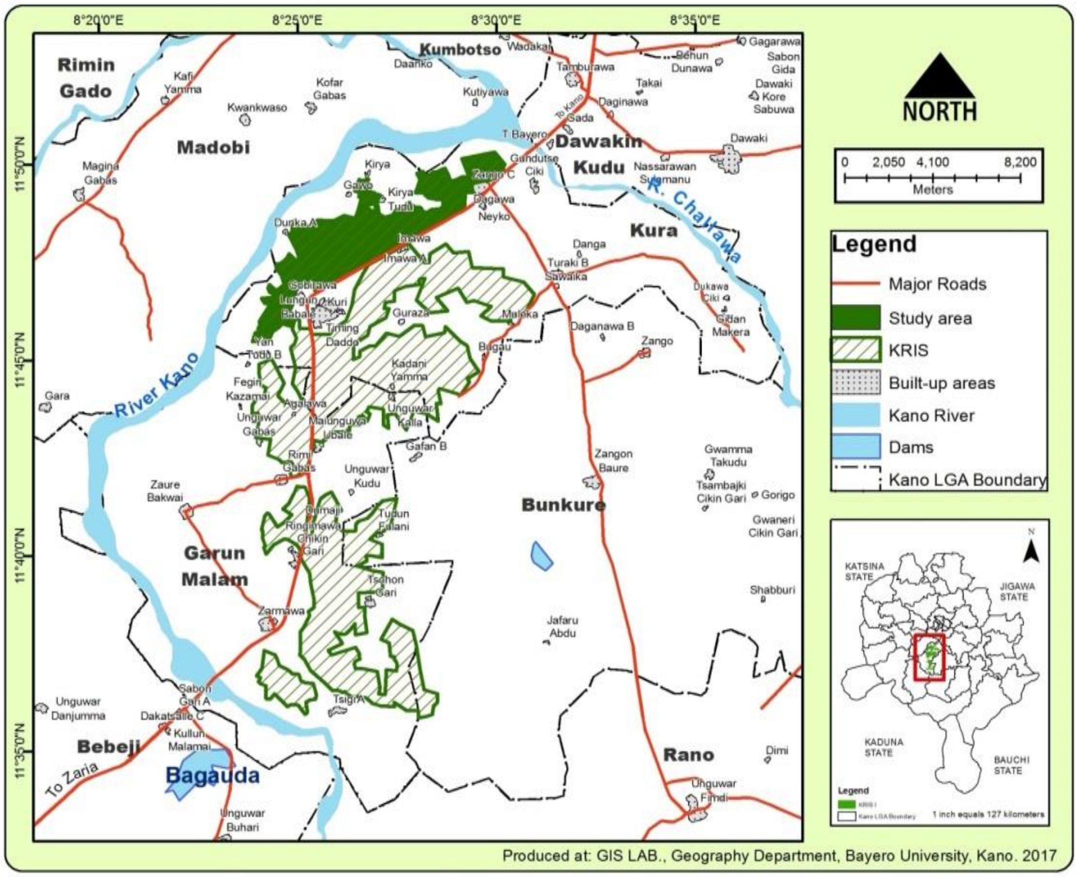

Figure 1: Kano River Irrigation Project 1 Showing the Study Area.
Source: Geography Department, Bayero University, Kano. 2017.

Sampling techniques

In the Western Branch Region (WBR), there are 41 sectors of which are considered as clusters. Using cluster sampling techniques as adopted from Krejcie and Morgan (1970), nine (9) clusters (sectors) were selected. The selected sectors (irrigation areas) are *Agolas IV, Boko, Dakasoye, Domawa, Gafan 2B2, Kirya, Makuntiri, Suwaika and Y/N Ruwa (Nisan Ruwa)*.

Yamani (1967) in Krejcie and Morgan (1970) and Israel (1992) formula was used to determine the number of respondents (farmers) from the population obtained from Water Users Association (3,433) in which 358 farmers were obtained as a sample based on Yamane formula (Equation 1):-

$$n = N/1+N(e)^2 \quad \text{.......... (i)}$$

Where n=sample size, N=total population and e= margin of error

Proportionate sampling procedure was used to divide the sample of 358 among the 9 selected based on aerial coverage in Ha as adopted from Abdulla, et al., (2014). Individual respondents from each sector were selected using availability sampling (farmers available on the farm during the survey).

In addition, there are total of twenty seven, (27) HJRBDA staff in the engineering and operation division at the Headquarters and WBR at Kura office, 16 staffs were purposively selected for the interview as adopted from Palinkas et al (2015).

Methods of data collection

The questionnaire was distributed and administered to the sampled farmers at different location within the study area, and HJRBDA staff were interviewed through Key Informant Interview (KII) to acquire information on design and implementation of the project. Field observation was used to aid the researchers to gather a lot of knowledge on irrigation practices, different types of water distribution facilities, roads and tracks across the project site and assessed their current conditions and challenges. Pictures were taken using a hand held camera. Irrigation water infrastructures within the project were measured to identify the level of implementation, particularly, the main canal depth, width and length and these parameters were subsequently compared with the initial design.

Method of Data analysis

The information derived from the questionnaire, field measurement and observation were analysed using descriptive statistics such as mean, frequency, cumulative frequency, percentages, line graphs, pie charts, bar graphs and tables with the aid of Microsoft excel and statistical package for social sciences (SPSS). The pictures were presented in form of plates. Interview results were presented through narration.

Results and Discussion

Initial design of the project

The initial design of the project which consists of the areal extent, canal systems and capacities, type of crops and cropping pattern and water utilization and management were evaluated and presented as follows:-

Areal Extent of the Project

From the initial design, the KRIP 1 was scheduled to be implemented in two phases. It was expected to cover about 22,000 ha of irrigable land. The entire phase 1 project was proposed to comprising of over 30 sectors, with about 18 sectors in WBR. The two regions (Western and Eastern Branch Regions) are to operate as separate entities both geographically and hydrologically. It was also part of the design that there should be a large dam as the main source of water for the project area, and a junction, where water will be dispatched to the two proposed regions. The whole project was segregated based on land uses and these are area allocated for settlements, rainfed, irrigation, grazing and forest reserves (Table 1). This is in line with FAO (1996) guidelines for planning an irrigation project in an area. The stakeholders maintained that "*the dam was provided for the project, it is there and the area design for a purpose should remain intact.*"

Table 1 Area Allocations for KRIP 1

Branch Region	*Total Area(acres)*	*Gross Irrigable Area (acres)*	*Net-Irrigable Area (acres)*	*Rainfed Cropped Area (acres)*	*Wasteland And Grazing Land (acres)*	*Forest Reserves (acres)*	*Area Taken by Villages, Roads, Drainage, etc (acres)*	*Total Area Coverage (acres)*
WBR	*96,915*	*44,365*	*33,670*	*28,130*	*14,905*	*4,345*	*5,170*	*227,500*
EBR	*70,265*	*19,650*	*16,375*	*28,695*	*13,755*	*3,830*	*4,335*	
Total	*167,180*	*64,015*	*50,045*	*56,825*	*28,660*	*8,175*	*9,505*	

Sources: Feasibility Report of KRIP, Part viii, 1976

Types of Crop and Cropping Pattern in the Initial design

From the feasibility report, two general cropping patterns recommended in the design. These included one for the well-drained soils (denoted as pa) and the second for the poor internal drained soils (denoted as pb). The well-drained soils covered about 87% of the irrigable are of the phase one. The following four years rotation plan was recommended for this area (Table 2). The design stipulates that 25-50% percentage of the field in each sector be left to fallow at every farming (rainy and dry) season. In the four-rotation plan, it was recommended that in the first year, during the rainy season, groundnut be planted and should cover 50% of the area while 50% be left fallow. In the dry season of the first year, wheat was recommended and should cover 50%. In the second year, leguminous crops such as cowpeas, soybeans, and green grams are expected to cover 50% while 50% was to be left to fallow. According to the stakeholders, "*the cropping pattern is expected not change from the original design.*"

Table 2 Design Cropping Pattern for well-drained soil in KRIP 1

Year	Season	Crop	Percentage	Bush Fallow (%)
Year One	Rainy	Groundnut	50	50
Year One	Dry	Wheat	50	50
Year Two	Rainy	Leguminous	50	50
Year Two	Dry	Vegetable	25	75
Year Three	Rainy	Groundnut	50	50
Year Three	Dry	Wheat	50	50
Year Four	Rainy	Cotton	75	25
Year Four	Dry	Guinea Corn	25	75

Source: Feasibility Report Part viii, 1976

In the dry season of the second year, vegetables such as lettuce, Swiss spinach, carrot, cabbage among others are to cover 25%. The design further stipulates that the area for vegetables at every season should not exceed 25% in order to curtail the incident of pests and diseases. In the third year, groundnut is expected to cover 50% during the rainy season, while the remaining is left fallow. During the dry season, wheat is to take 50% and the remaining 50% be left to fallow. In the last year, during the rainy season, cotton is to cover 75% and in the dry season, sorghum is recommended and should cover 25%. Wheat was also expected not to exceed 50% of the total area at every cropping season to avoid the occurrence of pests and diseases. For the poor internal drained soil covering about 13% of the irrigable area, rice was recommended during the rainy season while leguminous crops and wheat for the cool dry season. Stakeholders stated that "*change in the cropping pattern resulted into many problems in the area like salinity*." That is according to the stakeholders and the famers in the area.

Designed Water Utilisation in KRIP 1

The feasibility report for KRIP 1 indicated how water is to be used within the project site. All settlements within the project should have portable drinking water provided by HJRBDA using ground water resource, these settlements formed from the resettlement program during the implementation of the project. In addition, Fulani herdsmen were given restricted areas within the project where pastures and water are available for their animals.

From the design, according to the stakeholders *"it was recommended that the whole project is to be operated by gravity method of irrigation system. And Farmers were expected to use siphon only for water application to the farmlands, and the siphon diameter should be 65mm.*" The NSR were designed to be filled during the night for the water to be distributed to the sectors during the day.

Temporal Discharge of Water to the Project Sites

From the initial design specified for the water level and water discharge rate, the water level of the Tiga dam should not be less than 491.82 m/day, according to the findings of this study it was discovered that 520.08 m/day was obtained. Moreover, for the system to perform satisfactorily water discharge to the project site was proposed to be 3.2 l/s. The upstream water head proposed was 0.20 m above FTO (Table 3).

Table 3 Designed/implemented Water Discharged in KRIP 1

Parameter	Design	Implementation
Water level (m)	491.82	520.08
Water quantity discharge to KRIP 1(l/s)	3.2	3.5
Upstream water head (m)	0.20	0.21

Source: Feasibility report, 1976/Field work, 2017.

Dam from HJRBDA to KRIP 1 for 20 years (1998-2017) in order to examine and analyse its variations. The result of the study in figure 2 indicated water level at its lowest (517.94 m/day) in 2009, and highest (523.56 m/day) in 2001. This study established that the increase in the height of water level at Tiga Dam is attributable to the high level of siltation; that is, the sediment accumulation over a long period within the dam. The study concluded that the actual water height at Tiga Dam is much likely to be below the 491.82m/day recommended.

The water discharge rate to the project area from Tiga Dam was believed to be the highest with 3.48 l/s in 1999, and the lowest with 2.17 l/s in 2009. There is also indication of a steady water discharge to the project area from 2003-2017. The upstream water head obtained shows 0.21 m above FTO higher than the design. It was discovered by the study that the irrigators in KRIP 1 used automatic check structures (Begemann gates) to keep this upstream water head nearly constant along sections of the distributary canals.

The study analysed the water level at the Tiga Dam and compared it with water discharged from the RuwanKanya Reservoir to the project via main canal from 1998-2017 (Figure 2). The result indicated a strong relationship in the sense that when the water level increased the water discharged becomes higher, and when the water level decreased, the water discharged reduced. The highest water discharged (3.48 l/s) occurred in 2001, which coincided with highest water level attained during the period (523.56 m/day). Nevertheless, the only difference is the lowest water level of Tiga Dam is 517.94% that occurred in 2009, and the lowest water discharged is 1.75 l/s that occurred (Figure 2).

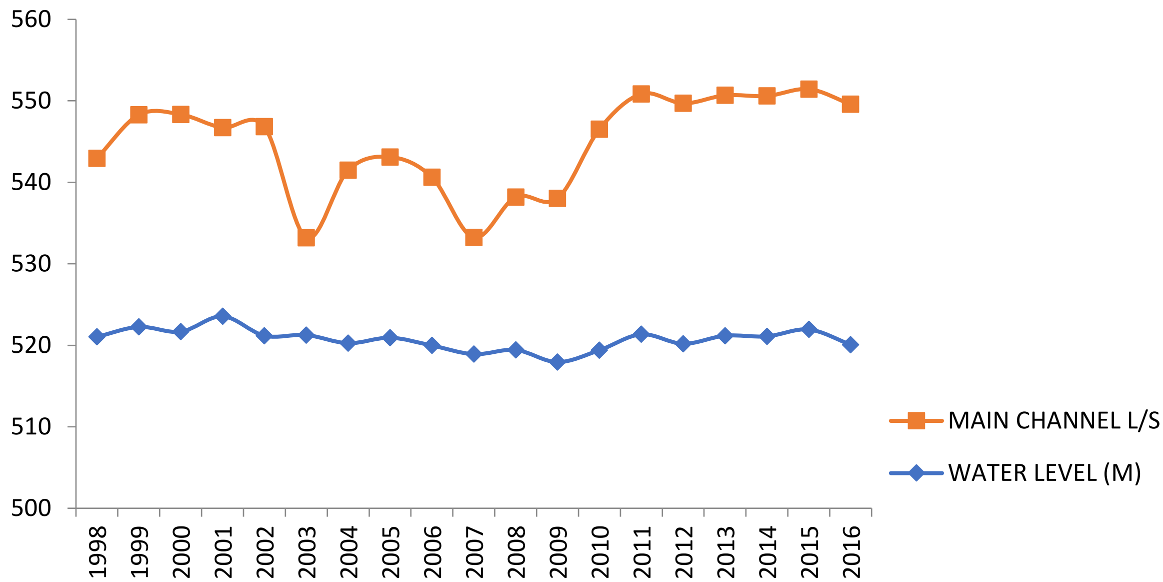

Figure 2: Water Level at Tiga Dam and water discharge rate to the KRIP 1
Source Field survey, 2017.

Stakeholders in KRIP

The study identified the followings as the major stakeholders in KRIP based on priority: farmers, HJRBDA, settlers, herdsmen, Water Users Association (WUA), fishermen, consumers, and laborers and drivers. The rest are suppliers of seeds and irrigation equipment, marketers, small businesses, tractors, truck and lorry transport owners, rice and tomato processing industries, Kano State Agricultural and Rural Development Authority (KNARDA), Kano Agricultural Supply Company (KASCO), Transforming Irrigation Management in Nigeria (TRIMING) and the World Bank. This result is substantiated by that of Jumiati, Fahmid and Riwu (2018) that the major stakeholders identified in Kampili irrigation project area in Indonesia are the non -P3A farmers, NGOs, water users association and researchers among others.

Aerial Extent of the Project, Water Sources and Utilization

The phase one of the KRIP was expected to cover 22,000 ha of irrigable land. As of early 1999 only 15,000 ha was covered. However, by the year 2000, about 2,000 ha were developed. This study discovered that only 17,000 ha have been realized out of the 22,000 ha proposed, which is 77.27%, but only 9,000 ha were in full operation. Example, Azores and much of Karfi sectors are not in operation because of poor design; it was observed that both Azore and Karfi sectors had no water for the last 30 years because the canals are below the fields; therefore, the water from those canals cannot reach the fields. This study observed that one of the impediments to the realization of this phasing schedule was the change of Government in 1975 and insufficient fund from Government afterwards.

The findings further revealed that in 1993, the 18 sectors in the WBR were reconstituted into 41 sectors due to difficulties experienced by HJRBDA staffs in charge for the management of the project.

The study established that Tiga Dam was constructed as the main source of water for KRIP 1 with a reservoir at Ruwankanya (RKR) near munture village to store water in case the main Dam failed. The project was segregated into two regions named; the Western Branch (WBR) and the Eastern Branch (EBR) regions from the design and was attained. The Rano junction served as the main point of water diversion into WBR and EBR. It was observed that there was one main Canal from RuwanKanya Reservoir (RKR) to the Rano junction and extended to the WBR and terminates at Imawa NSR.

The study observed the remains of both forest and the grazing reserves across the project, most especially around Gafan 2B2, Suwaika and Y/Nissan Ruwa. Part of these areas were encroached by farmers, cut down the tree and incorporated it as their farmlands as shown in plate 3. In Suwaika sector for instance, mango and cashew trees were trimmed to provide land for irrigation as shown in plate 1 and 2. It is in line with findings of Yahaya (2002) in Bakalori irrigation project that as work progressed in the project area, farmlands and economic trees were destroyed.

Plate 1: Forest Reserve Encroachment at Y/NRuwa
Source Field survey, 2017.

Plate 2: Forest Destructionin Suwaika.
Source Field survey, 2017.

Water Distribution Systems in KRIP 1

The sectors are divided into blocks each and served by distributary canals; larger sectors are divided in blocks that branch off from a lateral canal or sub-lateral canal. The canals observed are; the Main Canal (MC), Lateral Canal (LC), Distributary Canal (DC) and Field Canal (FC).

The result showed a total canals design in KRIP 1 to be 487, and 460 canals were implemented which represented 94% achievement. The result also indicated a total design length of the canals to be 794,186 m and the findings show 397,670 m were implemented, which represented 50%

achievement (Table 4). The findings indicated that the canals were adequately in place as far as KRIP 1 is concerned, which suggested a well-connected drainage network.

Table 4 Design and Implementation of Canals in KRIP 1

Item	Total Designed	Total Implemented	Percentage Implemented
Number of Canals	487	460	94%
Length of Canals (m)	794,186	397,670	50%

Source: Completion Report WBR, 1982/Field Work, 2017.

The findings indicated that from the blue print main canal proposed was to have a total distance of about 25,000 m. The result showed that a distance of 24,525m was implemented; that is 98.1% of the design, and also the feasibility report showed the main canal width designed of 5 m and the result of the study unraveled that it attained 100%. The study indicated the design depth of 2.5 m and 2.2 m implemented, which accounts for 88%, and for the canal construction it is stone pitching/earth line throughout (Table 5).

Table 5 Main canal`s Design and Implementation.

Item	Designed	Implemented	Percentage implementation
Length (m)	25000	24,525	98.1%
Bedwith (m)	5.00	5.00	100%
Depth (m)	2.50	2.20	88%
Canal Construction	Stone pitching/earth line	Stone pitching/earth line	100% Stone pitching/earth line

Source: HJRBDA /Field Work, 2017.

The study established that the taken over of the project by Kano state Government was responsible for its in-completion. After the Federal Government took over the project, the creation of River Basin Development Authority throughout the country, contributed to the slow face of the project due to long protocol and procurement of project. In addition, the lack of adequate funding from the Federal Ministry of Water Resources, lack of commitment and corruption in the ministry and HJRBDA were impediments to the successful completion of all KRIP`s objectives.

The section of the MC along Munture-Refawa village was cut across rock and formed a gorge as shown in (plate 6a), and it was observed to be free from any modification. The section from Refawa to GarinBabba is made up of earth lined (plate 3a and b). It was discovered from this research that the main canals and distribution canals contain dense typha grass due to informal irrigation is practices. Such practice is associated with withdrawal of water from the canal to farmlands not based on initial design. There are also presence of integrated farms and research centres in the section. The section from Garunbabba to Dorawarsallau until Agolas junction is made up of concrete and has large erosion along the profile of the MC (plate 4a). Furthermore, the study discovered large silts within the canal. While MC portion between Agolas junction (plate 4b) to Imawa NSR has erosion and siltation problem (Table 6).

Table 6 Main Canal`s status in KRIP 1

S/No	Area/Location	Design Condition
1	Munture-Refawa	Section cut in rock (Gorge).
2	Refawa-GarunBabba	Unlined section.
3	GarunBabba-DurawarSallau-Agolas junction	Concrete section.
4	Agolas junction-Imawa	Concrete section.

Source Field survey, 2017.

a) Rock Section near Munture b) Unlined Section at Refawa village

Plate 3 Main Canals

Source Field survey, 2017.

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a) Agolas IV section b) Y/Nissan Ruwa section

Plate 4 Damaged MCs

Source Field survey, 2017.

Types of Crops, Cropping Pattern and Irrigation System

The KRIP 1 as a large-scale irrigation scheme was meant to be successful and sustainable; therefore, the designed cropping pattern was compared with the implementation

Main crops grown by the Individual farmers

The result obtained from questionnaire administered to farmers revealed that the major crops grown during dry season in KRIP 1 are rice, which accounts for 21.2% of the entire crops grown, followed by tomato with total production of 20.1%, and third most important crop, is maize with 19.8%. Others include onion (16.4%), wheat (14.4%), watermelon (3.4%), cucumber (2.5%), pepper (2.0%) and carrot (0.3%) as shown in Figure 3.

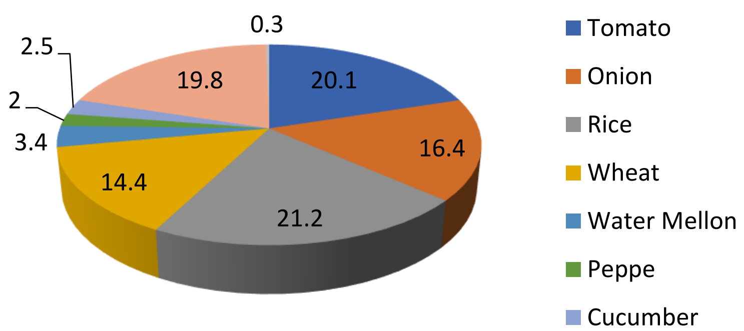

Figure 3: Main Crop Grown by Individual Farmers in KRIP 1
Source Field survey, 2017.

The only crops that were recommended and implemented were tomato and wheat although the level recommended was not attained. A crop nowadays is planted based on individual choice not based on projects designed.

The study established that each sector within the project specialized in a particular crop grown. The result indicated that the major crop in KRIP 1 during dry season nowadays is rice that account for 21.2% of the entire crop grown, and the major producers are: Agolasiv (24.0%), R/Nissan Ruwa (24.0%) and Suwaika (20.0%) (Table 7).

Table 7: Design and Implemented Cropping Pattern in KRIP 1

Initial Design Crops	Implemented Crops
Wheat	Rice
Vegetable	Maize
Tomato	Tomato
Groundnut	Onion

Source Field survey, 2017.

The second most important crop is tomato (20.1%) grown at Dakasoye (25.3%), Boko (19.7%) and Gafan 2B2 (18.3%). In addition, the research findings show that maize (19.8%) as the third important crop in the project produced at Boko (14.3%), Dakasoye (14.3%) and Agolasiv (12.9%). The fourth important crop is onion (16.4%), the major producer being: Kirya (25.9%), Makuntiri (24.1%) and Suwaika (20.0%). The fifth most important crop is wheat (14.4%) grown at R/Nissan Ruwa (25.0%), Agolasiv (21.6%) and Suwaika (19.6%) as shown in Figure 4.

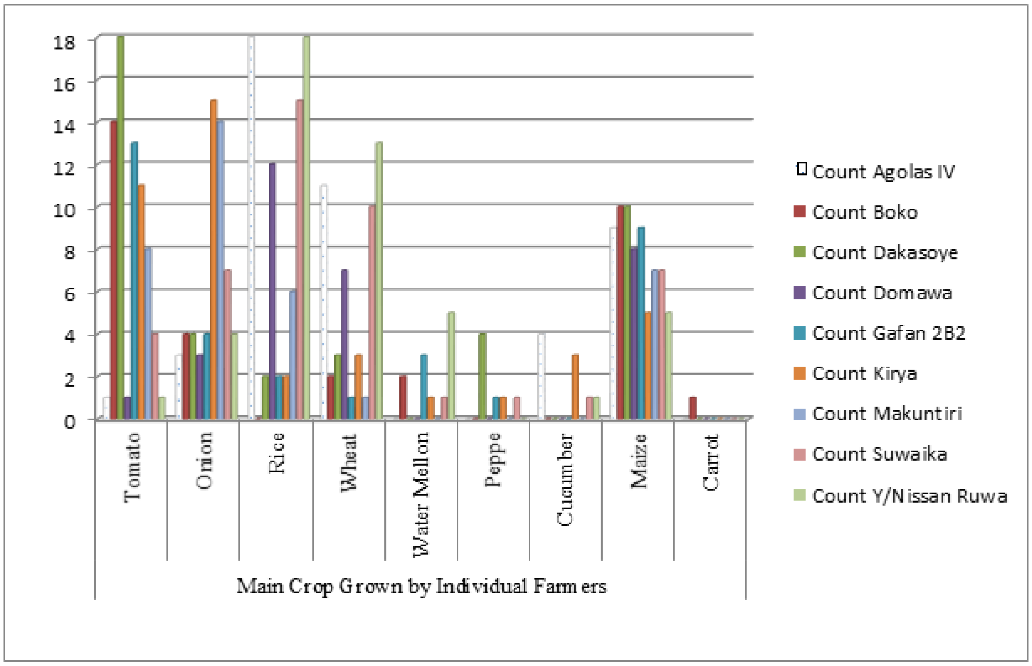

Figure 4: Main Crops Grown by Farmers in KRIP 1 at Sector Level
Source Field survey, 2017.

Water application method in KRIP 1

The study established that the gravity method recommended from the design is currently being practice by the farmers in the project. This was made possible because land clearing and leveling was done according to specification just because farmers must do that for them to receive water released from the FC. The slope according to the blue print was to control erosion and to ensure reasonable travel time, considering infiltration. The time recommended for water application is morning, and the days meant for irrigation water interval per sector is seven-day frequency.

The two major indicators of watering farmlands for as outcome of the research are dryness of soils and crops are related in the sense that dryness in soil conditions is often reflected in the condition of crops. According to the findings, farmers used soil (29.7%) as the major indicator for irrigation, and about 28.7% used crop dryness. Moreover, only 10.4% used the design indicator, which is seven days interval, while 20.2% used about eight days and above, but it depends on the time of planting, early watering is seven days while at the middle of irrigation and towards the end it exceeded eight days (Table 8). This finding tallies with that of El-Agha, et al., (2011) that realises that there is a mismatch between design and implementation of the irrigation projects in Nile Delta regarding water delivery system, which amounted to setbacks like in this project under study.

Table 8: Indicators for Watering Farmland

Indicator	Frequency	Percent
Crop Dryness	101.6	28.7
Water Availability	38.7	10.9
3-7 Days Interval	36.9	10.4
Above 8 Days Interval	71.6	20.2
Soil Dryness	105.2	29.7
Total	354	100.0

Source Field survey, 2017.

Water Resources Infrastructures and Management.

The result of the study indicated that despite the compliance of implementing the total number of sectors envisaged, little variations and modifications exist in the area extent and some canals between during implementation. An example can be observed in the NSR in the project, from the initial design, four was proposed but eight were implemented. These modifications were established by this study to impact on the progress of the project and affected the water management and utilizations.

The study established the check gate that controls water from NSR to the canals, it has an inlet and outlet gates. It was observed that the outlet was designed to be fully blanketed in order to sieve the sediments that may find its way into the canals. The essence of this is to control siltation, which is a very vital ingredient to affect water canals capacity and distribution. The blanket was replaced with an iron filter, which allows some sediment into the canals. This might be one of the major causes of siltation/sedimentation currently experienced in the project area. This result is in line with findings of Clemente et al., (2020) that in the Philipin's irrigation systems at design state canals were based on standard, but later there was change that resulted in deviations associated with unlined canal and reduced in aerial coverage that amounted in differences between designed service area and actual irrigated area.

It was also observed that the emergency spillways were also constructed in accordance with the design to discharge excess water into the drainage system. In addition, put in place in the project from the design were collector drains and field drains. Nevertheless, the study observed that farmers have converted these drains to farming plots. The conversion of these drains into farming plots is one of the causes of water logging on the field, and it also increased water demand during dry season due to increase in the plots from the design.

It was specified from the design that water flow from one canal to another be controlled and managed using sector turn out (STO), field turn out (FTO), and distributary turn out (DTO). The DTO regulates flow of water into the field canals, while the FTO regulates flow of water into the field for farmers to utilize (plate 5a and b).

Results of the study indicate that only the service roads are in place, the field tracks have been converted to farming plots by the farmers. Moreover, the length of these service roads is directly proportional to the length of the MC and LC they serve. The qualities of these roads were observed and assessed on the field and found to be in bad shape due to lack of maintenance (plate 6a and b). It is in agreement with findings of Peprah, et al., (2015). Reticulation irrigation scheme Ghana (2015), which determined that one of the major challenges in the irrigation area is difficult transportation to market. Farmers, settlers, cattle, herdsmen, even vehicles and tractors find alternative route more especially during wet season when the road is inaccessible. They used to walk along the edge of the canals and even sometimes when the water is not flowing, they pass through DC and FC, this caused the canals to further decay, hence affecting the capacity of the canals to distribute water effectively and efficiently.

In addition, the study revealed that the whole project is without extension workers since 1993, when the then military government reformed agricultural sector, all extension workers were transferred from River Basin Development Authorities (RBDAs) to Agricultural Development Programme (ADP), and this created a vacuum of experts /trained personnel in the project. The main functions of the extension workers as specified by the design include enlightening the farmers on innovations to achieve maximum productions and properly utilized and managed the available water resource. The study discovered that the farmers developed their own ways of utilizing and managing the available water resources to suit their own interest due to absence of extension workers. Thus, there was a loss of focus in sustaining the resources for future generations. Some of the farmers used water requirement of the crops grown to determine the method to adopt. For instance maize and tomato farmers in Gafan 2B2 sector adopted vertical (plate 7) and horizontal (plate 8a) ridges, where they plant the crop above the water level due to their low water requirement, while rice, wheat and onion farmers at Agolas IV and Kirya sectors used bedding method due to high water requirement of the crops (plate 8b).

a) STO at G/Babba section

b) LC`s DTO at Kirya

Plate 5 Ancillary Structures

Source Field survey, 2017.

Plate 6: Service Road

Source Field survey, 2017.

Plate 7: Vertical Ridge method

a) Horizontal Ridge Method

b) Bedding Method

Plate 8: Water Management Strategies

Source Field survey, 2017.

Conclusion and Recommendations

The study concluded that the water, which is discharged from Tiga and distributed through Ruwan Kanya Reservoir is steady and above the design. The study has established that, WBR of KRIP 1 failed to implement water resource utilization and management as designed; which resulted in the water shortage currently being experienced in most if not all of the sectors in KRIP 1. The study discovered the trend of water shortage in KRIP 1, it started gradually at Agolas sector and extended to Domawa and Y/Nissan Ruwa and serious at Suwaika sector and became worst at Kirya and Makuntiri sectors. It was also established that the farther away ones move from the main source of the water the less the water that is received due to informal irrigation practices over irrigation, wastage and mismanagement of water among others. It was found by this study that the increase in the height of water level at Tiga Dam is attributed to the high level of siltation, which block waterways. The result indicated that the major crop in KRIP 1 during dry season nowadays is rice. Therefore, the study concluded that there is conflict of choice between farmers' preference of rice, tomato and maize and the project preference of wheat, vegetable and guinea corn which amounted to change in the cropping pattern. The study established that the whole project has been without extension workers since 1993.

In order to ensure smooth and continuous benefits of the project and proper utilisation and management of water resource in KRIP 1, the following recommendations are made. The HJRBDA should take over the maintenance and repair of the water distribution system of the project. This will stop the farmers from carrying out maintenance and repair services themselves, thereby preventing them from removing the earthen materials within the DC and FC, which reduces infiltration, as well as breakage of canals and changing the type of crops and cropping pattern which may enable the authorities to take legal action on defaulters. The project lacks crossing points for both farmers and cattle and it is recommended that the authority should make provision for many crossing points across both canals in order to regulate farmers and cattle passing through the canals.

The HJRBDA should as a matter of importance use the blue print of the project to restore all the plots assigned from the design that were overtaken and converted as farmlands by stakeholders.

These include connector/field drains, forest/grazing reserves and field tracks. In furtherence, it should provide modalities that will prevent future reallocation. Water channels and canals should be dredge to avoid siltation, and more extension workers should be provided in the project area to ensure full compliance with the project design.

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