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The Performance of Traditional and Modern Irrigation Schemes in Improving Agriculture Crops Yields in Tanzania A Case of Mbeya Rural District

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Abstract: This study was conducted in Utengule Usongwe irrigation scheme, Mbeya District Tanzania. Specifically the study aimed to examine the potential of tradition and modern irrigation schemes in agriculture crops production and to identify the constraints facing both traditional and modern irrigation schemes in cultivating agriculture crops. A sample of 80 selected household heads was used in the study. The study employed cross sectional research design whereby data were collected by using questionnaire survey, interview and physical field visit. Simple random sampling technique was employed to identify the sample. Descriptive statistics including frequency and percentage was used in analyzing the information collected. The findings revealed that 55.7% of households practiced modern irrigation schemes cultivated large tomato farm size ranged between 4046.87m^2-6070.3m^2 as compared to only 19.3% of households practiced traditional irrigation scheme while in the same onion farm size the majority 93.4% of households adopted modern irrigation schemes cultivated onions as compared to few 31.3% of households adopted traditional irrigation scheme. Secondly the study revealed that farmers cultivated onions, tomatoes and vegetables the same farm size i.e 4046.87 m^2 those used modern irrigation schemes harvested more crops compared to those used traditional irrigation schemes. Lastly the study revealed the problems of loss of water through seepage in traditional scheme, lack of adequate extension services and lack of spare parts for water pumps in modern irrigation schemes. The study recommends education and training should be strengthened, construction of concrete canal river/spring diversion, supply water pumps on the basis of users demand and finally establishment and strengthening water use association.

Keywords: Traditional, modern, irrigation schemes and crops

1.0 INTRODUCTION

1.1 Background Information

Irrigation is the controlled application of water for agricultural purposes through manmade systems to supply water requirements that are not satisfied by the rainfall (Sirisha, 2016). Globally, about 40% of irrigation water is supplied from groundwater (Dhawan, 2017). FAO has projected that the global area equipped for irrigation may increase at a relatively low annual rate of 0.1 percent. At that rate, it would reach 337 million ha in 2050, compared to around 325 million ha in 2013 (FAO, 2016).Crop irrigation is vital throughout the world in order to provide the world's ever-growing populations with enough food (Sirisha, 2016). Approximately 70 % of global freshwater withdrawals (FAO, 2014) are used to meet the demand for irrigation, thereby altering the hydrologic cycle and raising questions about water resources sustainability.

Approximately 40% of the world's food comes from 17% of the world's cropland that is irrigated which consumes more than two third of the world's developed water supplies(Kbrom and Mehari 2016).A FAO analysis (Bruinsma, 2003) of 93 developing countries expects agricultural production to increase over the period 1998-2030 by 49% in rain fed systems and by 81% in irrigated systems. However, irrigation development in Tanzania is characterized by inadequate investments in water abstraction and storage infrastructure, low level of funding by the Government for irrigation investments, inadequate capacity of beneficiaries to invest in the infrastructure for their irrigation systems, low rate of investment in irrigated agriculture by the private sector, inadequate capacity of the private sector to participate in irrigation development and failure of technology transformation (Kiseto, 2014).Irrigated agriculture is concentrated mainly in the mountainous eastern and south-western regions of Tanzania, such as Kilimanjaro, Mbeya and Morogoro, where traditional irrigation has flourished, as well as Arusha and Iringa (Nkonya, 2013).The country has about 29 million hectares of land deemed suitable for irrigation, only 1 percent of which is currently irrigated (URT, 2017).Irrigation schemes can experience problems in technical performance owing to a range of factors. These include poor planning and design, declining soil fertility and productivity, financial unsustainability and deficits in operations and maintenance.

Mbeya rural district has two categories of irrigation scheme namely state farming irrigation and small holder farms irrigation schemes which also are in two types of traditional irrigation schemes and modern (improved) irrigation schemes. The Technical performance indicators of the irrigation schemes, such as on

yields, coverage, cost recovery and supply interruptions, provide entry points for identifying problems in performance (Naomi *et al;* 2017).

The existing literature on the performance of the traditional and modern irrigation scheme has done inadequately to examine the performance of these irrigation schemes in increasing agriculture crops productivity instead it has focused on water use related conflicts among water users in irrigation schemes. Therefore the objective of the study was to assess the performance of traditional and modern irrigation schemes in improving agriculture crops yields in Tanzania.

2.0 Methodology

The study was conducted in Utengule Songwe irrigation scheme covered two villages Itimba and Utengule Songwe located in Mbeya Rural District. The study area was selected because of the existence of both traditional and modern irrigation schemes. The crops grown in both traditional and modern irrigation schemes by farmers in the study area were tomato, tomato pot, oak, onion, cucumber and green pepper. In Utengule Usongwe village a community use the traditional method of irrigation owned by individual who have attempt to harness available water from river. Mostly irrigation method employed is manual using buckets, watering cans, ropes to lift water from streams. Surface irrigation water streams following gravity toward the farm. Apart from the government support of building water gates which allow water to flow following the stream to the farm, the technique of irrigation is traditional where water streams flow toward the gravity, manually using buckets or watering canes, or ropes for lifting water. In Utengule Songwe village the majority of farmers apply traditional method of irrigation.

Farmers in second village Itimba located in Utengule Songwe irrigation scheme have developed modernized irrigation technique using sprinklers, drip irrigation, surface irrigation by constructing watering streams across the farm, money maker pumps for pumping water from river streams to the farm; they have established water wells and reservoir for irrigation. Sprinklers and drip irrigation, in Itimba village farmers uses the small amount of water effectively and efficiently compared to the using watering cans and buckets. The farmers are assisted by Mbeya District Council funded by Japan International cooperation Agency (JICA), which supplies them with irrigation inputs and provides training and workshops on how to increase house hold income to farmer for modern irrigation.

Household questionnaire interview, focus group discussion and physical visit methods were used to collect data. These methods were used to triangulate the information so as to increase data reliability and validity. Household questionnaire was administered to households who were picked by using simple random sampling technique. A total of 80 households were picked. In case of interview four street leaders two each from Itimba and Utengule Songwe villages, Ward Executive Officer, Irrigation Schemes Committee Members were interviewed. Lastly physical visits were undertaken to both villages to observe the situation and practice of traditional and modern irrigation schemes in Itimba and Utengule Songwe villages.

3.0 Results and Discussion

3.1 Field crops grown using traditional and modern irrigation technology

3.1.1 Crops grown

The study revealed the common field crops produced by both irrigation technologies i.e. modern and traditional irrigations schemes were onions, tomato, and other vegetable like Chinese, Spinach, tomato pot and green pepper (Table 1) .These crops are produced due to high demand by Utengule Fruit Parking Association where they use them to produce tomato sauce, chill sauce, and also demand of these crops to the Mbalizi market as well as household demand in Utengule Usongwe community.

Table 1: Major Crops grown by traditional and modern irrigation schemes by farmers and their proportions in Itimba and Utengule Songwe villages

Traditional irrigation schemes in Itimba village			**Modern irrigation schemes in Utengule Songwe village**		
Type of crops	Frequency (n)	Percentages (%)	Type of crops	Frequency (n)	Percentage (%)
Tomato only	19	47.5	Tomato only	13	43.3
Onion only	10	25	Onion only	8	26.7
Tomato, Onion and vegetable	4	10	Tomato, onion and vegetable	4	13.3
Tomato and onion	2	5	Tomato and onion	3	10
Vegetable only	3	7.5	Vegetable only	1	3.3
Tomato, and vegetable	1	2.5	Tomato and vegetable	1	3.3
Onion and vegetable	1	2.5			
Total	**40**	**100**	**Total**	**30**	**100**

In the study area farmers engage much in growing tomato because it is easy to recover the initial cost of production, has better price and it involves harvest more than once compared to other crops like onion which are harvested once.

3.2 The potentials of irrigations schemes per farm size and average production

The average land holding under traditional irrigation method was 2023.44 m^2, the minimum land size ownership was1011.72 m^2 and 4046.87 m^2 maximum lands owned by traditional irrigation farmers, the majority 57.7 % of the farmers in the study area own 1011.72 m^2 of land. The average land owned by modern irrigation farmers was 4046.87 m^2, where tomatoes dominates production in the study area, the maximum size of land owned by farmers was 8093.75 m^2 equivalent to (5%) of the respondents, the minimum size of land owned was 1011.72 m^2 which was 5% of the respondents, the majority of farmers owns the land size which ranges from 1011.72 m^2 - 4046.87m^2 which was about 70% of the modern irrigation farmers.

Table 2: Tomato farm plot size cultivated (in m^2)

Traditional irrigation scheme in Itimba village			**Modern irrigation scheme in Utengule Songwe village**		
Farm size (m^2)	Frequency (n)	Percentage (%)	Farm size	Frequency	Percentage (%)
1011.72 m^2	15	57.7	1011.72m^2	1	5
2023.44m^2	6	23.1	2023.44 m^2	6	30
4046.87m^2	5	19.3	4046.87 m^2	8	40
6070.31m^2	0	0	6070.31 m^2	3	15
8093.75m^2	0	0	8093.75 m^2	2	10
Total	**27**	**100**	**Total**	**20**	**100**

Results from Table 2 shows that most of tomato traditional farmers about 57.7 per cent cultivate farm size of 1011.72 m^2since most of them operate limited small capital which enable them to afford to manage small piece of land, and where the modern tomato irrigation farmers about 95 per cent operate irrigation to the farm plot between 1011.72 m^2 to 8093.75 m^2 since they have adequate capital to purchase irrigation machines which can irrigate large farms within short time and conduct farming activities where traditional method cannot operate.

Tomato farm size in relation to the average products

The average tomato production in the study area to the land size of 1011.72 m^2 in both irrigation methods were as follows to the traditional irrigation methods, average products were 31 baskets, the minimum tomato production to the farmer were 12 baskets, maximum tomato production were 63 baskets while to the modern irrigation farmers the average products were 60 baskets. The farm size of 2023.44 m^2; in traditional irrigation farmers the average products were 142 baskets of tomatoes, the minimum harvest were 70 baskets, and maximum harvest were 250 harvests where to the modern irrigation methods ,the average tomato production were 215 baskets, minimum harvest were 75 baskets of tomato and the maximum tomato production were 325 baskets .

Farm size of 4046.87 m^2**,** to traditional irrigation methods, average products were 170 baskets per season where minimum tomato harvests were 70 harvest, and the maximum harvest were 300 harvest, while to the modern irrigation methods, the average tomato harvested were 274 baskets, minimum harvest were 75 baskets and maximum harvest were 500 baskets. Most of traditional irrigation farmers owns farms from 1011.72 m^2 to 4046.87 m^2 under irrigation only where most of modern irrigation farmers cultivate tomato at plot size of 6070.31 m^2 and 8093.75m^2, where the average product to the farmers who grows tomatoes of 6070.31 m^2 were 800 baskets per season, minimum harvest were 250 baskets, the maximum harvest were 1200 baskets harvested per season and to the farmers who owns 8093.75m^2,the average products were 900 baskets per season, Minimum harvest were 600 baskets, Maximum harvest of tomato were 1200 baskets per season.

Table 3: Onions farm plot size cultivated

Traditional irrigation technology			**Modern irrigation technology**		
Farm size (m^2)	Frequency (n)	Percentage (%)	Farm size (m^2)	Frequency (n)	Percentage (%)
1011.72 m^2	11	68.8	1011.72 m^2	1	6.7
2023.44 m^2	4	25	2023.44 m^2	7	46.7
4046.87 m^2	1	6.3	4046.87 m^2	7	46.7
Total	**16**	**100**	**Total**	**15**	**100**

The table 3 implies that most of traditional onion irrigation farmers owns small piece of land for irrigation farming about 1011.72 m^2 (68.8 per cent) followed by 2023.44 m^2 compared to modern irrigation farmers where about 93.4 per cent owns between 1011.72 m^2 to 4046.87 m^2 , this shows that modern onion irrigation farmers has big operating capital than traditional onion irrigation farmers.

Onion farm size in relation to average production

Farm size of 1011.72 m^2; in traditional irrigation farmers of onion, the average products were 18 bags, minimum harvest were 3 bags per season, and the maximum harvest were 50 bags where the modern irrigation farmers, their average products were 25 bags, the minimum harvest were 25 bags and maximum harvest were 30 bags of onion. Farm size of 2023.44 m^2 in tradition irrigation farmers of onion, the average products were 27 bags, minimum harvest were 15 bags and the maximum harvest were 50 bags where to modern irrigation farmers of onion the average products were 52 bags, where the minimum harvest were 24 bags and the maximum harvest were 80 bags of onion. The farm size of 4046.87 m^2; in traditional irrigation farmers of onion ,the average products were 39 bags, where to modern irrigation farmers, the average products were 69 bags, the minimum harvest were 40 bags and the maximum harvest were 100 bags of onion.

Table 4: Vegetable farm plot size cultivated

Traditional irrigation scheme in Itimba village			**Modern irrigation scheme in Utengule Songwe village**		
Farm size (m^2)	Frequency (n)	Percentage (%)	Farm size (m2)	Frequency (%)	Percentage (%)
1011.72 m^2	5	62.5	1011.72 m^2	3	60
2023.44 m^2	2	25	2023.44 m^2	2	40
4046.88 m^2	1	12.5	4046.88 m^2	0	0
Total	**8**	**100**	**Total**	**5**	**100**

The above table implies that there was close correlation in farm plot size of 1011.72 m^2 to 8093.75 m^2 under vegetable farming in both traditional and modern irrigation technology and few owns one acre to traditional farmers and modern farmers does not cultivate such plot siz**e.**

Farm plot size and average production

Farm size 1011.72 $m^2$to traditional irrigation farmers, the average products were 82 bags ,the minimum harvests were 15 bags per season, the maximum harvest were 184 bags where to modern irrigation farmers the average product were 93 bags, the minimum harvest were 30 bags and maximum harvest were 184 harvests. Farm size 2023.44 m^2 to traditional irrigation farmers, the mean products were 275 bags, minimum harvest were 50 bags and the maximum harvest were 500 bags where most of the farmers specialized in production of spinach, Chinese, oak while modern irrigation farmers specialized in production of Cucumber and tomato pot where the mean products were 39 bags, the minimum harvest were 30 bags and the maximum harvest were 48 bags. Farm size of 4046.88 m^2 a modern irrigation farmer does not own farm size while 12.5% of the traditional irrigation farmers own farm size of vegetable where the average products were 214 bags.

3.3 Major constraints encountered by farmers using traditional and modern irrigation schemes.

Irrigation has immense potential to improve the incomes of poor rural households in developing countries like Tanzania, but it is never free from problems. A field survey and key informant interviews indicates that both tradition and modern irrigations great benefit is accompanied with multidimensional problems. The problems of application of irrigation technology development range from individual household have biased attitudes to institutional arrangements. The major problems encountered in irrigation in the study area were problems related to cost, institutional problems, the policy environment, design issues, cultural factors and environmental problems.

Loss of water through seepage is the main problem in traditional irrigation systems in the study area. The non-durability of the physical structure of irrigation schemes and the nature of the study area causes high water seepage from river diversion canals. Seepage from irrigation canals is the main causes for water losses in Itimba village and modern irrigation farmers who use motorized water pumps there is loss of water through delicate water pipes which drips water; hence water doesn't reach the farm at the required amount.

Lack of adequate extension service, this is a big constrain to the development of traditional irrigation farmers, where most of respondent reported lack of agricultural knowledge from extension officer, compared to modern irrigation scheme farmers who were able to access these extension services even by hiring extension officer from other villages, lack of extension services affects the yields of the farmers.

Problems with irrigation water distribution also exist in the study area. In the two villages studied, water distribution and water use principles are unregulated except in where there are water use associations. This causes many conflicts between upstream and downstream irrigating households. For instance, in Itakasya there were water conflicts on the Utengule irrigation stream between downstream and upstream irrigating households. The main cause of the problem is the amount of water reaches at low pressure to the farmers which in Utengule irrigation downstream. The upstream community always uses all amount of water through canal river diversion. There are many households who use motor pump irrigation in the downstream but receive low amount of water. This creates conflict between upstream and downstream water users.

Time spend in watering the farm to traditional irrigation farmers is problem since using buckets and watering cane spend a lot of time in irrigating through traditional irrigation scheme compared to farmers who use motorized water pump, money maker pumps, they take short time to complete irrigating their farm this enable them to engage in other economic activities, according to the study area traditional farmers use five to six hours to complete 4046.88 m^2 and sometimes crops does not get enough water which eventually lead to low harvest, using money maker pump or motorized water pump use almost two hours to feed water to crops of one acre.

Lack of spare parts for water pumps and shortage of fuel is an issue. The lack of imported spare parts for motor pumps and treadle pumps are main causes for reduced efficiency in application of modern irrigation in the study area. Motorized water pump irrigation is used by many households. The main problems with motor pump irrigation are the frequent damage of the pump, lack of awareness of how to operate, cost of fuel and of the pump and lack of credit.

Super moneymaker pumps and Money maker hip pump is other tool used in irrigation technology in the study area. The Money maker pumps used in the study area were imported from India. In the key informant interview and focus group discussion the main problems with money maker pumps were lack of spare parts and non-functionality due to long service.

Crop diseases were another factor of importance. The study area is intensively cultivated with the same crops for long periods of time. Onion and tomato are repeatedly grown crops. In addition to the loss of productivity and fertility, this cultivation strategy facilitates crop disease like root rot and cut warm. Imported inputs to control these problems such as herbicides and pesticides are most costly for traditional farmers than modern farmers to purchase. Therefore, diseases and pests do limit the economic benefits of traditional irrigation activities in the study area.

Lack of market and marketing facility is another constrain. Although not directly related to the functioning of irrigation systems per se, the market is considered one of the main problems in the study area. Cultivated Crops in both traditional and modern irrigation like onion, tomato, tomato pot cucumber and the like are highly perishable and bulky crops so an efficient marketing channel is necessary .However, the study area marketing system does not always facilitate outcomes desired by farmers. One reason is the similarity of products and marketing patterns; onion and tomato are the dominant crops, often harvested by farmers at the same time, which leads to a high availability and low prices during the main marketing period. Compounding this, because there is no efficient storage system in the study area, products quality deteriorates rapidly, which means that farmers must sell within a very short time, often at what they consider low prices.

4.0 Conclusions and Recommendations

Access to irrigation schemes increases the opportunity for crop intensity and diversification, which increase cropping yield. Both modern and traditional irrigation schemes have potential in increasing household's agricultural crops yields. The study revealed modern irrigation schemes has more potential compared to traditional irrigation schemes including it enabled farmers to cultivate large farm size as compared to traditional therefore more household's yields and therefore more income. Also the problems facing modern irrigation schemes was lack of spare parts for water pumps while in traditional irrigation scheme were loss of water through seepage in traditional scheme and lack of adequate extension services. The study recommends education and training should be strengthened, construction of concrete canal river/spring diversion, supply water pumps on the basis of users demand and finally establishment and strengthening water use association.

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