TECHNICAL AND ECONOMIC COMPARISON OF PERFORMANCE BETWEEN FARMER AND GOVERNMENT MANAGED IRRIGATION SCHEMES IN TANZANIA: A CASE STUDY OF KAPUNGA IRRIGATION PROJECT

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Abstract

This paper compares the performance of government to farmer-managed irrigation schemes at Kapunga Rice Project in Mbeya Region, south-west Tanzania. The results showed that the farmer-managed irrigation scheme (FMIS) performed better than the government-managed irrigation scheme (GMIS) in attaining good performance. Applicable indicators for farmer-managed irrigation scheme are as shown below with those of government-managed scheme indicated in brackets. Its overall irrigation efficiency was 61 percent (29 percent);average productivity was 3.2 ton/ha (2.2 ton/ha); economic profitability: internal rate of return was 3.2 percent (5 percent), benefit/cost ratio of 0.60 (0.14); while its financial profitability: internal rate of return was 3.9 percent (5.1 percent), benefit/cost ratio was 0.60 (0.13). Both the government and farmer-managed schemes had canal maintenance problems. There was a corresponding big error in water adequacy of 86 and 98 percent for farmer and government-managed schemes, respectively, arising from improper water control at the secondary canal offtake.

Introduction

Tanzania's economy (about 80 percent) depends mainly on agriculture[1]. However, due to the unreliability of rainfall, different forms of irrigation schemes have been established in Tanzania to supplement crop water needs[2]. There are two forms of irrigation management in Tanzania: the farmer and the government-managed irrigation schemes. To date, 80 percent of irrigation schemes are farmer-managed, while 20 percent are government-managed[2]. Government-managed irrigation schemes (GMIS) are those in which the principal management responsibilities are carried out by government with farmers playing a subsidiary role. While farmer-managed schemes (FMIS) are those in which farmers play the principal role with the government playing the minor role. The major objective of establishing GMIS was to ensure national food security and economic growth while that of establishing FMIS was to increase farmers' productivity[1].

According to Mnzavas and Makonta[3] irrigation development in Tanzania has gone through three stages. First, the unpopular imposed smallholder schemes which were characterised by (i) lack of decision making by the farmers, (ii) lack of farmers/beneficiaries motivation, and (iii) conflicts with local community or other institutions on land ownership, water use, and social issues. The second stage was the large scale schemes in which only the government was involved in irrigation development and operation. In all these stages, farmers did not participate in planning, designing and constructing the proposed irrigation schemes. Also, responsibilities of farmers for operating and maintaining the schemes were not clearly defined. Therefore, their chances of adopting modern irrigation techniques were limited. Thus, irrigation practices remained at traditional level. On the other hand, government-managed irrigation schemes (GMIS) received substantial capital, modern equipment and trained manpower. However, the performance of these schemes remained low[4].

Due to the poor performance of the GMIS, the government of Tanzania is currently emphasising the development of farmer-managed irrigation schemes (FMIS) as a means of attaining sustainable irrigation farming (third stage). Although there is this emphasis by the government no comparative evaluation of performance of GMIS to that of FMIS was done to see which is superior.

Consequently, the overall objective of this paper is to compare technical and economic performance of the GMIS to FMIS at Kapunga Rice Project. The specific objectives are: (i) to evaluate water management factors influencing the two schemes and (ii) to evaluate productivity and economic performance of the two schemes.

Materials and Methods

Background to Study Area

The Kapunga Irrigation Rice Project consists of the smallholder rice irrigation scheme (farmer-managed) of 789 ha and the National Agriculture Food Corporation Scheme (NAFCO; government managed) of 3015 ha (Fig. 1). Farmers operating the FMIS come from nine villages namely: Igumbilo, Chimala, Mwanima, Matebete, Muwala, Isitu, Mbalimo, Ihai, and Itamboleo.

The government built all the infrastructure of both projects including irrigation and drainage canals, hydraulic structures and roads. The government also provides agricultural machinery, transport facilities and support staff to FMIS. NAFCO (GMIS) is operated, maintained and managed by government officials.

Location

Kapunga Rice Project is located between 8° 30'and 9° 00' latitude South and between 34° 00' and 34° 30' longitude east, north of Chimala in Mbeya Region, Tanzania, at an altitude of 1035 m above sea-level. The project lies between Chimala river and the Great Ruaha river in Usangu Plains (Fig. 1).

Project Layout

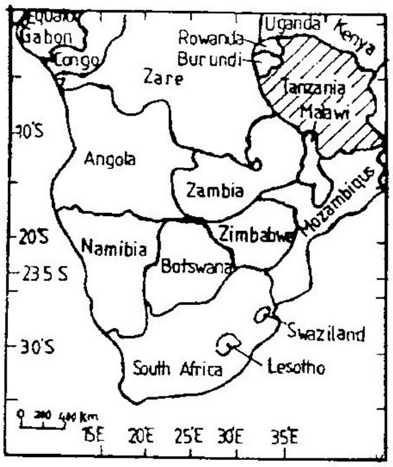
Irrigation water for the project is diverted from the great Ruaha river through the main canal intake structure. This water is then conveyed through earthen main canal which feeds the secondary canals numbers 1 and 2 for the government-managed scheme and number 3 for the farmer managed scheme (Fig. 2). The government- managed scheme is subdivided into a series of fields of 6 ha. Each of these fields is irrigated by field canal taking off from the secondary canal.

Field Operations

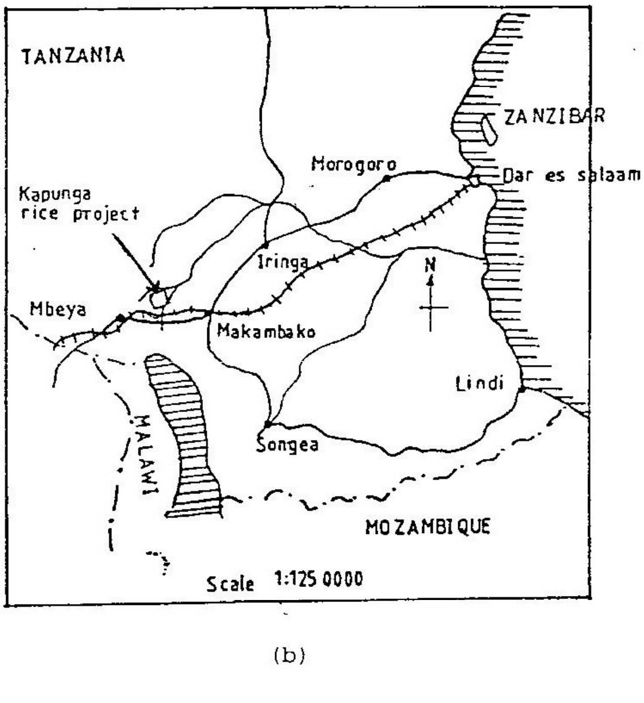
The government-managed scheme is fully mechanised from land preparation to grain storage, while the farmer-managed scheme's operations are carried out by human labour. Cultivation in the farmer-managed scheme is by hired tractors from the government-managed scheme and animal power from individual smallholder farmers.

Climate and Soils of Kapunga Rice Project

The average annual temperature is 21° C with a minimum of 14.5° C in July and a maximum of 24.3° C in November. Mean annual relative humidity is 66 percent



(a)



(b)

Fig. 1 (a) Position of Tanzania in southern Africa and (b) Kapunga irrigation scheme, Tanzania.

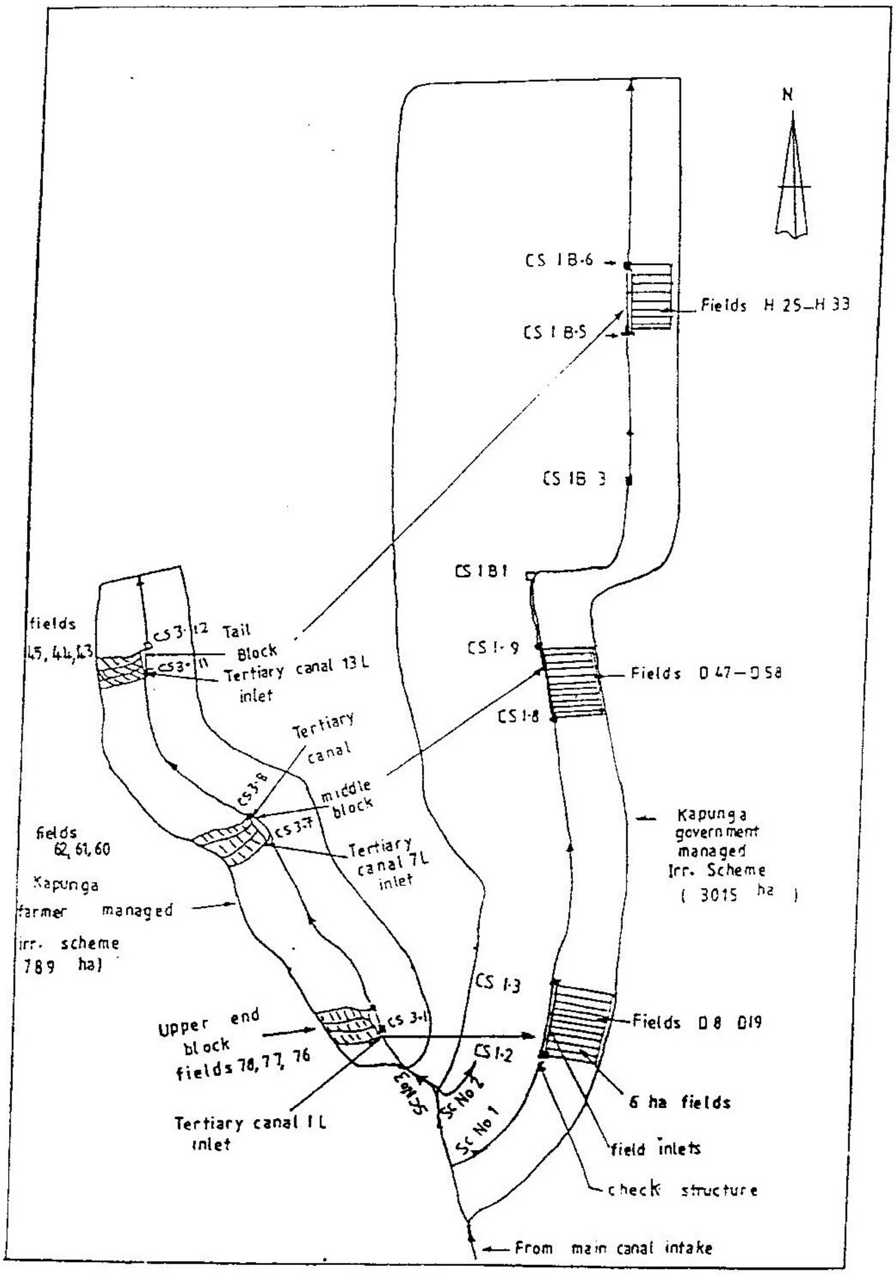


Fig. 2 Layout of Kapinga irrigation scheme

and ranges from 79 percent in February to 46 percent in December. The mean annual rainfall is 430 mm; the highest rainfall of 199 mm falls in February and the lowest of 0.4 mm occurs in October. The project area is part of the Usangu flood plains which receives water from rivers originating from the Poroto mountains at altitude ranging from 1800 to 2000 m above sea-level.

The soil texture of the project ranges from medium to heavy type. the clays are mainly derived from shale. The medium soil texture is mainly alluvial having been formed by periodic floods. Most of the project area has soils of pH ranging from 6.5 to 7.5. The organic matter content of the soil ranges from 0.5 to 5 percent, nitrogen (N) between 0.05 and 0.4 percent, phosphorus (P) in the form P_2O_5 ranges from 7 to 30 ppm, and potassium (K) varies from 1.05 to 2.06 me/100g. These soils could be considered of medium fertility.

Field Measurement

To evaluate both FMIS and GMIS several measurements were required including discharge rates and water applied in the field (for determining conveyance efficiency, distribution efficiency, application efficiency and overall scheme efficiency), crop yield, water depth above the soil surface and field moisture status.

Project Layout

Irrigation water for the project is diverted from the great Ruaha river through the which feeds the secondary canals numbers 1 and 2 for the government-managed scheme and number 3 for the farmer-managed scheme (Fig. 2). The government-managed scheme is subdivided into a series of fields of 6 ha. Each of these fields is irrigated by a field canal taking off from the secondary canal.

Thus, the following facilities existing at Kapunga Rice Irrigation Project were used in this study: (i) calibrated flume at the main canal intake, (ii) three constant head orifices at the secondary canals, (iii) Check structures and (iv) field canal inlets. These facilities were used to measure discharge rates.

Twenty eight smallholder farmers, two watermen, an extension staff for smallholder farmers (from the government-managed scheme) and two functional managers (production and field engineering) were also interviewed to get socioeconomic data.

Sample fields

Sample fields were randomly selected in the upper, middle, and tail end regions of the farmer and government-managed irrigation schemes (Fig. 2) for measuring the amount of water applied in the field, water depth above the soil surface, crop yield, field moisture and interviews to farmers.

To compare the statistical data between the FMIS (first sample) and GMIS (second sample) in which sample data were less than 30 and standard deviations were unknown, T-test was applied.

From decades 1 to 9 after transplanting, water depths over the sample paddy fields were measured daily at 1700 hours using a carpenter ruler. At the end of the cropping season, the average water depths that were maintained within the blocks in decades 1 to 6 and 7 to 9 after transplanting were calculated.

Productivity and economic performance

The 1994/95 season production of the sample plots in the government and farmer-managed schemes was weighed at 18 percent moisture content. Interviews were conducted to 28 farmers to obtain the 1991-1994 average yield, benefits and costs per hectare. Data for these variables for government-managed scheme were obtained from the scheme's office.

A T-test was used to compare the mean productions of the farmer to government-managed irrigation schemes. The record of production of earlier years (1991-1995), costs and benefits of both schemes were used in this test. Discounted costs and benefits were estimated to assess the economic and financial performance of these schemes.

Results and Discussion

The results of evaluation and comparison of the performance for farmer and government-managed irrigation schemes could be presented in two parts (i) water management aspects and (ii) productivity and economic performance.

Irrigation efficiencies

Different forms of irrigation efficiencies are shown in Table 1. The conveyance efficiency of the main canal supplying water to both schemes was found to be 85 percent. This is a good performance since it lies within the recommended range of 80 to 90 percent[5].

Table 1 Irrigation efficiencies (%).

	Block	Farmer manager	Government managed	Required
Application Efficiency	Upper	85	38	63
	Middle	96	43	63
	Tail	91	46	63
	Average	91	42	63
Distribution Efficiency	Upper	80	81	80
	Middle	82	83	80
	Tail	78	79	80
	Average	80	81	80
Conveyance		85	85	90
Overall		61	29	45

Table 2 T-test results for irrigation efficiencies

Degree of freedom v = 4		GMIS/FMIS/ FMIS	GMIS PLANNED
Distribution efficiency	Test statistic T	0.610	1.060
	Critical T at 5% level of significance	2.777	2.777
	Critical T at 1% level of significance	4.604	4.604
Application Efficiency	Test statistic T	12.27	8.700
	critical T at 5% level os significance	2.777	2.777
	critical T at 1% level of significance	4.604	4.604

To compare other efficiencies between the two schemes, such as distribution and application, a T-test was applied. Table 2 shows the results of this test. The distribution efficiency of the secondary canals for the GMIS and for FMIS were not significantly different. This is shown by the result of a T-test of 0.60 against a critical T-test of 4.06 at 1 percent and 2.77 at 5 percent levels of significance (Table 2). Comparison of distribution efficiency of the GMIS and the planned (design) distribution efficiency gave a T-test statistic of 0.87 against a critical T-value of 4.60 at 1 percent and 2.77 at 5 percent levels of significance (Table 2). This means that the distribution efficiency of the GMIS was not significantly different from the design value.

The analysis to compare the distribution efficiency of the FMIS to the design efficiency also showed that the distribution efficiency in the FMIS was not significantly different from the design distribution efficiency (Table 2).

The results of a T-test to compare the application efficiencies of farmer to government-managed irrigation schemes showed that the application efficiency in the FMIS differed significantly from that of the GMIS at both 1 percent and 5 percent levels of significance (Table 2). The application efficiency in the FMIS was higher than that in the GMIS due to the excessive time of water application in the GMIS. According to the scheme design, irrigation water was to be applied over the field for an average of 24 hours in a single irrigation event. However, it was observed that time of application of irrigation water in GMIS ranged from 36 to 72 hours which was too long.

Comparing the application efficiencies of the GMIS to the design value showed that the application efficiency of GMIS differed significantly from the design value both at 1 percent and 5 percent levels of significance (Table 2) due to the reason given earlier.

Application efficiency of the FMIS ranged from 85 to 96 percent, while the required (design) value was 63 percent (Table 1). These results showed that the application efficiency of FMIS was greater than the design value. This result was confirmed by a T-test which showed that the application efficiency of the FMIS differed significantly from the design value (Table 2).

Table 3 shows the results of the water delivery performance as estimated by the mean square prediction error theory[6]. These results indicated that both the FMIS and GMIS were not applying water in the plots according to the design quantities. This was shown by a big water adequacy error of 98 and 86 percent for the farmer and government-managed schemes, respectively (Table 3). The water applied in the FMIS was generally less than the design quantities. While the GMIS applied much more water than the design quantities. This was also indicated by the low average application efficiencies which amounted to 42 percent against the design value of 63 percent in the GMIS, while in the FMIS, the average application efficiency was high, amounting to 91 percent (Table 1). The inadequacy of water in the farmer-managed was due to (i) improper water control at the secondary canal and (ii) farmers were not following rotation rules at the level of the tertiary block.

Both the FMIS and the GMIS had a low error of equity of water distribution of 2 and 11 percent, respectively (Table 3). This low error of equity indicated that water was distributed more or less uniformly in the canal systems. This is due to the fact that both schemes were designed to discharge water along the canals automatically using fixed duck-bill check structures. However, the FMIS had the lowest equity error of 2 percent meaning that water was more uniformly distributed in the FMIS than in the GMIS.

Table 3: Water delivery performance

Type of error	% Error in farmer farmer-managed	% Error in government -managed scheme
Adequacy error (Aer)	98%	86%
Equity error (Eer)	2%	11%
Canal physical/ management error (Cer)	0%	3%

The management error between the actual and the design values of water was zero for the FMIS and 3 percent for the GMIS (Table 3). This means that the supply of water for irrigation was highly reliable, being supplied according to schedule and that the secondary canals' physical conditions were well. The high distribution efficiencies of the secondary canals (Table 1) confirm this result.

Water depth management

The comparison between the measured and the design water depths indicated that there was no significant difference between them for both farmer and government-managed schemes at 1 percent level of significance (Table 4). However, there was a significant difference between the design and the measured water depths in the FMIS while in the GMIS, there was no significant difference between these depths at 5 percent level of significance. In the GMIS, the water depth was maintained at the recommended values (design values) more than in the FMIS because the GMIS had watermen controlling water at the field inlets and field outlets. These watermen opened the field inlets at the time of irrigation, closed the inlet gates after irrigation and drained out the water from the fields as required.

Table 4: T-test results of water depth management

Degree of freedom v = 10		GMIS Against Required	FMIS Against Required
Decades 1 to 9	Test statistic T	1.300	3.130
	Critical T at 5% level of significance	2.228	2.228
	Critical T at 1% level of significance	3.169	3.169

Productivity and Economic Performance

The productivity of government-managed scheme fell from 4.34 ton/ha in 1991 to 2.20 ton/ha in 1995 with the minmum of 1.85 ton/ha in 1993; while there was an increase in productivity for the farmer-managed scheme from 2.50 ton/ha in 1992 to 3.20 ton/ha in 1995 (Fig. 3). This continuous fall in productivity for government-managed scheme impedes its sustainability.

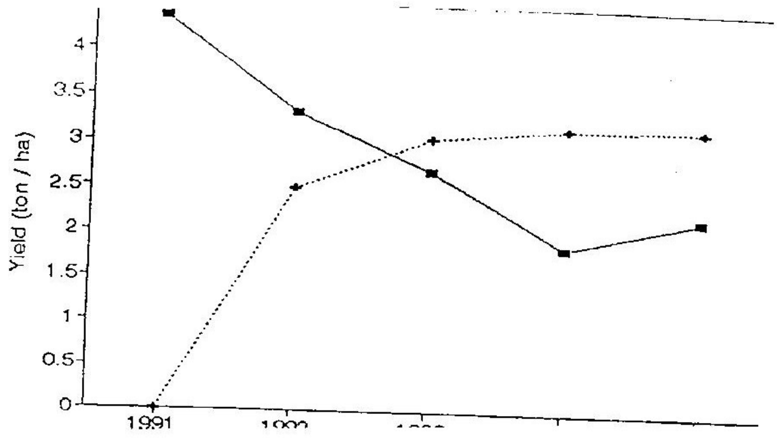


Fig. 3 Annual productivity (ton/ha).

The result of T-test to compare the production rates of the FMIS to GMIS indicated that the mean yields from the farmer-managed scheme differed significantly from those of government-managed irrigation scheme (Table 5). The average yield from the sample plots (0.35 kg/m^3 of water) of farmer-managed scheme was greater than that of government-managed scheme (0.10 kg/m^3 of water). Transplanting of seedlings was also a factor contributing to the bigger increase of the rate of paddy yield in the FMIS than in the GMIS where direct seeding was applied.

Compared to the national opportunity cost of capital of 23 percent, economic performance indicated that both the GMIS and FMIS had low economic and financial internal rate of return (Table 6). Also, both schemes had benefit/cost ratio less than one. However, the farmer-managed scheme had a relatively higher benefit/cost ratio of 0.60 than that of government-managed scheme of 0.13. The reason for such low performance of GMIS was the low average production per unit area, high operating costs and huge capital for developing the scheme. The net present value indicated that in about three years of further production the farmer-managed scheme could recover or pay back the capital and operation costs. At this rate of production and cash flow, the government-managed scheme would not pay back the development and operation costs as the annual net income was negative.

Table 5 : T-test for average yield/unit of water

Degree of freedom v = 4	GMIS against	FMIS
	Test statistic T	7.190
Rate of yield (ton/ha)	Critical T at 5% level of significance	2.776
	critical Ta at 1% level of significance	4.604
	Test T statistic	11.75
Rate of yield (Kg/m^3)	Critical T at 5% level of significance	2.776
	Critical T at 1% level of significance	4.604

Table 6: Economic and financial analysis

Measure of profitability	Government -managed scheme	Farmer managed scheme
Economic analysis		
Internal rate of return	5.0%	3.2%
Benefit/Cost ratio	0.14	0.60
Financial analysis		
Internal rate of return	5.1%	3.9%
Benefit/cost ratio	0.13	0.6

Conclusions and Recommendations

Conclusions

From the study, the following conclusions were made:

i. In terms of productivity (yield per unit of water), economic and financial measures, the Kapunga farmer-managed scheme performed better than the Kapunga government-managed scheme.

ii. The conveyance and distribution efficiencies of the main and secondary canals for both the farmer and the government-managed schemes were quite high. This meant that there were no substantial water losses through the main and secondary canals at Kapunga Rice Irrigation Project.

iii. The average application efficiency in the farmer-managed scheme were higher than those in the government-managed scheme. Compared to the design value, the application efficiency in the FMIS was higher than that of GMIS. These variations in irrigation efficiencies were caused by poor water control at the tertiary block in the GMIS.

iv. Both schemes, in the upper, middle and tail ends, received water in equal proportions. This was indicated by a relatively low error of equity of 2 and 11 percent for farmer and government-managed schemes, respectively. However, water was more equally distributed in the farmer-managed scheme.

v. Paddy nurseries in the government-managed scheme underwent undesirable water stress due to long irrigation intervals.

vi. From this study it could be concluded that the farmer-managed scheme at Kapunga performed better than the government-managed scheme.

Recommendations

Farmer-managed scheme

i. The Mbeya Regional Office and/or Kapunga Irrigation Project should intervene to make sure that a responsible farmers organisation is formed within the farmer-managed scheme so that it is properly managed. A well-functioning irrigation association (which is not available at present) would help to provide education to farmers and other services such as water distribution, canal maintenance and operation, credits for agricultural inputs, extension and identification of markets for their produce.

ii. Currently, those who manage the scheme (leaders) at various levels have no motivation. Availability of motivation to leaders and transport facilities for the farmer-managed scheme officer who stays 26 km away from the scheme could increase the performance of the scheme.

Government-managed Scheme

For the government-managed scheme, the following should be done:

i. Water losses should be reduced through improved water application efficiency. This can be achieved by adopting correct time of irrigation, size of irrigated basins and canal maintenance. Within the first and second decade after planting, the irrigation interval for nurseries should not exceed 10 days which can be increased to 14 days from the third decade onwards.

ii. The average production rate and therefore the average income were low for the government-managed scheme. An effort should be made to increase the rate of production through the correct use of water and other agricultural inputs while taking into account reducing unnecessary expenditure.

iii. Enough budget should be set aside to cover maintenance and operation costs especially for machinery and canals.

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