A SOCIO - ECONOMIC ANALYSIS OF MODERN IRRIGATION PROJECTS UNDER SMALL-SCALE FARMING: A CASE STUDY OF THE LOWER MOSHI IRRIGATION PROJECT IN KILIMANJARO REGION

BY

GERMANA CHANUO LAURENT OROTA

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ABSTRACT

This study analyses the socio-economic aspects of the Lower Moshi Irrigation Project in Kilimanjaro Region, Tanzania. Financial and economic analyses are performed to determine if the investment is a justifiable use of the scarce resources available in Tanzania for investment.

Survey results show that the project is doing well with average yields per ha of 6.5 tons for paddy and 2.5 tons for maize. A benefit-cost ratio of 2.5, net present worth of shs 614 million and internal rate of return of over 50 percent is obtained from the financial analysis when costs and benefits are discounted at 18 percent.

Results from economic analysis show a benefit-cost ratio of 2.3, a net present worth of shs 1028 million, and an internal rate of return of 49.25 percent when a 12 percent discount factor is used. Both the financial and economic analyses therefore, judge the project very profitable to the farmer and the economy as a whole.

This study also attempts to evaluate the impact of the project on employment, cropping patterns, yield levels of principal crops, farm income and land values. It is revealed that, the provision of irrigation facility has increased labour employment in the study area. Impacts of the project on cropping patterns, yield levels, farm income and land values show positive results when compared to the same in the non-project area.

This study also looks into the problems that hinder project development and expansion. These include problems of drought; high unit water requirements; illegal use of water outside the project area and institutional problems such as those of farmers' ignorance of the farming operations under modern irrigation.

The following are the recommendations: 1. There is a need to improve the knowledge about modern irrigation practices at the farmer's level. 2. Water User Groups should be separated from other political and administrative bodies in the project area; 3. There is a need to look for alternative ways of increasing water supply in project area during drought years and also solve the water shortage problem. A example is that of using boreholes to increase water supply. At present there are only few boreholes for this purpose in the project area.

DECLARATION

I, GERMANA CHANUO LAURENT OROTA do hereby declare to the Senate of Sokoine University of Agriculture that the work presented here is my own, and has not been submitted for a higher degree in any other University.

Signature Orota

Date 16/2/1993

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DEDICATION

This work is dedicated to my late father,
Chanuo Laurent Orota, my mother, Mangila,
Dr. Mgila R.L. Mwase and his family, who
sacrificed much for my education.

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CHAPTER I

INTRODUCTION

1.1 Background

During the past two decades, drought has caused major production setback over wide areas of tropical Africa (La Anyane 1985).

Irrigation development holds the potential for reducing drought risk and increasing intensive production. Irrigation farming is an important input in crop production because it reduces the effects of erratic rains and can potentially double the harvest. Moreover, it enables expansion of cultivatable land by opening up dry areas.(URT 1982; Msambichaka et el. 1983).

The irrigated area in Africa is very small. It amounts to about nine million ha in total. By contrast, India which has only about one-tenth of the surface area of Africa, irrigates nearly five times as much land (FAO 1986).

Irrigation development is still limited even in countries with large scale irrigation projects like Mali and the Sudan. However, the areas under irrigation have increased fairly rapidly in almost all the countries. Apart from Sudan, Somalia and Madagascar which had undergone significant irrigation development before the 1960s, rapid growth rates ranging between 108 and 400 percent had occurred in the Gambia, Mali, Malawi, Cameroon, Burundi, Kenya, Sierra Leone and Ivory Coast in that order during the period 1961 to 1976 (Faeth 1984). There are irrigation schemes also in Tanzania, Zambia and along the Limpopo river in Mozambique. In Zimbabwe, about 20 percent of agricultural production is from irrigation (La Anyane 1985). Most of the schemes in Eastern and Southern Africa sub-region are of the large scale type, catering for state or cooperative farms. Small-scale irrigation is more commonly practised in the Sahel and Western African sub-region.

Agriculture is the backbone of Tanzania's economy and will continue to play this role for a long time (URT 1982). In 1989, it accounted for about 62 percent of the gross domestic product. About 88 percent of the population lives in the rural areas and 83 percent of the economically active population is engaged in the agricultural sector (URT 1990). This portion of economically active population in agriculture has to produce enough food for both the rural as well as the urban population.

Although Tanzania has, so far, depended mainly on rainfed agriculture, the future expansion of agriculture will depend on irrigation. About 75 percent of Tanzania receives only 750 mm to 1000 mm of rainfall a year which is usually unreliable and unevenly distributed (URT 1982).

In Tanzania, the history of irrigation dates back to the pre-colonial days. Evidences of existence of traditional irrigation are found in the slopes of Oldonyo Lengai, Kilimanjaro, Kilombero and in the areas of Usambara, Pare, Sukumaland, Tukuyu and Pangani. These were mainly small-scale irrigation schemes and depended on gravitation and other conventional technologies. However, it was never treated as a national strategy of increasing agricultural production.

At present area under irrigation in Tanzania is estimated to be 144 000 ha, with traditional smallholder irrigation accounting for 85 percent (URT 1982). Small-scale irrigation schemes are predominant in Arusha, Kilimanjaro, Ruvuma, Morogoro and Mbeya regions. Potential irrigable land is estimated at 933 000 hectares. These have been identified in the Usangu Plains, Kilombero valley and the Lower Rufiji. Other areas of high potential are Lake Victoria and the Wami river basins. Both national and international survey teams who carried out investigations during the past 30 years, indicate that there is great potential for irrigation (Table 1-2).

Table 1-1 Tanzania: Regional areas under irrigation 1987/88 (ha)

Region	Traditional irrigation	Modern irrigation	Total area under irrigation
Arusha	13 347	4047	17 394
Coast/DSM	53	905	958
Dodoma	1776	81	1857
Iringa	828	405	1233
Kagera	5983	648	6031
Kigoma	249	81	330
Kilimanjaro	38 380	6080	44 460
Mara	0	0	0
Mbeya	17 500	4047	21 547
Morogoro	2212	8947	11 159
Mtwara/Lindi	198	40	238
Mwanza	2988	120	3109
Rukwa	500	0	500
Ruvuma	14 580	81	14 601
Shinyanga	14 184	20	14 204
Singida	267	20	287
Tabora	1193	20	1213
Tanga	4130	405	4535
Total	118 378	25 947	143 658

Source: URT:Basic Data (1983/84- 1987/88)

Table 1.2: Major basins with potential for irrigation

Name of basin	Potential irrigable area (ha)
Rufiji	700 000
Wami	32 000
Lake Victoria	29 000
Kagera	20 000
Ruvu	20 000
Ngono	16 000
Pangani	10 000
Others	98 000

Source: Mascarenhas. A., Ngana, J. and Yoshida, M. 1985.

1.2 Location and Characteristics of the Study Area

1.2.1 Location

The Lower Moshi area lies on the eastern skirt of Mount Kilimanjaro at altitudes between 700 m and 800 m above sea level. The area is administratively divided into 20 villages of which 19 villages are in Moshi District and one in Mwanga District. All these villages have been traditionally established by sponteneous transmigrants since long ago.

The study area occupies the far western part of the Lower Moshi area, and is located about 3 to 15 km south-east of Moshi town, the capital of Kilimanjaro region. The project area consists of a relatively narrow strip of land developed on alluvial along the right bank of Rau river. The area covers the administrative areas of four villages, namely, Mabogini, Rau ya Kati, Chekereni and Oria. It is bounded by the Rau river on the east, the sugar plantation of the Tanganyika Planting Company (TPC) on the west and on the north, and by Kahe National Agriculture and Food Corporation (NAFCO) farm on the south (Fig.2).

1.2.2 Climatic conditions

The climate of the project area is characterized by three seasons: a long rainy season from March to May, a dry season from June to October and a short rainy season from November to February.

Annual rainfall averages 590 mm of which about 370 mm or 63 percent falls in the long rainy season, 60 mm or 10 percent in the dry season, and 160 mm or 27 percent in the short rainy season (URT 1980).

Mean temperature is fairly constant throughout the year, being 25 degrees centigrade to slightly above 30 degrees centigrade. The mean daily maximum temperature rises above 30 degrees centigrade in October to April, while the mean daily minimum temperature falls close to 15 degrees centigrade in July and August (URT 1980). Evaporation varies widely from 3 mm/day in May to 9 mm/day in January, the annual value being more than 2000 mm.

1.2.3 Topography

The project area generally has a gently undulating topography, with land slopes ranging from 0.5 percent near Moshi town and 0.2 percent close to the NAFCO farms (URT 1980). Almost all the project area is under cultivation except a forest area extended along the Rau river.

1.2.4 Soils

The soils of the project area are composed of Dystric Cambisols, Mollic Gleysols and Etric Gleysols. The Dystric Cambisols are derived from old alluvium deposited mainly by the Rau river. They are generally silt clay or clay with slight acid. Most of the project area is covered by

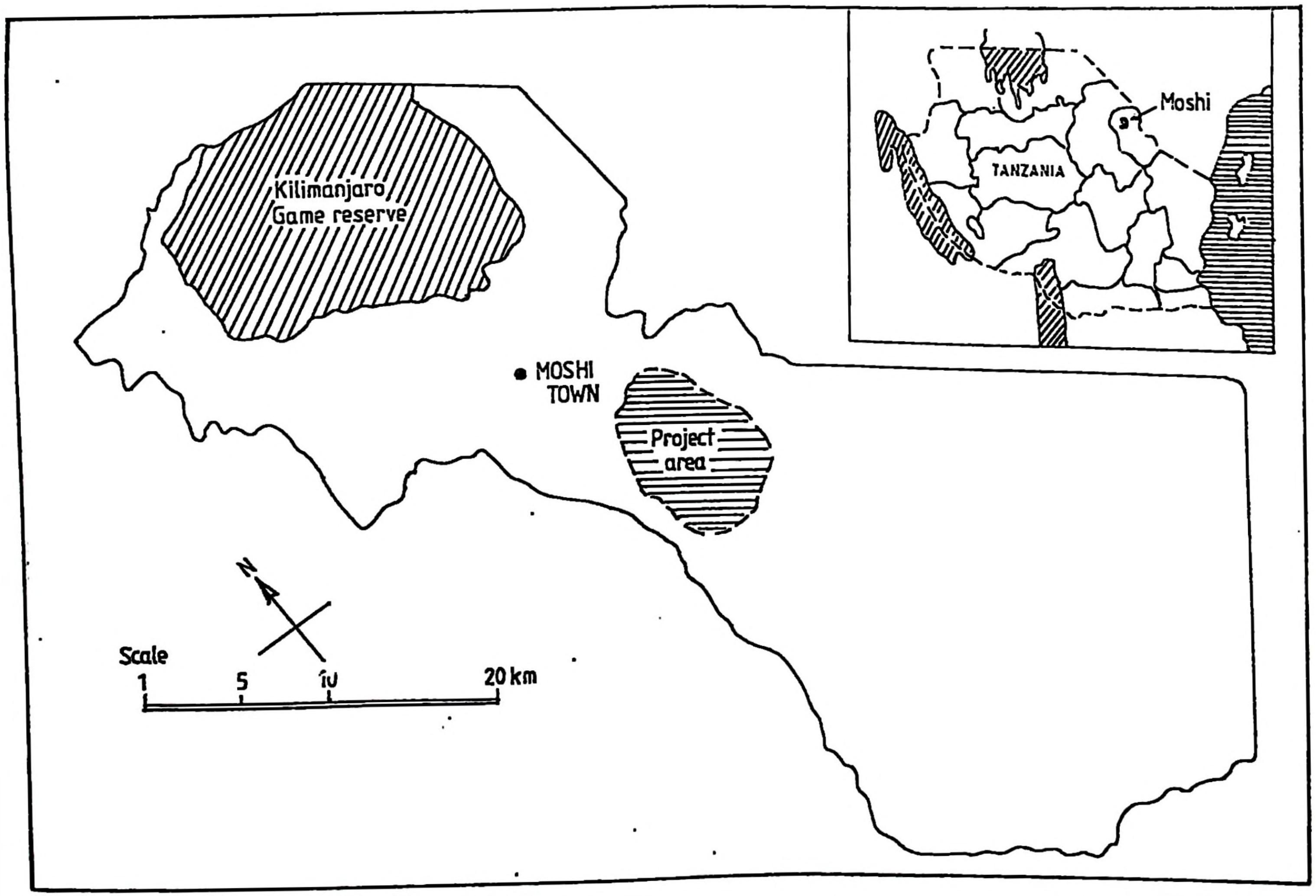


Fig. 1 . Kilimanjaro Region: Location of the Lower Moshi area

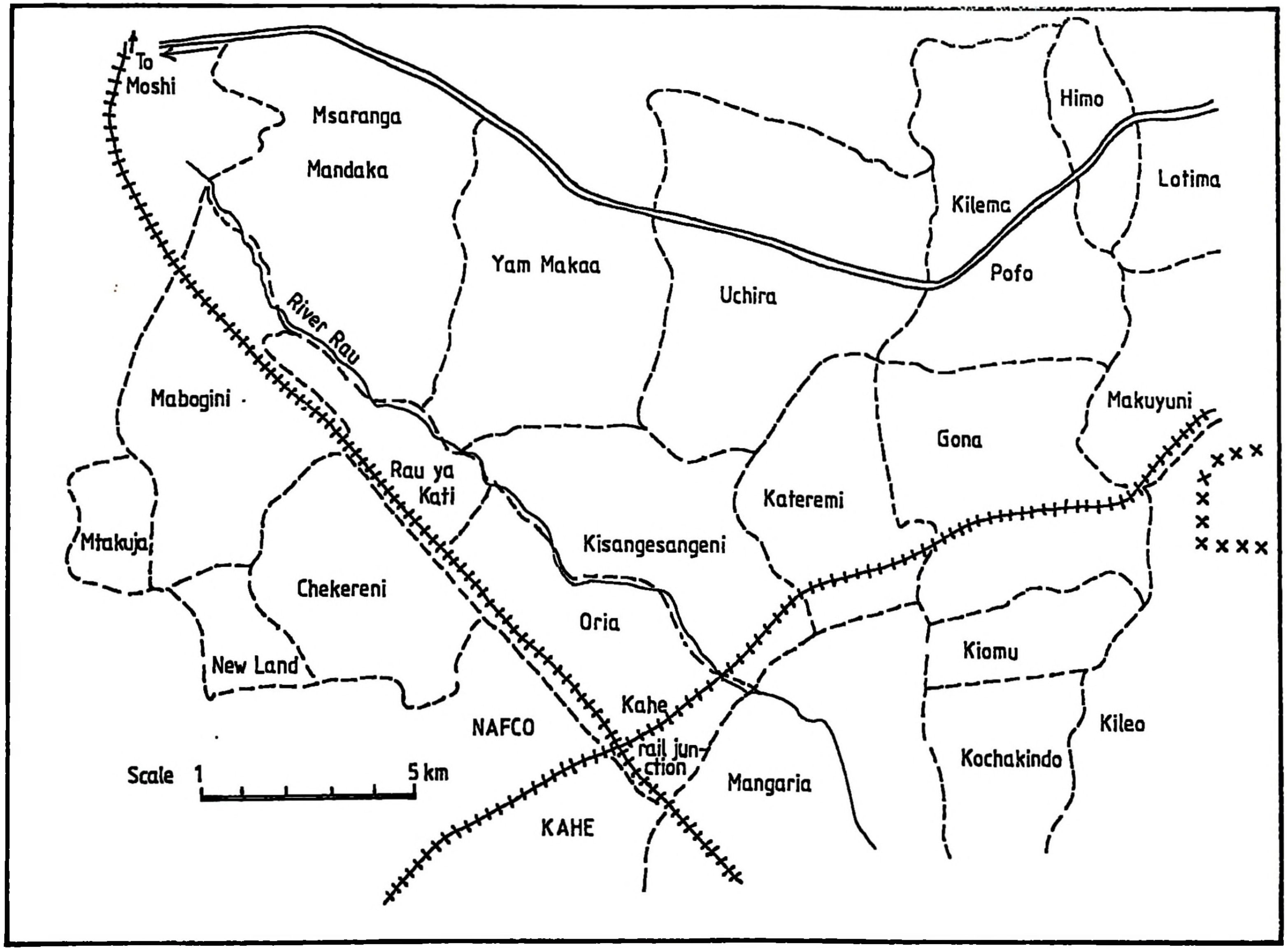


Fig. 2 . Adiministrative boundaries of villages in the whole Lower Moshi area

these soils. The Mollic Gleysols develop mainly on narrow depressions along Rau river, and are clay to silty clay slightly affected by salinity. These soils are mostly distributed in the Rau ya Kati area. The Etric Gleysols develop mostly on the low-lying area in the Upper Mabogini. They are of clay texture and free from salinity.

1.2.5 Hydrology

The Rau river rises in Mount Kilimanjaro near its Kibo peak, flows down southwards along the mountain slope, then changes its course south-eastward near Moshi town and flows meanderingly till it joins the Ruvu river. The slope of the river is 1/5 to 1/30 on the mountain slope and 1/200 to 1/400 near the project area. The estimated annual discharges for the recent 10 years range from 11 to 71 million cubic metres, averaging 35 million cubic metres (URT/JICA 1980).

The Njoro river, a tributary of Rau river originates from a series of springs scattered in the east of Moshi town. It flows south-eastward and joins the Rau river near Mabogini village, about 7 km south-east of Moshi town. The flow of the river is relatively constant throughout the year with a minimum of 0.9 cubic metres per second in March and a maximum of 1.2 cubic metres per second in May. The mean annual discharge is estimated at about 34 million cubic metres.

1.2.5 Land use

Agriculture in the Lower Moshi project area has been developed by spontaneous, transmigrants, and the arable land has been reclaimed close to its possible maximum for agricultural production. There are two categories of the agricultural land defined as follows:

Upland fields: This category consists of irrigable and rainfed land. The irrigable land is managed by the use of traditional furrows. Crops grown include maize, beans, fingermillet, coffee and bananas. The rainfed land has no irrigation facilities. Maize, millet and beans are grown under rainfed conditions.

Paddy fields: The land is managed by use of modern irrigation facilities, and paddy is grown under irrigated conditions. Some maize and vegetables are also grown as secondary crops on communal village farms.

The agricultural setting in the project area is characterized by small, individually owned farms. In this setting, there are two types of land holding tenure. One is the "Kihamba", an almost free land customary ownership type of tenure. This tenure is, however, limited to only a small percentage of farmers, who have settled in the area since long ago.

Almost all the farm land in the project area is being held by user right type of land tenure, whereby the owner maintains the right as long as he continues to use it. In this, farmers have different sizes of arable land acquired through inheritance from elders, bought or bushland clearing. According to the statistical data provided by village offices, the unit size of the land holding per farm family in the user right area varies from 0.3 to 2.5 ha and the average is estimated to be about 1.2 hectares.

Livestock grazing is the most important agricultural element other than the cereal crop production in the project area. Cattle, goat and sheep populations are distributed over the whole of the project area, mainly for home consumption as well as for cash earning.

1.3 Irrigation Development in Tanzania

1.3.1 Importance of irrigation development

Irrigation holds the potential for reducing drought risk and increasing intensive production (La Anyane 1985). Irrigation of farm lands seems to be an obvious way to extend the farming period, and provide more employment to farmers and increase agricultural productivity.

Water is the most important requirements for the growth of plants. Crops can be raised successfully only if water is available in appropriate quantities, and at the right time depending upon the species of plants and climatic conditions (Sharma 1985). Crops like sugar-cane and rice need larger quantities than wheat and other cereals.

Irrigation, that is, artificial supply of water to plants, is therefore, vital to stabilize agriculture and augment production for all areas where rainfall is scanty and unevenly distributed.

Irrigation is the principal means by which man modifies climate to increase food supplies. New developments in irrigation technology plus complementary advances in plant breeding, crop protection and agronomy "packages" have increased profitability resulting from higher yields, multiple cropping of two or more crops per year and a reduced risk of crop failure (Clayton 1970; Carruthers 1983).

Ruthernburg (1976) described the effects resulting from irrigation as:

(a) the increase in gross returns per ha through increased yields per crop and several crops per year especially in the sub-tropics, and a switch to intensified use of labour and fertilizers;

(b) achievement of continuous land use without intermediate fallow;

(c) the reduction in fluctuations in harvests and consequently more regular food supply for man and animals;

(d) the increased flexibility in the programmes of production and degrees of intensity;

(c) an extension of farming to arid areas which could not be used otherwise;

Irrigation diversifies and transforms the cropping pattern with such beneficial effects as the substitution of inferior and low value crops by superior high value ones that prove more remunerative to the farmer (Satpathy 1984).

While irrigation development itself needs some capital, its availability generates on-farm employment through increased crop intensity and adoption of improved labour intensive cultural practices like transplanting, weeding, application of fertilizers, manure and pesticides. Thus, in abundant labour supply rural economy, irrigation reduces the rigours of unemployment by enhancing the man-days of employment (Satpathy 1984).

Tanzania as many other countries, is searching for ways to increase food production in order to reduce the need for costly food imports and provide a means of agricultural production to feed the nation and to generate farmers' incomes even when rains fail. Increasing and stabilizing food and agricultural production is important to the Government's goal of food self-sufficiency as well as to the industrial sector where many agricultural processing plants operate below capacity (Soule 1988).

1.3.2 Importance of small-scale irrigation projects

Small-scale irrigation project developments have a number of advantages. One of the essential elements in the success of small-scale projects is the participation of the local population and the mobilization and use of local resources. Based on the desire of the population to increase agricultural productivity and to improve the living standard in the villages, priority is given by the Tanzanian Government to support local initiatives. This helps to mobilize human and material resources locally available and strive to promote among smallholder farmers, a self-help mentality (FAO 1987).

Carruthers (1983) describes other advantages of small-scale projects as the initiation of a development process and thus greater flexibility; the encouragement of self-reliance through learning by doing and a less radical technological change; low requirements for infrastructure and long-term investments; a reduced level of capital costs which facilitates earlier project success.

Hazlewood and Livingstone (1982) urgue that, small-scale irrigated farming has the advantage of economizing in scarce management, in using family labour and in distributing widely the benefits of irrigation.

1.3.3 Constraints on Tanzania's small-scale irrigation developments

Problems frequently encountered in small-scale irrigation projects include managerial, technical and institutional problems.

Management of small-scale irrigation projects has been rather poor, thus, contributing to the failure or poor performance of many irrigation projects in the past. Lack of competent staff and poor planning of small-scale projects have been the major constraints to irrigation development e.g. during experimentation stage of Ikowa scheme in Dodoma, there was a comprehensive management and some discipline. After the scheme was handed over to the Farmers Association, there was a lack of coordination and discipline and the scheme eventually failed.

Reliance on sophisticated irrigation techniques which demand heavy investment, highly trained manpower and a big component of foreign exchange have also contributed to failure or low success of small-scale irrigation projects. The level of technology of the beneficiary farmers is often low. They are therefore unable to adopt innovations quickly, and to implement a complicated operation and maintenance schedule. Moreover, rapid deterioration and late rehabilitation of physical infrastructure have sometimes led to more costs of running a project e.g. the Kahe scheme in Kilimanjaro region and the Mto wa Mbu scheme in Arusha region. There are also problems in securing inputs, agricultural services and timely technical advise after experimentation period e.g. for the Ikowa scheme in Dodoma, during experimentation period there were tractors, harrows, ox-ploughs, siphons, pesticides and fertilisers provided to the farmers. But with the departure of the agricultural team in 1961-62, availability of inputs became very scarce. Only a few siphons were left behind, the rest of the equipment was taken away (Mascarenhas 1985).

Since the success of small-scale irrigation projects has generally depended on the cooperation of a larger range of Government institutions e.g. the Ministry of agriculture, the regional agricultural corporations and sometimes the district councils, budgetary and institutional problems have tended to be even more common. Lack of funds and budgetary delays often aggravated in the case of small-scale irrigation projects by competition for funds and staff between project components.

Due to often considerable technical sophistication incorporated into the designs of small-scale projects and the tendency for the Government to try to control output prices and marketing operations, farmers have tended to neglect or abandon irrigation when there are better returns to their labour elsewhere. Policies for irrigation development usually give little thought to the elementary socio-economic conditions that will make projects attractive to the farmers, and thus sustainable.

1.4 Statement of the Problem

Rainfed agriculture has been a major traditional way of farming in Tanzania. Production from such a technique is often coupled with irregular fluctuations caused by unreliable rainfall. The major drawback is the prediction of both time of assurance of adequate rain and the quantity expected. This requires appropriate farming techniques to avoid crop yield fluctuations caused by natural climatic hazards. Therefore, there exists a possibility for diverting resources from other sectors of the economy for investment on irrigation.

Under the Economic Recovery Programme, the Government of Tanzania has introduced major changes to its macro-economic policies. These changes have been aimed at restructuring the economy so as to ensure that there is a more efficient allocation of resources to productive sectors. The agricultural sector has received major emphasis because of its great potential in increasing production as the mass of the population still depends on agriculture for their income. While it is widely believed that Tanzania has a comparative advantage in the production of most traditional export crops, the situation in relation to cereal crops has been more a subject of debate.

Future increase and/or diversion of scarce resources to irrigation would be justifiable only if the past investments have positively helped the intended beneficiaries, that is, the farmers. Such an exercise entails an evaluation of the various promotional effects of irrigation on the agricultural economy of the study area.

The contribution of irrigation with respect to the area, crop and cropping pattern, yield and income increase have to be analyzed to find answers to questions as to whether irrigation development has increased the net cropped area by bringing new lands under cultivation, and gross cropped area by encouraging higher cropping intensity; or whether irrigation has led to any crop substitution and diversification in the cropping pattern; and whether provision of irrigation facility has enhanced the yield rates of crops and therefore improvement in crop incomes received by the project farmers.

Assessment of sustainability of a project is also important, since only sustainable projects will be able to generate the anticipated benefits on a continuous basis. Sustainability refers to the prevention or minimization of adverse physical changes such as waterlogging, leaching of soil nutrients, salinity, erosion, silting and infestation [illegible] needs. Sustainability of a project is determined by the attractiveness to the farmers, of the balance of positive and negative effects. Only if farmers can expect a significant betterment due to the project, will they be willing to participate in its operation and maintenance. Hence, farmers can only sustain a project if the costs can be met by the general annual cash supply, leaving them with income increase that provides enough of an incentive for them to participate fully in the project activities.

Moreover, it is imperative to examine if the availability of irrigation water has increased the prospects of employment to rural people in the study area and thereby contributing towards the well-being of the farm families. This study attempts to calculate the man-days of on-farm employment resulting from provision of modern irrigation facilities.

Apart from this direct impacts on irrigation, an indirect effect is the increase in the value of land that occurs with irrigation development. Although not strictly a social benefit, it has been used as an index to the land holders. Since in an agricultural economy like Tanzania, land constitutes the major form of assets on the farm family, the net appreciation of land values after development of irrigation indicates a measure of its benefits. Thus, it is pertinent to examine if irrigation expansion has been associated with enhancements in land values in the study area.

The Lower Moshi Irrigation Project has been unable to reach its targets of cultivating 1900 ha of paddy per year. The project established at a cost of shs 213 504 000 has only managed to cultivate an average of 1418 ha of paddy per year since its completion in April, 1987. In the face of this less than capacity utilization of irrigation potential, the contribution of the project to agricultural output has remained less than expected. In this context, it would be extremely fruitful to examine in depth, among other things the basic causes of such sub-optimal utilization and the consequences thereof.

1.5 Objectives of the Study

The general objective of this study is to examine and analyze the impact of modern irrigation development on the small-scale farm households and on the whole economy of the study area.

1.5.1 Specific objectives

The specific objectives set forth for the study are to:

(a) determine the costs incurred by the farm households and the returns obtained as a result of irrigation development;

(b) determine the impact of the project on employment erosion in the study area;

(c) investigate the problems facing the project and suggest possible solutions. This include managerial, technical, social and institutional problems hindering projects' performance.

CHAPTER II

LITERATURE REVIEW

Empirical studies confirm that reliable and adequate irrigation system raises productivity, income and employment (Chambers 1988).

2.1 Benefit-cost Analysis in Small-scale Irrigation

Sandford (1955) used benefit-cost analysis to evaluate the performance of Mwea Irrigation scheme in Kenya. Results at the beginning of 1954-55 indicated a present value of £ 386 000 and hence at this date, the project was justifiable in terms of benefit-cost criterion. However, the results could be sensitive to some assumptions; if for instance one uses the market price of labour (3.31 Kenya shillings) per man-day at that time in the calculations instead of a lower value based on an estimate of real social value, then, the project was unjustifiable in 1954-55 unless one also assumes that the return to capital in Kenya was very low by then. Rates of discount as low as 5 percent can no longer be acceptable. Seen however, from the point in time of 1957-58, except under most unfavourable assumptions, the Mwea project has been a success and continued investment in the scheme thereafter yielded very high returns.

Charan (1973) made a detailed study of the benefits and costs of West Banas Irrigation Project in Rajasthan, India. The study was based on a considerable field investigations designed to obtain a detailed farm cost and return data from the project area.

The analysis of the data suggests that gross farm output was significantly higher in canal irrigated areas as compared to the rainfed area. After meeting the cost of cultivation, which was also comparatively higher, the project farmers had greater net surplus with them. On the basis of the above results, direct primary benefit-cost ratio of the project was calculated. When the project was sanctioned, the anticipated productivity rate was reckoned at 4.1 percent. In the course of time, the estimates of costs had to be revised. However, as the revised estimates of costs were high, the project proved to be financially unsound. Hence, it was likely that had the original estimates being made on the basis of the revised figures, the project would not have been sanctioned on the financial ground.

Researchers in the same field have been criticising Charan's study on the grounds that, the analysis appears to be handicapped by two basic shortcomings. In the first place, while the benefits as well as the associated costs of farming are estimated at 1968-69 prices, the capital cost of the project which was completed by 1962-63, is in actual pre-1963 values. Secondly, for the benefit-cost analysis, Charan departs from the accepted practice of deducting the associated costs from the value of increased output due to irrigation in order to estimate the net benefits. He calculates net benefit gross of associated costs, and costs include both project and associated costs of farming. This is not justifiable. While correction for the later would increase the benefit-cost ratio, using comparable prices to estimate the benefits as well as the costs would reduce it, possibly quite significantly.

Chambers and Moris (1973) traced through the history of Mwea Irrigation Project in Kenya for two decades and their report showed that, it was financially successful for small-scale farmers. They also observed that the project produced some of the highest rice yield in the world. On the results of social benefit-cost analysis, they concluded that:

"In the social benefit-cost analysis, under range of differing assumptions, the decision to implement Mwea is found to be justifiable and only where the most unfavourable assumption are combined, is the project unjustifiable by the benefit-cost criterion. As to the secondary benefits, not much could be concluded. It seemed the scheme did not really have strong secondary benefits except for the training and experience in irrigation it gave to farmers"

Tagarino and Torres (1976) undertook a study to provide insights into the formulation of future policies on irrigation charges in the Upper Pampanga River Project in the Philippines. Surveys of farmers within and outside the project area were undertaken to estimate benefits and costs associated with the project, and to assess farmers' capacity to pay the costs. Benefits from irrigation were estimated through a 1974-75 stratified random sample survey of 123 project and 121 non-project farms, representing "with" project and "without" project farms respectively.

The conclusions were that: the average size of farms was 2.6 hectares. The "with" project farms grew a mean of 1.7 crops per year, a substantially higher cropping intensity than the 1.0 for "without" project farms. Annual rice production costs were about double those for "without" project farms. More than 50 percent of the total costs were non-cash, representing imputed values for in-kind wage payments to hired labour and farm owned inputs, e.g operator and family labour, land, seed, machinery and equipment. Of cash expenses, those for hired labour were highest, followed by those for fertilizer. Normal yields for the "with" project farms were about 80 percent higher than normal yields on the "without" project farms. The yield increase attributable to the project is 3.1 tons/ha per year based on 1974-75 data, 2.4 tons/ha per year under normal conditions and 3.9 tons/ha per year for future potential conditions.

A benefit-cost ratio and internal rate of return were calculated for the project, assuming a 50-year repayment period and a 7 percent interest rate on funds borrowed for the project. The benefit-cost ratio was 2.4 and internal rate of return was 20.7 percent, indicating that the project was economically viable. If interest rates are assumed to be 18 percent, however, benefit-cost ratio falls to 1.1

However, the study shows that, only under production and pricing conditions considerably more favourable than those of 1974-75, does the average project farmer have enough surplus income from rice production to meet even the irrigation fee.

World Bank sponsored projects reviewed between 1982 and 1985 have been evaluated by use of internal rate of return method. The results at the completion of projects were estimated as in Table 2-1.

Considering the rate of return of 8 to 12 percent as usually the level acceptable at present for an irrigation project; the projects reviewed passed the test successfully except for Morondave where extremely high cost could not have compensated, except for very high value crops as vegetables and very intensive land use; and for Senegal River Polders where the return is at the lowest limit, not only because of the relatively high cost of works, but because of low benefit due to low intensification (FAO 1987).

Further consideration shows that SEMRY II in Cameroon was viable because of very high yields of paddy and a question arises as to whether this performance (9.5 tons/ha/year) could be easily maintained or replicated under African conditions.

The economic results above were obtained at project completion, when projects were still benefitting from very intense support and supervision, and a considerable pressure on the part of the donor to obtain from the governments concerned the resources in funds, manpower and policy required to make a success of a project. However, World Bank reviews made a few years after completion of the projects have recorded several cases of a decline in project performance, probably due to the withdrawal of the heavy support during project implementation and to increasing financial and managerial difficulties of governments under harsher world economic condition.

Although the sample reviewed, high cost projects presented as good a level of return as low cost projects, it is obvious that a much high degree of risk is involved with high cost projects because of the stricter improvements on yields and intensification of land use, which would be difficult to achieve by a farmer in transition from self-subsistence agriculture (FAO 1987).

2.2 Employment and Small-scale Irrigation

Irrigation, higher cropping intensities and associated changes in cropping patterns all affect different groups in different ways. For small farmers, irrigation means more productive work on their land, and increased intensities means productive work on more days of the year. For labourers, irrigation means work on more days of the year especially where there is a second or more irrigation seasons.

A comparison of an irrigated village and a largely unirrigated village in West Bengal by Gosh (1984) shows that in the irrigated areas, there was virtually no dead season, and also that a large number of migrant labourers came in for peak periods. This ensures assurance and continuity of work to the labourers, to provide them with regular income without gaps. This contrasts with conditions in unirrigated village where a negligible agricultural employment over two to three months in the year must have meant either seeking other low-paid work, migration or some combination of these.

Table 2-1: World Bank sponsored projects
Estimated rate of return (IRR)

Project	Year of evaluation	Economic IRR(%)	Cost US$/ha
Cameroon:SEMRY I	1976	23	2240
SEMRY II	1986	20	9780
Egypt: Delta Drainage	1985	25	500
Madagascar:Lake Alaotra	1975	22	900
Morondave	1981	Extremely low	14740
Mali: Mopti Rice	1980	17	500
Morocco:Doukkala I	n.a	20.5	5370
Senegal: River Polders	n.a	8	4170
Sudan: Rahad	1983	19.5	3140
Tunisia: Medjerda	1984	32	910
Nebhana	1984	33	850

Source: FAO Irrigation and Drainage Paper No.42 (1987)

Clayton (1970) has shown that, although the cost of employment creation in Kenya is high in irrigated agriculture, its labour absorptive capacity is twice as much as that of dry farming. Moreover, he urges that irrigation farming evens out the seasonal unemployment for averting risks and uncertainties caused by weather.

The high employment of labour observed by de Wilde et al (1967) on Mwea-Tebere scheme in Kenya does point out three significant conclusions:

Development of small holdings bring about a considerable increase in employment. Thus, on 35 farms surveyed, it was found that an average of 95.7 work-days per acre were contributed by paid labour. If this amount is assumed to be representative for the entire 5340 acres cropped in 1963-64 and if 250-300 work-days are accounted equal to one work year, it may be said that the development of Mwea-Tebere has created the equivalent fulltime employment for 1703 to 2044 persons, quite apart from the farmers and their families.

The second conclusion is that, it may well have been impossible to allot as much as four acres of transplanted rice to each tenant, if it had not been for the availability of casual labour from nearby densely populated rural areas to cope with the peak labour requirements for transplanting and harvesting. By far, the greater part of the paid labour was indeed employed on these tasks.

The third conclusion is in the form of an observation, that the income elasticity of demand for labour is high. This means that, when incomes rise, there is a tendency for farmers to use a substantial portion to hire labour in order to enable the farm family itself to enjoy more leisure. Thus, while hired labour is undoubtedly necessary to meet peak labour loads; available evidence indicates the total amount used during the years is well above what would be required if family labour were fully utilized and even to some extent above what is needed during peak periods.

2.3 Socio-economic Impacts of Small-scale Irrigation Projects

Pandya and Sharma (1986) attempted to study the socio-economic impact of Ramganga Command Area Development Project in India. The main findings were as follows:

-the project had a definite impact on the cropping pattern. This was manifested by the fact that, wheat, paddy and potatoes were major crops on beneficiary farms, whereas on unirrigated farms, major share of cropped area was under maize and gram;

- the project had increased the cropping intensity from 130 to 170 percent;

the use of fertilizers per unit area is considerably higher on project farms as compared to unirrigated farms;

- the yield of major crops like wheat and paddy have become double due to the project, but are still half of the potential yields;

- the project has increased the farm's income of the beneficiaries by Rs 876 per hectare;

Rao (1987) assessed the impact of canal irrigation system on the land utilization pattern, income, employment opportunities and living conditions of farm families in Dhawar District of Karnaka State in India. A "with" and "without" approach was used to compare the contribution of irrigation on various aspects of rural development in the studied area.

Both investments and returns were found to be much higher on the irrigated farms than on the non-irrigated farms. The same was the case with regard to resource productivity and other infrastructural gains. Rao's study leads to the conclusion that, irrigation has played its role successfully in transforming the ones dry villages to prosperity.

CHAPTER III

DESCRIPTION OF THE LOWER MOSHI IRRIGATION PROJECT

1.1 Project History

The Third Five Year Plan gave a high priority to the development of the agricultural sector. In the plan, major emphasis was placed on achieving a stable production of foodstuffs, for self-sufficiency.

In line with the above government policy, agricultural development plan in the Lower Moshi area was undertaken. A preliminary investigation was conducted in the area during the period from 1975 to 1977 with the technical cooperation of the Government of Japan. The plan was accepted by the Tanzanian Government and was selected as one of the top priority projects to be implemented under the said Five Year Plan.

During the period from December, 1979 to August, 1980, a feasibility study on the plan was executed. Through the study the following four schemes with a net irrigation area of 6320 ha were identified in the Lower Moshi area:

- Rau River system	2300 ha
- Miwaleni Pump scheme	2000 ha
- Himo River system	1000 ha
- Groundwater scheme	1020 ha

Among the above four schemes, the Rau River system (hereinafter called " the project") with a net irrigation area of 2300 ha showed the highest economic viability and was given priority for early implementation.

In June 1982, the Overseas Economic Cooperation Fund of Japan (OECF) extended a loan to the Government of Tanzania for the design and implementation of the project.

Before tender call for civil works, however, reviews were made on the scope of the civil works by both the Tanzanian Government and the OESF, so as to suit the scope to the then financial and economic conditions of Tanzania. Under the revised scope of works, the area to be developed as paddy field was reduced from 2000 ha of the original plan to 1100 ha and the upland cropping area was increased from 300 to 1200 ha, the total development area having remained unchanged. The construction works started in May, 1984 and completed in April, 1987 taking a period of three years.

Crop production in the project area started early in August, 1985 before construction works were completed. During project planning, production targets were put at 4.5 tons/ha for paddy and 2.5 tons/ha for maize. The available data for eleven seasons shows an average production of 6.5 tons/ha of paddy, and 2.5 per ha of maize (Table 3-1).

3.2 Outline of the Project Works

The Lower Moshi Irrigation Project aims at profitable agricultural development by the use of irrigation and drainage systems and flood protection dykes in the area covering 2300 ha of land catering for about 20 000 people. In order to achieve this objectives of the project, the provision of necessary infrastructure is envisaged as follows:

<u>Irrigation systems:</u> In view of the topographic conditions and the distribution of irrigation areas, the project is divided into two sub-areas, namely, the Upper Mabogini area, and the Rau ya Kati area and Chekereni area. Each sub-area is provided with an irrigation system, consisting of intake weir and a canal system. For the Upper Mabogini area, the intake weir is located on the Njoro river. For the Rau ya Kati area, the intake weir is sited on the Rau ya Kati.

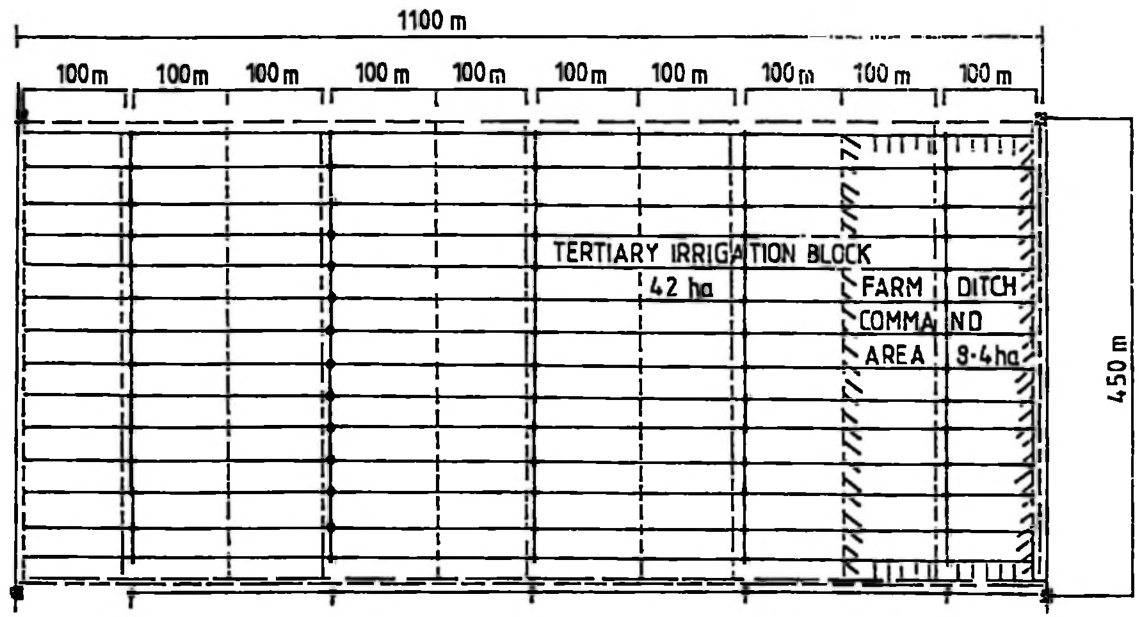
<u>Drainage systems:</u> The project area is broadly divided into two areas in respect of drainage. The area extending along Rau and Njoro rivers is drained directly to these rivers. In the remaining areas, which are mostly located at the western side of the Moshi-Kahe road, the drainage water is drained to an existing drain of NAFCO. The drainage system consists of tertiary, secondary and main drains.

Table [illegible]: Lower Moshi Irrigation Project: Area cultivated, average, and total output for the first eleven months

Year	Season	Area cultivated (ha) Paddy	Area cultivated (ha) Maize	Average output (tons/ha) Paddy	Average output (tons/ha) Maize	Total output (tons) Paddy	Total output (tons) Maize
1985	Dry season	93.52	-	7.5	-	655	-
1986	Rainy season	119.12	455	7.0	2.5	834	1138
	Dry season	472.97	-	6.5	-	3074	-
1987	Rainy season	414.00	900	6.4	2.4	2691	1800
	Dry season	473.29	-	6.5	-	3076	-
1988	Rainy season	432.80	900	7.0	2.5	3030	2250
	Dry season	463.02	-	6.5	-	3010	-
	Dry season	391.02	-	6.5	-	2542	-
1989	Rainy season	500.60	900	6.5	2.0	3105	1800
	Dry season	517.51	-	6.0	-	3224	-
	Dry season	413.30	-	n.a	-	n.a	a/

Source: Lower Moshi Irrigation Project Reports, 1989

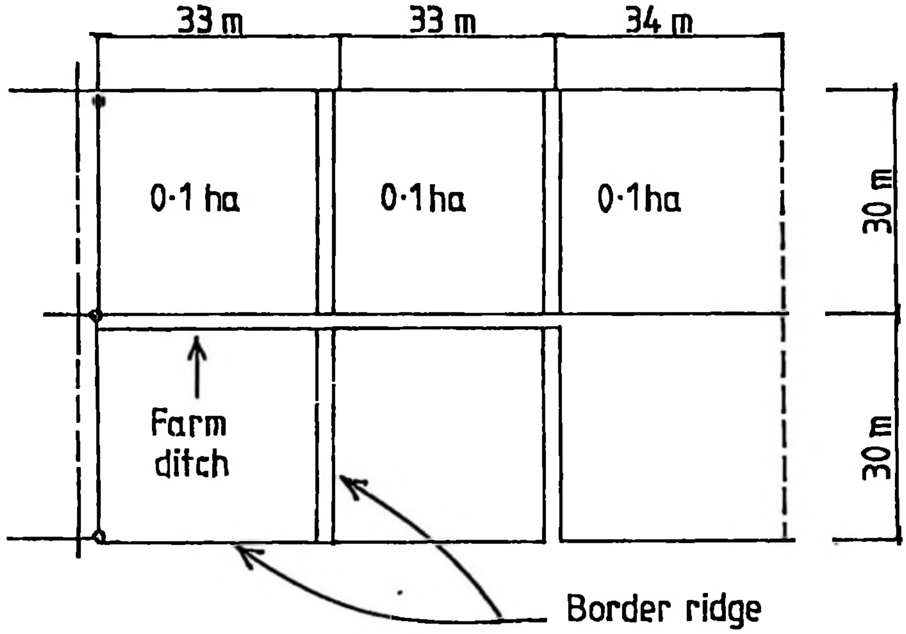
a/ Data for this season were yet to be compiled by the time the researcher was on data collection.



Source: Lower Moshi Irrigation Project Office

Secondary irrigation canal and turnout
Tertiary irrigation canal and division box
Farm ditch and farm outlet
Tertiary drain
Farm drain
Secondary farm road
Tertiary farm
Field road

Fig. 3 . Typical field layout for paddy field block



Source : Same as figure 3

Key

— — — — — Tertiary drain

——— - - - ——— Field road

———•——— Farm ditch and farm outlet

Fig. 4 . Typical field layout for paddy plot

Flood protection works: The project area was periodically inundated due to seasonal floods of the Rau river and its distributaries. It is estimated that 430 ha or 20 percent of the project area was flooded every year and 1080 ha or 50 percent by the 1979 floods. In order to protect the project area from such inundations, flood protection dykes are provided along the right bank of the Rau river.

Farm roads: For proper operation and maintenance of the project facilities as well as for the transportation of farm inputs and outputs, a farm road network is established in the project area. The farm road network consist of a trunk road, main, secondary and tertiary roads.

On- farm roads: The project area is divided into a number of irrigation blocks, each of which is sub-divided into farm plots (Fig.3 and 4). One typical farm plot has an area of 0.3 ha with a dimension of 30 m * 100 m, and a typical irrigation block contains 70 farm plots (21 ha). One tertiary canal, drain and a road serve an irrigation block; and water courses, field drains and field roads are aligned so as to face short sides of the farm plots.

3.3 Cropping Pattern

Owing to relatively mild climate for crop growth excluding the uneven distribution of rainfall each year, Various kind of crops have been introduced in the Lower Moshi project area, and of them maize is the most predominant crop not only as a staple food, but also as a cash crop. Maize is grown mostly under rainfed conditions except for a few farms mostly village communal farms which are provided with irrigation water for only one season per year.

Beans are the second most important food crop, followed by such minor crops as millet, sorghum, pigeon peas, sunflower, sweet potatoes, cassava, fingermillet and vegetables. These are mainly grown under rainfed conditions.

Rice, which is also a staple food is rather new in the area. Rice is cultivated in the paddy fields during rainy season as well as in the dry season due to the availability of a modern irrigation facility. Most of the project farmers cultivate rice two to three times a year on the same plot. The farmers are able to meet the home consumption needs for food with much surplus for sale.

3.3.1 Farming practices

Land preparation: Apart from rotating the availability of irrigation water, the project management is responsible for all land preparation in the project area. Land preparation is done by use of tractors owned by the Kilimanjaro Agricultural Development Corporation (KADC). There are 35 tractors for this purpose in the project area. Harrowing is done after ploughing, to make the land level and for even distribution of irrigation water and protection of young seedlings. This practice is done by the project management to ensure greater thoroughness of land preparation and improve the timing of farming operations.

Seeding: The variety of paddy used is IR 54 from the Philippines which takes about 130 to 150 days to mature. In each village under the project, paddy seedlings are prepared in a common nursery bed, and thereafter each project farmer transplant the seedlings on individual fields. Transplanting in the paddy plots is done manually in a 15 cm * 30 cm spacing or planting two to three seedlings per one hill.

Fertilization: Proper application of fertilizers is essential for realization of the anticipated crop production in the project area. The soils are quite deficient in plant nutrients especially organic carbon, nitrogen and phosphates. Therefore it is necessary that these chemical elements be supplemented by the use of fertilizers. This is done by the farmer himself with extension advice given by field assistants stationed in each village office.

Plant protection: Intensive application of insecticides and fungicides is required for control and protection of the crops from the damage caused by insects, pests and diseases. Privately owned spray pumps are used for the application of insecticides. Suitable dosage of each chemical is advised by field assistants, based on the life-cycle of insects and growing stages of the crops.

Weed control: Weed control is one of the essential farming practices in crop production. Weeding is done by the use of traditional tools e.g small-size hand hoes.

Irrigation: The project management is responsible for rotating the availability of irrigation water. The tertiary canals are designed based on a 5-day rotation of irrigation water for an average of an irrigation block of 25 hectares.

Harvesting and threshing: This is done manually by project farmers.

Marketing: Most of the farmers in the project area sell their crops through private routes. For paddy, private businessmen are readily available on the farm sites for the buying and even sometimes help the farm families in harvesting and packing. Moreover, they provide the packing materials and transport, and they offer higher prices compared to the official National Milling Corporation and the Regional Cooperative Union prices. In

Chekereni village, farmers are restricted to selling two bags of paddy to the Cooperative Union.

Farmer cooperation and discipline: The successful operations of the project have depended on the adherence by both management and farmers to a fairly rigid schedule of operations. Agricultural operations cannot be permitted to get out of season, nor can a farmer in a particular area be allowed to get out of step with each other in such a way as to upset the land preparation on irrigation schedule.

Persuasion is the principal means of getting the farmers to accept discipline. The field assistants and the block heads are primarily responsible for inducing farmers to time and synchronize their farm operations properly, e.g. plots must be prepared adequately prior to the farming season by proper cleaning of drains and feeders, repairs of bunds etc. Failure to comply with agricultural instructions, the farmers are punished according to the kind of operation not performed or wrongly done, e.g. violation in the use of the recommended seeds and pesticides leads to paddy plots being cleared away.

<u>Charges for management supplies and services:</u>

Farmers pay a lump sum fee for irrigation services provided by the project management which include land a operation, delivery of water and other costs associated with operating the irrigation system and the services provided. For instance during the year 1990 at Rau ya Kati Village, the project farmers' service and water charges were as follows per paddy plot of 0.3 of a hectare per season.

Water charges	shs.1000
Harrowing	2016
Seeds	600
Water Users Association charge	660
Central Water Users Committee	50
Total	4326

In some of the villages, there were additional charges e.g. contribution to the village development fund added to the service and water charges. These charges for management supplies and services are payable to the project office before an agricultural season begins.

3.3.2 Project Organization and Management Structure

The management structure of the project is divided into two sections: the technical section and the farmers section. The technical section falls under the leadership of the Kilimanjaro Regional Development Director (RDD). There is a project office which deals with operation and maintenance of project facilities, tractors and extension services.

On the other hand, the project farmers are organized into water users' groups within tertiary blocks, and the leaders of the groups form water users' assemblies (WUA) in each village within the project area. The representatives from water users' assemblies and crop cooperative societies form a central water committee for the whole project area under the guidance of Moshi District Council.

The complexity of the irrigation facilities call for special discipline in operation and maintenance over a long period. This depends on the farmers themselves with minimum necessary technical guidance and support from the Government. The farmers organization and management structure deals with day to day activities of operation and maintenance of the project facilities, from tertiary canals to water courses in the farm lands.

There is also a technical support system which deals with some aspects of operation and maintenance which are new and beyond the technical capabilities of the farmer, such as sophisticated equipment, crop culture and general extension services.

3.3 Constraints to the Lower Moshi Irrigation Project

The Lower Moshi Irrigation Project has been unable to reach its targets of cultivating 1900 ha per year due to different limitations, though crop yields/ha have remained high and surpass the planned targets. The project has only managed to cultivate 1418 ha of paddy per year since 1987. The major problems that have contributed to this under target cultivation capacity are as follows:

3.3.1 Drought

The 1987 drought reduced the discharge water in the fields. The annual rainfall totalled 416 mm compared to normal amount of rainfall of 1000 mm per year for the normal years (Moshi Airport Meteorological Station). This shortage of rainfall led to shortage of water for the project by 470 litres/sec. during the drought period (up to February, 1988).

3.3.2 High unit water requirements

The high unit water requirements in paddy fields against the target, and the usage of water upstream intakes for farming activities have greatly contributed to water shortage in the project area. The targeted water requirement is 1.49 litres/sec/ha while the actual usage of water is currently 2.9 litres/sec/ha.

3.3.3 Illegal use of project water

It is estimated that about 600 litres/sec of water is illegally tapped through traditional furrows outside the project area. This amount of water tapped illegally is estimated to reduce the project paddy area to be irrigated by 200 ha every season.

3.3.4 Other constraints affecting crop production

Earlier, when crop production commenced under the project, farmers were very much concerned over the agricultural practices in the farms. However, in recent years (perhaps because of high incomes from crop sales), farmers have tended to hire labour for most farming activities without enough supervision from the farmers themselves. Activities such as application of fertilizers and pesticides, transplanting and weeding need closer supervision in order to ensure higher yields.

Moreover, some project farmers prefer to hire their paddy plots, particularly to businessmen and office workers. These non-project farmers have less time to follow up carefully, the recommended agricultural practices and they mainly hire labour for almost all farming operations.

Charges for hired labour have been rising almost every season, leading to some project farmers failing to perform farming operations like transplanting on time and as recommended. The high labour charges are mainly caused by the non-project farmers especially businessmen hiring plots from project farmers, who are ready to pay the high charges to attract more labour to their plots. If this situation continues, the project farmers may fail to sell their crops because of high production costs.

CHAPTER IV

NOTES ON METHODS

4.1 Data Collection Procedures

4.1.1 Questionnaire formulation

Two sets of questionnaire forms were formulated for farm data collection from the farmers. These sets of questionnaire forms were administered to project and non-project farmers respectively. Guideline questionnaires were also used to collect data from the village leaders and Government officers working with the project.

4.1.2 Sampling procedure

The project covers areas in four villages, namely, Mabogini, Rau ya Kati, Chekereni and Oria. All these villages were selected to cover surveys of the whole project area. For technical data, two Government officers i.e the Project Director and an agronomist were selected purposively. Village leaders (i.e village chairman and secretary) were also selected purposively in each village surveyed. Village leaders were purposively selected in order to help in providing general information e.g total number of farmers, total acreage, crops grown, etc. They also participated in locating the farmers' households selected in their respective villages for interviews.

4.1.2 Sample size

Due to time and resource constraints a sample of 15 farmers was drawn randomly from the register of the total farmers provided by village secretaries for each of the four villages. Of the 15 farmers in each village, 10 were project farmers and five were non-project farmers. The registers indicated clearly as to which farmer is involved in the project and who is not. Thus, a total of 40 project farmers and 20 non- project farmers were selected for this study.

4.2 Data Collection

Data for this study were collected in the Lower Moshi Project area between August and October, 1990. The procedure and the type of data collected are as follows:

4.2.1 Primary data

The main method used in collecting primary data was a formal survey. A questionnaire was administered to each selected project and non-project farmer by the researcher. The researcher was able to interview at least two and at most four farmers per day. This depended on the willingness of the respondents to answer questions quickly and the walking distance from one selected farmer to another. The data collected using this method include family size and the number engaged in agriculture, farm size, crops grown, input costs, yield/ha, crop prices, labour requirements by operation and crop, hire charges for labour and implements, revenues received from crop sales and non-farm employment.

4.2.2 Secondary data

These were obtained through review of documents related to the study area and through interviews with the project officers and village leaders. These data included information on location, rainfall, temperature, construction and operation costs, input prices and their availability, water use charges and other costs paid by the farmer, cropping pattern, project management and problems facing the project.

Personal observations on the project irrigation facilities, the crop fields, extension services and the on-going operations in the crop fields made the researcher to understand more the concepts of the project.

4.3 Data Analysis

4.3.1 Data limitation

The data used in this analysis were collected from farmer surveys and project records and documents. Data collection from farmers are often not consistent. One example is that farmers in the non-project areas do not measure their fields in terms of hectares. Some fields [illegible] are irregular and difficult to measure, which reduces the accuracy of yield measurements. Another example is that many transactions are not recorded. Farmers had to rely on their memories to indicate the number of workers for certain tasks and how much they paid for inputs. These factors reduce the reliability of the data. The results of the analysis, thus are not without problems, but they provide a useful information on which to base investment decisions which must be made.

4.3.2 Techniques of analysis

The economic evaluation of the Lower Moshi Irrigation Project encompasses three major aspects, namely, to determine the impact of modern irrigation facility on the small farm families and on the whole economy of study area. This entails a determination of the economic and financial returns which farmers derive from this irrigation farming. The second aspect is to determine whether irrigation development has enhanced employment opportunities to both the farmers and the nearby non-project farmers. The last aspect looks into the problems hindering the project's performance since its completion in 1987.

The main analytical methods utilized in this study are descriptive analysis, cross tabulations, financial and economic analyses. Descriptive analysis and cross tabulations are used to identify farmer conditions, employment, farming pattern and constraints. Financial and economic analyses like benefit-cost ratio and internal rate of return calculations are used to evaluate returns to improved irrigation system.

4.3.2.1 Computation procedure

The evaluation of the Lower Moshi Irrigation Project is based on "with" and "without" principle under which two situations such as the development of the economy with the project, and the development that would accrue without it are compared. This methodology has been adopted in view of the absence of any benchmark survey necessary for the " pre-project" and "post-project" analysis.

4.3.2.2 The choice of a suitable discount rate

To obtain an appropriate measure of benefits and costs which occur at different periods, it is necessary to compound past values or discount future values by a suitable discount rate. The discount rate, therefore, provides the link between different time periods and allows for an expression of a present value. The purpose of discounting is to measure different flows of income and expenditure in terms of their present so that they can be compared (Gittinger 1984).

The discount rate may be expressed in real or nominal rate, the former being the nominal rate after the effects of inflation have been removed. As a proxy measure of nominal discount rate, some analysts use prevailing market rate of interest. This rate, however, in a less than perfect market economy will be a less than perfect measure of a discount rate and may fail to reflect society's regard for consumption by future generations.

For economic analysis using efficiency prices, the discount rate used is the opportunity cost of capital. This reflects the choice made by the society as a whole between present and future returns, and hence the amount of total income the society is willing to save.

Given the difficulty of estimating an exact discount rate, both Powers (1981) and Baum and Tolbert (1985) suggest using a real discount rate of 10 to 12 percent for public investment projects. A common choice is 12 percent (Gittinger 1984).

For financial analysis, the discount rate is usually the marginal cost of money to the farm or firm for which the analysis is being done. This will often be the rate at which a private enterprise is able to borrow money. Bank lending rate to agricultural projects in Tanzania lies between 18 and 25 percent. This study adopts 18 percent in its financial analysis. A 25 percent rate is also used in testing the sensitivity of the project due to change in the discount rate or marginal cost of money.

4.3.3 Financial and Economic analyses of the Lower Moshi Irrigation Project

4.3.3.1 Financial analysis

This refers to part of project analysis in which a project's viability is assessed from the viewpoint of the individual or agencies contributing capital and sharing its rewards (Brown 1979). Financial analysis is conducted to determine if the project yield an acceptable rate of return on the investment when benefits and costs are valued at market prices. A project must produce a financial rate of return at least as great as the discount rate to provide incentive for investment by the private sector. This goal may not be necessary in the case of public investment where the goal of profit maximization is not the only criteria for investment.

In this part of the analysis, quantities and costs of inputs are detailed, and a without project situation is used so that the incremental stream of benefits and costs can be calculated. The structure of the financial analysis, then serves as the basis for the economic analysis when market prices are replaced by efficiency prices.

4.3.3.2 Review of analysis criteria

Three criteria are used to assess the financial and economic worthiness of investment on the Lower Moshi [illegible] the project. These are the benefit cost ratio (BCR), the net present worth (NPW) and the internal rate of return (IRR).

Benefit-cost ratio: This is one of the most common techniques used to evaluate projects. It compares benefits generated by a project and the costs incurred. Benefits and costs are counted at the time they are earned or spent and the cash flows are extended over a period of several years usually the number of years assumed to be the useful life of the project. Since the project life extends over several years, the cash flow must be discounted to compensate for the time value of money.

The present worth of the benefit stream is divided by the present worth of cost stream to get the benefit-cost ratio. In this study, the method used in the calculation of benefit-cost ratio is as described by Gittinger 1984.

The decision rule in the benefit-cost analysis is to accept all projects with a benefit-cost ratio greater than one when discounted at a suitable discount rate, most often the opportunity cost of capital.

<u>Net Present Worth</u>: To calculate the net present worth, the stream of costs over the life of the project is subtracted from the stream of benefits. This yields the net benefit stream. For the Lower Moshi Irrigation Project analysis, The without project stream of benefits is

subtracted from the with project net benefit stream to give the incremental net benefit stream. The incremental net benefit stream is then discounted using the appropriate discount rate to yield the net present value.

Internal rate of return: This is another frequently used measure of project worth. It does not require the use of a discount rate for its calculation because the internal rate of return is " the discount rate that makes the net present worth of the incremental cash flow equal to zero. A satisfactory return should be at least as high as the estimated discount rate.

The BCR, NPW and the IRR in this study are worked out by conventional methods as follows:

$$\text{Benefit-cost ratio (BCR)} = \sum_{t=1}^{t=n} \frac{Bt-Ct}{(1+i)}$$

$$\text{Net present worth (NPW)} = \sum_{t=n}^{t=n} \frac{Bt-Ct}{(1+i)}$$

Internal rate of return (IRR): The discount rate i, is such that:

$$\sum_{t=1}^{t=n} \frac{Bt-Ct}{(1+i)} = 0$$

Where:

Bt is the benefit or cash flow from the investment over time period t;

Ct is the initial investment or cost of the project;

n is the life of the irrigation system and

i is the discount rate.

CHAPTER V

RESULTS AND ANALYSIS

5.1 Introduction

A project is normally evaluated in order to determine whether the project investment is beneficial to the beneficiaries and to the whole economy. The need to evaluate projects is based on the economic concept of scarce resources. In the case of public investments in developing countries like Tanzania, there exists a limited supply of funds available for financing development projects.

It is from this background, that this part of the study attempts to evaluate the Lower Moshi Irrigation Project and examine whether the project is beneficial to the farmer and the economy as a whole.

Benefits and costs of the project are calculated and then used in the financial and economic analyses of the project. Other socio-economic impacts of the project are also discussed in this part.

5.2 Some Working Assumptions

Value of production: Paddy and maize are the only crops considered for both sampled project farmers and non-project farmers. The actual area under each crop in the years 1985 to 1989 and the projected area to be cultivated obtained from the Lower Moshi Irrigation [illegible] Office are used in the project benefits and costs.

The crop prices used in the financial analysis reflect market prices after the February/July, 1990 harvests. These prices collected from survey data were shs [illegible] per ton for paddy, and shs 20 000 per ton of maize. A case using official National Milling prices is also presented for comparison. These official prices are 62 percent lower for paddy. The official prices are shs [illegible] per ton for paddy and shs 13 000 for maize.

Average yields of 5.5 tons/ha for paddy and 2.5 tons/ha for maize are taken as representative yields in the project farms. These happen to be the average yields since production started in 1985. Calculation of the average yield in the sample farms also showed the same averages. For the non-project farms, the average yields are 1.5 tons/ha for both paddy and maize as depicted from the sample farms.

Project costs: Costs of the Lower Moshi Irrigation Project can generally be identified as construction and production or material costs. Material costs include farm input costs such as seed and fertilizers. The construction costs include capital and administration costs.

Table 5-4 Lower Moshi Irrigation Project:

Annual costs from 1982/83 to 1986/87

(in million shs)

Fiscal year	Local cost portion	Foreign cost portion	Total cost
1982/83	[illegible]	4.013	6.696
1983/84	4.260	3.322	7.582
1984/85	23.470	17.850	41.320
1985/86	31.900	27.990	59.900
1986/87	66.480	31.530	98.010
Total	126.800	86.700	213.500

Source: Lower Moshi Irrigation Project Report, (1988) Irrigation and service charges: A project farmer pays these charges to the project office. These charges include a water charge of shs 2000 per ha per season; tractor charges are shs 6653 per hectare. Others are shs 2172 and 465 per ha per season paid as water users' charges and central water users' committee charges respectively. Maize farmers pay a fee of shs 2500 per season per hectare.

Seed: This is a major input for the farmer. One ha of paddy requires approximately 30 kgs of seed. This costs the farmer a total of shs 1930 payable to the project office which is responsible for seeding and care of the seed beds. The acquisition of the required maize seed is the responsibility of the individual farmer.

Fertilizers: Project farmers are obliged to apply fertilizers in their fields as directed by field officers. A total of 215 kg (Urea) and 86 kg (TSP) are recommended per ha of paddy. This costs the farmer on average, shs 2795 for Urea and shs 1204 for TSP.

Labour: Hired labour is the most expensive input for the farmer. The payments for hired labour differ depending on the type of operation. Labour is hired on piece-work basis, normally measured in terms of paddy plots. The most labour demanding operations are transplanting, weeding and harvesting.

Table [illegible]: Average cost of hired labour per ha in the sample project farms (in thousands of [illegible])

Type of operation	Type of crop	Cost per hectare
Transplanting	Paddy	9.671
	Maize	0
Weeding	Paddy	26.330
	Maize	4.000
Harvesting	Paddy	8.000
	Maize	–

Source: survey data, 1990

Table 6-3: Lower Moshi Irrigation Project:
Estimated costs and returns per ha for a typical project and non-project farm, 1990

	Farm costs and returns(in thousandshs/ha)			
	Project farm		Non -project farm	
Cost item	Paddy	Maize	Paddy	Maize
Land preparation	6.55	7.83	7.83	7.83
Seed	1.98	1.35	3.80	2.70
Water charges	5.04	2.50	0	0
Sub-total	14.28	11.68	11.63	10.53
Fertilizer:				
Nitrogen	2.80	2.68	0.65	0.65
Phosphorus	1.20	1.26	0.70	0.70
Chemicals:				
Insecticides	2.04	0	0	0
Sub-total	6.04	3.94	1.35	1.35
Hired labour:				
Transplanting	9.67	0	0	0
Weeding	26.33	4.00	0	0
Bird scaring	6.00	0	0	0
Harvesting	8.00	0	0	0
Sub-total	50.00	4.00	0	0
Grand total	70.32	19.62	12.98	11.88

Table 5.3 contd.

Benefits:				
Paddy	274.221	-	63.205	
Maize	-	50.00	-	30.00
Net benefit/ha	203.91	30.38	50.31	18.12

Source: Calculated from survey data, 1990 [illegible] budgets

Crop budgets are constructed by identifying the benefits and costs per ha of each crop for the 199[illegible] agricultural year. Costs are not identical for both project and non-project farmers, therefore, crop budgets are prepared for the groups (Table 5-3). Benefits and costs per unit to the farmer are aggregated by multiplying the results by the number of ha to be included in the project each year.

5.[illegible] Results of financial analysis

A financial analysis uses market prices and indicates the return to the resources used. There are two levels of enquiry for the Lower Moshi Irrigation project. The first examines the return to investments actually made by the sample farmers (Table 5-3). The second level of enquiry examines the rate of return on the whole project investment for the entire project including all farmers. The net present worth, the internal rate of return and the benefit-cost ratio are calculated for the whole project (Appendices 1 and 2).

The project earned a positive present value of shs 614 million indicating that the return to investment is more than the costs when stream of incremental net benefits after financing over 25 years are discounted at a rate of 18 percent. At this discount rate, investment and other costs are recovered after the project's economic life of 25 years.

The analysis show that, even after this period, the project will remain with a surplus of shs 614 million (Table 5-4)

It is observed from Table 5-4 that after discounting all benefits and costs at 18 percent, the benefit-cost ratio becomes 2.5. The results also show an internal rate of return greater than 50 percent, which is far above the opportunity cost of capital of 18 percent. When official prices are used to evaluate the whole project, all the measures responded positively giving a net present worth of shs 235 million. This implies that at the end of the project's life, assuming official prices are used, the project can recover its costs and remain with a surplus of shs 235 million. The internal rate of return is 45.1 percent and the benefit-cost ratio is 1.6.

It follows therefore that the Lower Moshi Irrigation Project is financially profitable if the true cost of capital is 18 percent.

Table [illegible] [illegible] Moshi Irrigation Project:

Results of financial analysis ([illegible]-2007)

Measure of project worth	Value at [illegible] price at 10% discount rate	Value at [illegible] price at 25% discount rate	Value at official at 10% discount rate
NPV	[illegible] 1/	[illegible] 1/	234.8 1/
IRR	>50	>50	45.1
BCR	[illegible]	2.2	1.6

Source: Appendices 4,5,6 and 7

1/ Value in million shs.

Sensitivity analysis: To test systematically what might happen to the earning capacity of the project, if the opportunity cost of capital of 18 percent is raised, a sensitivity analysis was carried out. A discount factor of 25 percent is used on the benefits and costs of the project valued at market prices. The results show that the net present value is reduced to shs 321 million, the internal rate of return is greater than 50 percent and the benefit-cost ratio becomes 2.2. This implies that the project is profitable even when the financial opportunity cost of capital is raised.

5.3.2 Economic analysis

This requires a determination of the likelihood that a project contributes significantly to the development of the whole economy, and that its contribution will be great enough to justify using the scarce resources of the national economy.

Since economic objectives of a project is national rather than individual farmer or project specific, market prices that do not reflect scarcity values are not acceptable for measuring a project's worthiness. Therefore, project benefits and costs are valued at economic or efficiency prices. Economic prices are introduced to reflect the opportunity cost to the society for the project's inputs and outputs.

[illegible] Some assumptions in the calculation of economic measures of project worth

No value for taxes or subsidies were included in the project economic analysis calculation. Payment of tax does not reduce national income. It is a direct transfer payment and not a cost from the standpoint of the society as a whole. The payment of taxes and other duties is normally treated as a cost in the financial analysis.

Value of production; Border prices of paddy and maize (c.i.f Tanga Port) plus transport cost to the project area are used in this analysis as estimates of their economic value. This value for paddy in the year 1990 was estimated to be shs 53 954 and for maize shs 21 645 per ton.

Costs; Project costs are revalued in border prices by the application of an estimated standard conversion factor (SCF) -(Appendix 11). The SCF is defined as the ratio of the border values of all goods entering into a country's trade to the domestic values of all such goods (Gittinger 1984). Adjustments for costs of various items were made by multiplying the individual costs by 68 percent, to determine their economic value. These include capital items, administration and fertilizers. Prices of other items like seed were not adjusted because they are available locally in the project area.

Labour: The opportunity cost labour or forgone output in its best alternative use often referred to as labour wage rate. In a competitive labour market, the market wage rate is a good estimate of the marginal product of labour and labour's forgone output. In the agricultural sector, the market wage rate approximates the forgone output of labour during peak seasons; but during off seasons, the supply of daily agricultural wage labour usually exceeds the demand and few alternative opportunities may exist for earning comparable income.

In the case of the Lower Moshi Irrigation Project, hired labour is not needed year round by the farmers, but only at certain critical times such as during the time of transplanting and weeding and in particular during the February/July, 1990 season. These are the peak labour times for all farmers in the area, and labour is scarce. During these times, the market rate serves as a good estimate of the opportunity cost of labour. Hence for the economic analysis, of the Lower Moshi Irrigation Project, the market wage rate in the February/July, 1990 season equals the shadow wage rate for hired labour.

Family labour is treated separately from hired labour when computing shadow wage rates. Since wages for family labour are not subtracted from project benefits as a direct cost, the net benefit which remains after all other farming costs have been paid represents the return to the efforts of family members.

Skilled labour which is provided by the Government is also treated separately because the costs for skilled labour are aggregated in the project administrative costs.

5.3.2.2 Results of economic analysis

The results of economic analysis of the Lower Moshi Irrigation Project are presented as shown below (Table 5-5). Results from this analysis show a benefit-cost ratio of 2.3 after discounting all benefits and costs at 12 percent. This implies that investment and project costs can be recovered at the end of the assumed project life of 25 years. The possibility that the whole economy will benefit from the project is very high. A proof to this is rate of return of over 50 percent which is well above the opportunity cost of capital.

The net present worth obtained is shs 1028 million. This means that the project costs can be recovered at the end of the 25 years, and that the project will have a surplus of about 1028 million.

Table 5.[illegible] Lower Moshi Irrigation Project:

Economic analysis results

Measure of project worth	Economic value at 12% discount rate	Economic value at 18% discount rate
NPV	1028.4	530.6
IRR	>50	49.24
BCR	2.3	2.04

Source: Appendices 8 and 9

Therefore investment in this project is economically justifiable in terms of benefit cost and net present worth.

However, when discount factor is raised to 30 percent, the internal rate of return becomes 49.24 percent, the benefit cost ratio is reduced to 2.04 and the net present worth becomes shs 530.6 million meaning that the project is economically profitable even when the opportunity cost of capital is raised.

5.4 Socio-economic Impacts of the Lower Moshi Irrigation Project

The socio-economic impacts of the project to the economy of the project area is examined in terms of changes in cropping pattern, input use, yield, farm expenditure, income and employment.

5.4.1 Changes in cropping pattern

The cropping pattern followed by the project farmers and that followed by non-project farmers differ significantly. Paddy is the main crop grown by the project farmers, and to most of these farmers, paddy is grown twice per year on the same plot, while for a few farmers, paddy is grown three times a year. Maize is the second crop grown under the project once per year. Irrigation service is provided for maize farms to supplement water requirements in periods of scarce rainfall.

Paddy occupies 32 percent of the total developed area, while maize occupies 19 percent. Other crops such as sugarcane, vegetables, coffee and bananas cover only 3 percent (Table 5-6).

In the case of non-project farmers, maize is the most important crop followed by beans. Small quantities of fingermillet, cassava and vegetables are also grown. A few non-project farmers grow paddy mainly for home consumption. The overall cropping pattern in the study area, therefore broadly indicates that the availability of irrigation water has resulted in diversification of cropping pattern . This is because, whereas in non-project farms, no crops are grown in the dry season, in the irrigated project farms, paddy is grown. This shows that, the provision of irrigation facility has transformed the cropping pattern and diversified it.

Furthermore, it is pertinent to note that high value crops like paddy involve high cost of cultivation. The high productivity per ha of paddy coupled with the good price compensates the high costs incurred compared to crops grown in the non-project areas, which have been highly susceptible to vagaries of weather.

Thus, since in the Lower Moshi Project area, maize and pulses were replaced by the high yielding variety of paddy. It can be concluded that provision of water leads to substitution of less profitable crops by more lucrative ones.

5.4.2 Changes in the use of major inputs

The overall view of input use per ha between the two categories of sample farms is obtained by observing average use of inputs per ha of cropped area, which has been calculated in terms of weighted average using the proportion of cropped area under each crop (Table 5-8).

Table 5-8 confirms the intensive use of inputs on project and indicates the extent of additional use of various inputs on these farms compared to non-project farms.

Table 5.6: Lower Moshi Irrigation Project:
Cropping pattern in sample farms (area under different crops), 1990

Condition	Gross cultivated area of farm land(ha)	Net acreage area(ha)	Maize (ha) Irr.	Maize (ha) Rf.	Paddy(ha) Irr.	Paddy(ha) Rf.	Other
With project	7500	4700	900	2030	1500	-	150
Without project	5080	4220	350	350	2495	-	1075
%			19		32		3

Source: Lower Moshi Irrigation Project Office reports.
Irr. stands for Irrigated; and
Rf. for Rainfed

Table 5-7: Lower Moshi Irrigation Project:

Cropping calendar, 1990

Crop	Activity and timing of operation			
	Rainy season		Dry season	
	Seeding	Harvest	Seeding	Harvest
Paddy	March	July	September	January
Maize	February	July	-	-

Source: Same as Table 5-6.

Table 5.8: Lower Moshi Irrigation Project:
Average input use per ha on project and non project farms in the sample area. 1990

Input	Project farms Maize	Project farms Paddy	Non-project farms Maize	Non-project farms Paddy	Recommended input use in project farms Maize	Recommended input use in project farms Paddy
Seeds(kg/ha)	15	30	30	60	15	30
Fertilizers:						
Urea (kg/ha)	75	180	50	50	53	215
TSP (kg/ha)	90	90	50	50	86	86
Chemicals: a/						
Insecticides(mls)	-	12.5	-	-	-	12.5
Labour requirement (man-days)	126	198	108	114	-	-

Source: Survey data and project reports

a/ The type of insecticides applied are mainly Diazinon and Thiodan.

Table 5-9 Lower Moshi Irrigation Project:
Yield of different crops on project and non-project sample farms (tons/ha)

Crop	Project farms	Non-project farms	Increase (%)	Projected yield	Yield increase against projected
Paddy	6.5	1.5	333	4.5	111
Maize	2.5	1.5	67	2.5	--

Source: Same as Table 5-8.

Some of the non-project farmers interviewed indicated using none of the inputs for the reasons that they can't afford buying the inputs. The difficulty in supervision by field officers when some of the inputs like fertilizer are applied by farmers, lead to some of the recommended levels being different from supplied levels particularly for maize.

5.4.3 Differences in yield levels

The average yield of crops obtained on the sample farms saved by the project and the non-project farms are shown and compared in Table 5-9.

As the data indicate, yield levels are higher on project farms. The increase in paddy yield per ha amounts to 333 percent while for maize, the yield level is about 67 percent more than non-project farms. When compared to the projected yield (when the project was initiated), the average yield increase for paddy is still higher by 111 percent. This could be due to use of better varieties and improved crop husbandry practices relative to that applied for projection trials.

5.4.4 Changes in farm income

Besides boosting up agricultural production in an area, the main objective of irrigation projects is to raise farmers' incomes in order to enable them get to better standard of living (Table 5-10).

It can be seen from Table 5.10 that irrigation conditions resulted into an increase in farm income by Rs 152 600 per ha of paddy and 11 960 per ha of maize which amounts to difference of 305 percent and 46 percent respectively from non-project farm returns. Although the entire additional farm income cannot be attributed to only water, but since higher use of other inputs was also made possible by the availability of irrigation facility, the resulting additional income is basically the outcome of irrigation.

5.4.5 Impact of irrigation on man-days of employment

The agricultural production has increased in the project area due to higher yield per unit area and also due to the change in cropping pattern. With these changes, labour requirement also has increased which is met by family and hired labour. A part of this additional labour requirement is met by more use of tractors during land preparation. But still, an increase in the use of labour was observed in the study. This additional use of labour on average are worked and shown in Table 5-11.

[Table 5-10] Lower Moshi Irrigation Project: Comparison of returns per ha between project and non-project farms, 1990 (in thousand shs/ha)

Crop	Type of farm	Average revenue at market price	Average cost	Average net benefit
Paddy:	Project farm	274.24	70.32	203.91
	Non-project farm	63.29	12.98	50.31
	Difference	210.95	57.34	30.31
	As a percent of non-project			305
Maize:	Project farm	50.00	19.62	30.38
	Non-project farm	30.00	11.88	18.42
	Difference	20.00	7.74	11.96
	As a percent of non-project			65

Source: Calculated from Table 5-3

Table 5.11: [illegible] Mechi Irrigation Project:
Labour requirement per ha for a typical project and non-project farm (in man-days), 1990

	Project farm		Non-project farm	
Farm operation	Paddy	Maize	Paddy	Maize
Nursery works	17	-	-	-
Field preparation	20	18	20	[illegible]
Planting	52	18	4	[illegible]
Weeding and thinning	31	30	14	10
Plant protection and upkeeping	20	6	10	-
Irrigation operation	14	12	12 a/	-
Harvesting	20	22	24	19
Primary processing	24	20	30	16
Total	198	126	114	73

Source: Same as Table 5-9.

a/ indicates traditional irrigation man-days of labour.

Table [illegible] presents the average number of man-days of employment per ha for paddy and maize in project and non project farms. The man-days of employment consists of six hours of work and [illegible] family as well as hired labour. The above table shows that on an average, the project farms engage [illegible] man-days as against the man-days utilized on non-project farms. Hence irrigation water supply pushes up the labour employment opportunities in the agricultural sector in the project area. Such a situation occurs on account of diversification of crop pattern and cultivation of labour intensive crops and double cropping system in the project area as compared to the non-project area.

5.4.6 Impact of irrigation on values of agricultural land

Enhancing the land value is one of the biggest indirect benefit attributed to irrigation projects. In the Lower Moshi Irrigation Project area, there are three contributions to land value enhancement.

The first is the large increase of arable land, particularly in the lowlying area along the Rau and Njoro rivers as a result of flood control and drainage improvement. About 430 ha or 20 percent of the project area is now free from seasonal floods as a result of the

... dam flood protection works constructed under the project.

Secondly, stabilization of crop productivity is also a large contribution in this project. As a result, capacity for settlement has increased in the area. Some of the farmers who used to reside on the highland areas and seasonally migrating for farm work in the project area before the project commenced, are now settled permanently in the area, since the double cropping of paddy keeps them busy throughout the year.

The third contribution is the improvement of social environment, communication and transportation. This gives sufficient incentives to the farmers to improve their livelihood.

From the study, it was also observed that on the average, the capital value of land in the project area has appreciated as compared to non-project areas. No project farmer interviewed was ready to dispose his plot. However, a few project farmers admitted to be renting their paddy plots at least once per year. The charge for renting was on average shs 60 000 per ha or shs 20 000 per 0.3 ha paddy plot per season. Such high value of land has made the asset position of the project farmers more sound.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The Lower Moshi Irrigation Project was funded by the Japanese Government in collaboration with the Government of Tanzania, to help farmers increase grain production, in the lowland areas by introducing modern small-scale irrigation. The initial objective of this project was to sustain the increases in local food production by training farmers to manage their farm activities independent of outside assistance.

Against such a background, this study intended to objectively determine the costs incurred by the project farm households, and returns obtained as a result of irrigation development in the Lower Moshi area. Financial and economic analyses were conducted to determine the project's worthiness. The economic analysis of the project is directed towards determining empirically whether the investment on the project contribute significantly to the development of the economy as a whole.

The study also attempts to evaluate the impact of the project on employment. It also studies the changes in cropping patterns, yield levels of principal crops, farm income and land values. All these aspects have been related to "with" and "without" project conditions.

In addition, the study looks into the problems facing the project (outlined in Chapter III of this study) and contributing to low development and expansion of the project irrigated area.

5.2 Conclusions

5.2.1 Financial and economic analysis

The measures of project worth used to evaluate the project are the benefit-cost ratio, the net present worth and the internal rate of return. The estimated financial returns to the resources actually invested by the project farmers were more than sufficient to elicit participation in the project. The financial rate of return is well above 50 percent, the benefit-cost ratio greater than one and the net present worth is positive when market prices are used and 18 percent discount rate is applied on the project benefits and costs. The high internal rate of return implies that, the project can operate without subsidy.

Official National Milling Corporation prices were also used in calculating the measures of project worth in order to compare the magnitude of change if farm outputs are assumed to be sold only through official channels. This can also act as a sensitivity analysis since the market prices are higher than official prices. All the measures of project worth responded positively when official prices were used and 18 percent discount factor applied, although the magnitudes were lower.

Since this is a public project, the Government of Tanzania and the donors are more interested in the economic measures of project worth than the financial rates. As far as the benefit-cost ratio is greater than one, the net present worth positive and the economic rate of return exceeds the opportunity cost of capital, the project proves to contribute significantly to national income and therefore viable.

Sensitivity analysis regarding the opportunity cost of capital variations was conducted both in the financial and economic analyses, to allow for rational conclusions. This was necessary to accommodate higher opportunity costs of capital (i.e. 18 percent for the economic analysis and 25 percent for the financial analysis). It was observed that under the assumed increase in opportunity costs of capital, the project is still profitable. The financial rate of return remained greater than 50 percent, the net present worth was shs 321 million and the benefit-cost was 2.2 when a 25 percent discount factor was applied on the benefits and costs of the project using market prices.

When 18 percent discount factor was used on the project economic benefits and costs, the net present worth was reduced to about 50 percent of the value obtained at 12 percent discount rate. The economic rate of return was greater than 50 percent and the benefit-cost ratio was still greater than one.

5.2.2 Socio-economic impacts of the project

From the evaluation of the impacts of modern irrigation on the farm economy of the study area, the following tentative conclusions have emerged.

The project area has exhibited a more diversified cropping pattern in the rainy and dry season as compared to the non-project area. While in the project area, paddy is grown during dry season by use of irrigation, the non-project areas went without any crop.

It was observed also that, provision of irrigation in the project area has enhanced labour employment (both family and hired labour). On the whole, a ha of an irrigated farm has increased the labour use by 84 man-days for paddy and 53 man-days for maize per season, as compared to the non-project area.

The overall output or gross returns per ha for the irrigated farms was higher than that of the non-project farms. The project has increased the farmers' income by shs 153 600 per ha of paddy and shs 11 960 per ha of maize.

Further, the study also revealed that the average per ha value of land, the single most important item of farm household asset in the project area has appreciated more than that of the non-project area.

Problems observed in this study that hinder project development and expansion, included those of drought, high unit water requirements in the project farms against the targeted, illegal use of water outside the project area and institutional problems of which solutions have to be sought to ensure sustainability of the project and fulfilment of its objectives.

6.2 Recommendations

The foregoing discussions have led to the logical conclusion that the Lower Moshi Irrigation Project is profitable both to the farmers and the economy as a whole. This proves that if appropriate measures are carried out by the project authorities, the area under irrigation can be expanded and productivity per ha increased or maintained.

Since farmers can grow food crops locally for self-sufficiency, it makes sense to assist farmers in stabilizing their crop production. The Lower Moshi Irrigation Project has made great success so far towards stabilizing production by use of irrigation. The project leadership should continue training farmers by use of extension workers to enable farmers follow closely the crop farming recommendations. There should be efforts to improve the knowledge about modern irrigation practices at the farmer's level even though water delivery systems perform well.

Any technical innovation has to be borne by new skills and knowledge that are specifically required to make proper use of that innovation. In the case of the Lower Moshi Irrigation Project, this means that programmes of research, training and extension should be integral parts of the project as a step towards maintaining success. It is not only farmers who have to learn the modern irrigation cropping, but also extension workers who may have previously engaged only in the technical instruction in rainfed crops. Personnel development programmes have to be encouraged. Developing skills and special programmes for personnel and field staff are desperately required.

To ensure faster rate of quantitative expansion of irrigation area, construction of boreholes may be important especially during drought years. The few boreholes existing in the project area helps in increasing the volume of water for irrigation. This may also solve the problem of high water requirement in the project farms.

By-laws should be introduced and used in the project area in order to ensure an agricultural discipline is adhered to by both project leaders and farmers. Security concerning project facilities should be strengthened and legal measures taken against those utilising the project facilities illegally. Moreover, the water user organizations should participate under well-defined responsibilities. Water user groups which are absolutely separate from other political and administrative bodies are needed in the project area. The present system of irrigation management has been interfered with the political (i.e. Party units) and administrative entities (village/town councils) which consequently have created conflicts and cause inefficiency.

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Appendix 1: Lower Moshi Irrigation Project: Calculation of incremental production costs (in million shs)

Year	Area under paddy (ha)	Production costs (Paddy)		Incremental costs (paddy)	Area under maize (ha)	Production costs (Maize)		Incremental costs (maize)	Total incremental costs
		With project	Without project			With project	Without project		
1985	93.52	6.57	1.21	5.36	-	-	-	-	5.36
1986	592.09	41.54	7.69	33.95	455	8.93	5.40	3.53	37.48
1987	887.29	62.39	11.52	50.87	900	17.66	10.69	6.97	57.84
1988	1286.84	90.49	16.70	73.79	900	17.66	10.69	6.97	80.76
1989	1431.41	100.66	18.58	82.08	900	17.66	10.69	6.97	89.05
1990	1500.00	105.48	19.47	86.01	900	17.66	10.69	6.97	92.98
1991	1550.00	109.00	20.12	88.88	900	17.66	10.69	6.97	95.85
1992	1650.00	116.03	21.42	94.61	900	17.66	10.69	6.97	101.58
1993	1800.00	126.58	23.36	103.22	900	17.66	10.69	6.97	110.19
1994	1900.00	133.61	24.66	108.95	900	17.66	10.69	6.97	115.92
1995-2007	1900.00	133.61 a/	24.66 a/	108.95 a/	900	17.66 a/	10.69 a/	6.97 a/	115.92
Total		2629.38	485.31	2144.07		379.79	229.89	149.90	2293.97

Source: Calculated from own survey data, 1990.

a/ Annual amount for years 1995 through 2007 inclusive. To reach column total, this amount must be included 13 tim

Appendix 2: Lower Moshi Irrigation Project:
Calculation of incremental benefits using market prices
(in million shs)

Year	Total revenue (paddy) With	Total revenue (paddy) Without	Incremental benefit (paddy)	Total revenue (maize) With	Total revenue (maize) Without	Incremental benefit (maize)	Total incremental benefit
1985	27.63	5.92	21.71	-	-	-	21.71
1986	157.67	37.47	120.20	22.76	13.65	9.11	139.30
1987	243.31	56.15	187.16	36.00	27.00	9.00	196.20
1988	302.21	81.44	220.77	45.00	27.00	18.00	238.80
1989	371.65	90.60	281.05	36.00	27.00	9.00	290.10
1990	411.35	94.90	316.45	45.00	27.00	18.00	334.50
1991	425.06	98.09	326.97	45.00	27.00	18.00	345.00
1992	452.50	104.42	348.08	45.00	27.00	18.00	366.10
1993	493.62	113.91	379.71	45.00	27.00	18.00	397.70
1994	521.05	120.24	400.81	45.00	27.00	18.00	418.80
1995-2007	521.05 a/	120.24 a/	400.81 a/	45.00 a/	27.00 a/	18.00 a/	418.80 a/
Total	10 249.7	2386.3	7863.4	949.8	580.7	369.1	8254.6

Source: Same as Appendix 1.

a/ Annual amount for years 1995 through 2007 inclusive.
To reach column total, this amount must be included 13 times.

Appendix 3: Lower Moshi Irrigation Project:
Calculation of incremental benefits using official prices
(in million shs)

Year	Total revenue (paddy)		Incremental benefit (paddy)	Total revenue (maize)		Incremental benefit (maize)	Total incremental benefit
	With project	Without project		With project	Without project		
1985	17.03	3.65	13.38	-	-	-	13.38
1986	103.32	23.09	80.23	14.80	8.90	5.90	86.13
1987	149.94	34.60	115.34	23.40	17.60	5.80	121.14
1988	222.61	50.19	172.42	29.30	17.60	11.70	184.12
1989	229.03	55.82	173.21	23.40	17.60	5.90	179.01
1990	253.50	58.50	195.00	29.30	17.60	11.70	206.70
1991	261.95	60.45	201.50	29.30	17.60	11.70	213.20
1992	278.85	64.35	214.50	29.30	17.60	11.70	226.20
1993	304.20	70.20	234.00	29.30	17.60	11.70	245.70
1994	321.10	74.10	247.00	29.30	17.60	11.70	258.70
1995-2007	321.10 a/	74.10 a/	247.00 a/	29.30 a/	17.60 a/	11.70 a/	258.70 a/
Total	6315.7	1458.2	4857.6	618.3	378.5	239.8	5177.1

Source: Calculated from own survey data, 1990.
a/ Annual amount for years 1995 through 2007 inclusive.
To reach column total, this amount must be included 13 times.

Appendix 4: Lower Moshi Irrigation Project:
Calculation of benefit-cost ratio using market prices
(in million shs)

Year	Incremental costs: Capital items	Operation and maintenance	Administration	Production	Gross	Discount factor 18%	Present worth 18%	Value of incremental production	Disc. factor 18%	Present worth 18%	Disc. factor 25%	Present worth (costs)	Present worth (ben.)
1983	6.70	0	2.4	0	9.1	.847	7.71	0	.847	0	.800	7.28	0
1984	7.59	0	2.4	0	9.99	.718	7.17	0	.718	0	.640	6.39	0
1985	41.32	0	2.4	5.4	49.1	.609	29.9	21.7	.609	13.2	.512	25.1	11.1
1986	59.90	0	2.4	37.5	99.8	.516	51.5	139.3	.516	71.9	.410	40.9	57.1
1987	98.40	0	2.4	57.8	158.2	.437	69.2	151.2	.437	55.7	.328	51.9	54.4
1988	0	1.6	2.4	60.8	64.7	.370	33.4	253.2	.370	227.6	.262	22.2	73.3
1989	0	1.6	2.4	89.1	93.0	.314	29.2	290.1	.314	91.1	.210	19.5	61.3
1990	0	1.6	2.4	93.0	97.0	.266	25.8	334.5	.266	89.0	.168	16.3	56.2
1991	0	1.6	2.4	95.9	99.9	.225	22.5	345.0	.225	78.0	.134	13.4	46.2
1992	0	1.6	2.4	101.6	105.6	.191	20.2	366.1	.191	69.9	.107	11.3	39.2
1993	0	1.6	2.4	110.2	114.2	.162	18.5	379.7	.162	61.5	.086	9.8	32.4
1994	0	1.6	2.4	115.9	119.9	.137	16.4	415.9	.137	57.0	.069	8.3	28.9
1995-2007	0	1.6 a/	2.4 a/	115.9a/	119.9a/	.675 b/	80.9	422.3 a/	.6756	284.6	.283	33.9	119.1
Total	265.5	31.6	69.6	2294.0	2599.1	5.467	410.2	8294.6	5.467	1024.0	3.984	263.3	594.7

Sources: Calculated from Table 5-1 and Appendices 1 and 2.

Benefit-cost ratio at 18 percent: 1024.0 /410.2 = 2.5

Benefit-cost ratio at 25 percent: 594.7/263.3 = 2.3

a/ Annual amount for years 1995 through 2007 inclusive.
To reach column total, this amount must be included 13 times

b/ Present worth of an annuity factor for years 1995 through 2007 inclusive.

Appendix 6: Lower Moshi Irrigation Project:
Computation of internal rate of return using market prices
(in million shs)

Year	Incremental costs: Capital items	Incremental costs: Operation and maintenance	Incremental costs: Admini-stration	Incremental costs: Produ-ction	Incremental costs: Gross	Value of incremental production (gross benefit)	Incremental net benefit (cash flow)	Discount factor 45%	Present worth 45%	Discount factor 50%	Present worth 50%
1983	6.7	0	2.4	0	9.1	0	-9.1	.690	-6.28	.667	-6.07
1984	7.58	0	2.4	0	9.98	0	-9.98	.475	-4.74	.444	-4.43
1985	41.32	0	2.4	5.36	49.08	21.7	-27.37	.328	-8.98	.296	-8.10
1986	59.90	0	2.4	37.48	99.78	139.3	39.52	.226	8.93	.198	7.82
1987	98.00	0	2.4	57.84	158.24	196.2	37.96	.156	5.92	.132	5.01
1988	0	1.6	2.4	80.76	84.74	298.8	214.06	.108	23.12	.088	18.84
1989	0	1.6	2.4	89.05	93.03	290.1	197.07	.074	14.58	.059	11.63
1990	0	1.6	2.4	92.96	96.96	334.5	237.54	.051	12.11	.039	9.26
1991	0	1.6	2.4	95.85	99.83	345.0	245.17	.035	8.58	.026	6.37
1992	0	1.6	2.4	101.6	105.6	366.1	260.5	.024	6.25	.017	4.43
1993	0	1.6	2.4	110.2	114.2	397.7	283.5	.017	4.82	.012	3.40
1994	0	1.6	2.4	115.9	119.9	418.8	298.9	.012	3.59	.008	2.39
1995-2007	0	1.6 a/	2.4a/	115.9a/	119.9a/	418.8 a/	298.9	.026 b/	7.77	.014 b/	4.18
Total	213.5	31.6	60.0	2293.97	2599.1	8255.6	5653.5	2.223	75.7	2.000	54.74

Source: Same as Appendix 4.

Since no sign change after using 50 percent discount rate, then the internal rate of return is greater than 50 percent

a/ Annual amount for years 1995 through 2007 inclusive. To reach column total, this amount must be included 13 times.

b/ Present worth of an annuity factor for years 1995 through 2007 inclusive.

Appendix 6: Lower Moshi Irrigation Project:
Computation of benefit-cost ratio using official NMC prices
(in million shs)

Year	Incremental costs: Capital items	Incremental costs: Operation and maintenance	Incremental costs: Admini-stration	Incremental costs: Produ-ction	Incremental costs: Gross	Discount factor 18%	Present worth 18%	Value of incremental production (gross benefit)	Discount factor 18%	Present worth 18%
1983	6.70	0	2.4	0	9.1	.847	7.71	0	.847	0
1984	7.58	0	2.4	0	9.98	.718	7.17	0	.718	0
1985	41.32	0	2.4	5.36	49.08	.609	29.29	13.36	.609	8.15
1986	59.90	0	2.4	37.48	99.78	.516	51.49	18.13	.516	44.44
1987	99.00	0	2.4	57.84	158.24	.437	69.15	121.14	.437	52.94
1988	0	1.6	2.4	80.76	84.74	.370	31.35	184.12	.370	68.12
1989	0	1.6	2.4	89.05	93.03	.314	29.21	179.01	.314	64.90
1990	0	1.6	2.4	92.98	96.96	.266	25.79	206.70	.266	56.71
1991	0	1.6	2.4	95.85	99.83	.225	22.46	213.20	.225	50.89
1992	0	1.6	2.4	101.58	105.56	.191	20.16	226.20	.191	46.93
1993	0	1.6	2.4	110.19	114.17	.162	18.50	247.70	.162	41.91
1994	0	1.6	2.4	115.92	119.90	.137	16.43	252.70	.137	35.44
1995-2007	0	1.6 a/	2.4a/	115.92 a/	119.90 a/	.675 b/	13.91	258.70 a/	.675 b/	30.00
Total	213.5	31.6	60.0	2293.97	2599.1	5.467	410.2	5177.1	5.467	645.01

Source: Calculated from Table 5-1 and Appendices 1 and 3.

Benefit-cost ratio at 18 percent: 645.01 / 410.2 = 1.57

Net present worth at 18 percent: 645.01 - 410.2 = 234.8

a/ Annual amount for years 1995 through 2007 inclusive. To reach column totals, this amount must be included 13 times.

b/ Present worth of annuity factor for years 1995 through 2007 inclusive.

Appendix 7: Lower Moshi Irrigation Project:
Computation of internal rate of return using official prices
(in million shs)

Year	Incremental costs: Capital items	Operation and maintenance	Administration	Production	Gross	Value of incremental production (gross benefit)	Incremental net benefit (cash flow)	Discount factor 45%	Present worth 45%	Discount factor 50%	Present worth 50%
1983	6.70	0	2.4	0	9.1	0	-9.1	.690	-6.28	.669	-6.07
1984	7.58	0	2.4	0	9.98	0	-9.98	.476	-4.75	.444	-4.43
1985	41.32	0	2.4	5.36	49.08	13.38	-35.70	.328	-11.71	.296	-10.57
1986	59.90	0	2.4	37.42	99.72	18.13	-13.65	.226	-3.09	.198	-2.70
1987	98.00	0	2.4	57.84	158.24	121.14	-37.10	.156	-5.79	.132	-4.90
1988	0	1.6	2.4	80.76	84.74	184.12	99.38	.108	10.73	.088	9.78
1989	0	1.6	2.4	89.05	93.03	179.01	85.98	.074	6.36	.059	5.07
1990	0	1.6	2.4	92.98	96.96	208.70	109.74	.051	5.60	.039	4.29
1991	0	1.6	2.4	95.55	99.83	213.20	113.37	.035	3.97	.026	2.95
1992	0	1.6	2.4	101.58	105.56	226.20	120.64	.024	2.90	.017	2.05
1993	0	1.6	2.4	110.19	114.17	247.70	133.53	.017	2.24	.012	1.58
1994	0	1.6	2.4	115.92	119.90	255.70	135.80	.012	1.67	.009	1.11
1995-2007	0	1.6 a/	2.4 a/	115.92 a/	119.90 a/	258.70 a/	138.80 a/	.026 b/	3.61	.014 b/	1.94
Total	213.5	31.6	60.0	2293.97	2599.1	5097.4	2498.3	2.222	5.32	2.000	-0.94

Source: Same as Appendix 6.

Calculation of internal rate of return (by interpolation):

45 + 5(5.32/ 0.94 + 5.32) = 49.25 percent

a/ Annual amount for years 1995 through 2007 inclusive. To reach column total, this amount must be included 13 times.

b/ Present worth of annuity factor for years 1995 through 2007 inclusive.

Appendix 8: Lower Moshi Irrigation Project:
Computation of benefit-cost ratio using economic prices
(in million shs)

	Incremental costs							Value of					
Year	Capital items	Operation and maintenance	Admini-stration	Produ-ction	Gross	Disc. factor 12%	Present worth 12%	increm. production (gross benefit)	Disc. factor 12%	Present worth 12%	Disc. factor 18%	Present worth costs	Pres. worth ben.
1983	11.26	0	4.03	0	15.3	.893	13.6	0	.893	0	.847	13.0	0
1984	12.73	0	4.03	0	16.8	.797	13.4	0	.797	0	.718	12.1	0
1985	69.42	0	4.03	5.6	79.2	.712	56.3	44.8	.712	31.9	.609	48.2	27.3
1986	100.63	0	4.03	39.7	144.4	.636	91.8	152.5	.636	97.0	.516	74.5	78.7
1987	154.60	0	4.03	61.5	220.2	.567	124.8	305.2	.567	113.4	.437	96.2	95.7
1988	0	2.7	4.03	85.4	92.1	.507	46.7	333.0	.507	168.8	.370	34.1	112.1
1989	0	2.7	4.03	94.1	100.7	.452	42.4	296.1	.452	133.2	.314	31.6	92.9
1990	0	2.7	4.03	98.2	104.8	.404	32.9	334.4	.404	135.1	.266	27.9	33.9
1991	0	2.7	4.03	101.2	107.8	.361	36.6	345.0	.361	124.5	.225	24.3	77.6
1992	0	2.7	4.03	107.1	113.8	.322	35.2	366.1	.322	117.9	.191	21.7	69.9
1993	0	2.7	4.03	116.1	122.8	.287	33.1	399.7	.287	114.7	.162	19.9	64.9
1994	0	2.7	4.03	122.1	128.7	.257	29.5	415.3	.257	107.4	.137	17.6	57.4
1995-2007	0	2.7 a/	4.03 a/	122.1 a/	128.7 a/	1.651 b/	16.4	413.2 a/	1.651 b/	95.9	.576 b/	14.9	46.6
Total	353.7	53.8	100.8	2417.6	2930.8	7.846	796.7	8510.7	7.846	1525.1	5.467	511.0	1042.3

Source: Computed from Appendix 10 and 11.

Benefit-cost ratio at 12 percent : 1525.1 / 796.7 = 1.9

Benefit-cost ratio at 18 percent: 1042.3 / 511.05 = 2.04

a/ Annual amount for years 1995 through 2007 inclusive. To reach column totals this amount must be included 13 times.

b/ Present worth of annuity factor for years 1995 through 2007 inclusive.

Appendix 9: Lower Moshi Irrigation Project:
Computation of internal rate of return using economic prices
(in million shs)

Year	Incremental costs: Capital items	Operation and maintenance	Administration	Production	Gross	Value of incremental production (gross benefit)	Incremental net benefit (cash flow)	Discount factor 45%	Present worth 45%	Discount factor 50%	Present worth 50%
1983	11.26	0	4.03	0	15.3	0	-15.3	.690	-10.5	.667	-10.2
1984	12.72	0	4.03	0	16.8	0	-16.8	.476	-8.0	.444	-7.4
1985	69.42	0	4.03	5.6	79.0	44.5	-75.5	.328	-24.8	.296	-22.4
1986	100.63	0	4.03	39.7	144.4	152.5	-105.4	.226	-24.0	.198	-21.1
1987	154.54	0	4.03	61.6	230.2	205.2	-135.9	.156	-21.2	.132	-17.9
1988	0	2.7	4.03	85.4	92.1	303.0	227.2	.108	24.5	.088	20.0
1989	0	2.7	4.03	94.1	100.7	299.1	270.5	.074	20.0	.059	16.0
1990	0	2.7	4.03	98.2	104.9	334.4	321.3	.051	16.4	.039	12.5
1991	0	2.7	4.03	101.2	107.8	345.0	329.6	.035	11.5	.026	8.6
1992	0	2.7	4.03	107.1	113.8	366.1	350.6	.024	8.4	.017	6.0
1993	0	2.7	4.03	116.1	122.8	399.7	383.0	.017	6.5	.012	4.6
1994	0	2.7	4.03	112.1	128.7	418.8	403.1	.012	4.9	.008	3.2
1995-2007	0	2.7 a/	4.03a/	112.1 a/	128.7 a/	418.8 a/	403.1 a/	.026 b/	3.2	.014 b/	2.0
Total	348.7	53.0	100.8	3417.6	2930.0	8312.7	7174.1	2.223	14.1	2.000	-2.6

Source: Computed from Appendix 10 and 11

Calculation of internal rate of return (by interpolation):

45 + 5(14.1 /14.1 +2.6) = 49.2 percent.

a/ Annual amount for years 1995 through 2007 inclusive. To reach column total, this amount must be included 13 times.
b/ Present worth of annuity factor for years 1995 through 2007 inclusive.

Appendix 10: Lower Moshi Irrigation Project:
Calculation of incremental production costs using economic prices
(in million shs)

Year	Production costs (paddy)		Incremental costs (paddy)	Production costs (maize)		Incremental costs (maize)	Total Incremental (costs)
	With project	Without project		With project	Without project		
1985	7.38	1.80	5.58	-	-	-	5.58
1986	46.75	11.38	35.37	12.57	8.20	4.37	39.74
1987	70.06	17.05	53.01	24.86	16.31	8.55	61.56
1988	101.61	24.73	76.88	24.86	16.31	8.55	85.43
1989	112.02	27.51	85.51	24.86	16.3	8.55	94.06
1990	118.44	28.83	89.61	24.86	16.31	8.55	98.16
1991	122.39	29.79	92.60	24.86	16.31	8.55	101.15
1992	130.28	31.71	98.57	24.86	16.3	8.55	107.12
1993	142.13	34.60	107.53	24.85	16.31	8.55	116.08
1994	150.02	36.52	113.50	24.86	16.31	8.55	122.05
1995-2007	150.02 a/	36.52 a/	113.50 a/	24.86 a/	16.31 a/	8.55 a/	122.05 a/
Total	2952.34	718.68	2226.66	534.83	350.70	193.92	2417.58

Source: Same as Appendix 1.

a/ Annual amount for years 1995 through 2007 inclusive. To reach column total, this amount must be included 13 times.

Appendix 11 : Estimation of a standard conversion factor (SCF) for Tanzania
(in million shs)

	1983	1984	1985	1986	1987	1988	1989
1. Value of total imports (M)	13 037	14 280	17 196	39 971	78 949	122 505	196 904
2. Value of total exports (X)	6075	6345	4932	12 265	23 842	38 451	60 961
3. M + X	19 112	20 625	22 128	52 236	102 790	160 956	257 765
4. Taxes on total imports (Tm)	24 496	23 994	69 998	210 140	582 028	1 314 280	2 433 818
5. Taxes on total exports (Tx)	20 410	21 972	63 184	203 286	532 295	1 079 804	1 737 129
6. Net taxes on trade (Tm - Tx)	4086	2022	6814	6854	43 730	234 476	696 696
7. M + X + net taxes on trade	23 198	22 647	28 942	60 092	146 520	395 442	954 461
8. SCF = 3/7	0.82	0.91	0.76	0.87	0.70	0.41	0.27

Average SCF = 0.68

Source: Tanzania Economic Trends: Quarterly Review of the Economy. Various volumes.

Appendix 12: Lower Moshi Irrigation Project:
Computation of incremental benefits using economic prices
(in million shs)

Year	Total benefit (Paddy)		Incremental benefit (Paddy)	Total benefit (Maize)		Incremental benefit (Maize)	Total incremental (benefit)
	With project	Without project		With project	Without project		
1985	4.41	0.94	3.47	-	-	-	3.47
1986	45.66	10.43	35.23	4.51	2.70	1.81	38.34
1987	119.00	27.46	91.54	11.09	6.32	2.77	94.30
1988	398.11	89.54	308.57	25.45	15.89	10.59	319.20
1989	477.23	115.78	361.45	38.96	29.22	9.74	371.20
1990	527.92	121.33	406.59	48.70	29.22	19.48	426.10
1991	543.28	125.37	417.91	49.70	29.22	19.48	437.40
1992	579.33	132.46	444.87	48.70	29.22	19.48	464.40
1993	630.91	145.59	485.32	48.70	29.22	19.49	504.80
1994	665.96	153.68	512.28	49.70	29.22	19.48	531.59
1995-2007	665.96 a/	153.68 a/	512.28 a/	48.70 a/	29.22 a/	19.48 a/	531.80 a/
Total	12649.29	2921.69	9727.57	957.64	582.09	375.55	10104.14

Source: Survey data, 1990

a/ Annual amount for years 1995 through 2007 inclusive. To reach column total, this amount must be included 13 times.

Appendix 13: Sub-Saharan Africa: Estimates of irrigated areas in relation to irrigation potential

Area developed, 1982 ('000 ha)

Country	Irrigation potential	Modern	Small-scale or traditional
Angola	6700	0	10
Benin	86	7	15
Botswana	100	0	12
Bukina Faso	350	9	20
Burundi	52	2	50
Cameroon	240	11	9
C.African Rep.	1900	0	4
Chad	1200	10	40
Congo	340	3	5
Eq.Guinea	n.a	n.a	n.a
Ethiopia	670	82	5
Gabon	440	0	1
Gambia	72	6	20
Ghana	120	5	5
Guinea	150	15	30
Guinea Bissau	70	n.a	n.a
Ivory Coast	130	42	10
Kenya	350	21	28
Lesotho	8	0	1
Liberia	n.a	3	16
Madagascar	1200	160	800
Malawi	290	16	4
Mali	340	100	60
Mauritania	39	3	20
Mauritius	n.a	9	5
Mozambique	2400	66	4
Niger	100	10	20
Nigeria	2000	50	800
Rwanda	44	0	15
Senegal	180	30	70
Sierra Leone	100	5	50
Somalia	87	40	40
Sudan	3300	1700	50

Appendix 12 contd.

Swaziland	7	55	5
Tanzania	2300	25	115
Togo	86	3	10
Uganda	410	9	3
Zaire	4000	4	20
Zambia	3500	10	6
Zimbabwe	280	127	3
Total	33 641	2638	2381

Source (Appendix 13): FAO 1986. Study team estimates of areas developed; irrigation potentials from FAO Land and Water Division, 1985 (provisional estimates).