Irrigation-based Livelihood Challenges and Opportunities

A gendered technography of irrigation development intervention in the Lower Moshi irrigation scheme in Tanzania

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DEDICATION

To my children:

Jennifer, Jeffrey and Jacqueline

I honour my late parents:

Mariam and Ally

"For the LORD gives wisdom, and from His mouth come Knowledge and Understanding"

(Proverbs 2:6)

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Kalunde Kissawike

Wageningen, June 2008

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ABBREVIATIONS AND ACRONYMS

ALIN-EA	Arid Lands Information Network in Eastern Africa
ASDP	Agricultural Sector Development Programme
ASDS	Agricultural Sector Development Strategy
ASP	Agricultural Strategy Paper
CHAWAMPU	Chama cha Wakulima wa Mpunga (Rice Farmers' Cooperative Society)
CIDA	Canadian International Development Agency
CMOC	Context-Mechanism-Outcome Configuration
DANIDA	Danish International Development Agency
DFID	Department for International Development
ENRECA	European Network for Religious Education in Europe through Contextual Approaches
FAO	Food and Agriculture Organization
HYV	High Yielding Variety
IA	Irrigators' Association
ID	Irrigation Division
IG	Irrigators' Group
IIMI	International Irrigation Management Institute
JICA	Japanese International Cooperation Agency
KADC	Kilimanjaro Agricultural Development Centre
KADP	Kilimanjaro Agricultural Development Project
KATC	Kilimanjaro Agricultural Training Centre
KIDC	Kilimanjaro Industrial Development Centre
KIP	Kimani Irrigation Project
KRIDP	Kilimanjaro Regional Integrated Development Plan
LMIP	Lower Moshi Irrigation Project
MAFS	Ministry of Agriculture and Food Security
MALD	Ministry of Agriculture Livestock Development
MOA	Ministry of Agriculture
MOAC	Ministry of Agriculture and Cooperatives
MoWNR	Ministry of Water and Natural Resources
MWLD	Ministry of Water and Livestock Development
NAFCO	National Agriculture and Food Cooperation Farms
NEPAD	New Partnership for Africa's Development
NGO	Non Government organization
NIDP	National Irrigation Development Plan
NPES	National Poverty Eradication Strategy
NVIDP	National Village Irrigation Development Programme
PRA	Participatory Rural Appraisal
PRSP	Poverty Reduction Strategy Process Paper
RBMSIIP	River Basin Management and Smallholder Improvement Programme
RDD	Regional Development Director
RDS	Rural Development Strategy
RDSP	Rural Development Strategy Paper
ROSCA	Rotating Savings and Credit Association
SACCO	Savings and Credit Cooperatives

SAP	Structural Adjustment Policies
SIIC	Smallholder Irrigation Improvement Component
SMUWC	Sustainable Management of the Usangu Wetlands and its Catchment
SNV	Dutch Development Organization
TANU	Tanganyika African National Union
TAS	Tanzania Assistance Strategy
TIP	Traditional Irrigation Project
TNW	Tanzania National Website
TPC	Tanganyika Planting Company
UNDP	United Nation Development Program
URT	United Republic of Tanzania
UVIP	Usangu Village Irrigation Project
WD	Water Development
WIA	Women's Irrigation Association
WUA	Water Users' Association
WUG	Water Users' Group
ZIU	Zonal Irrigation Unit

CHAPTER 1

RESEARCH CONTEXT AND SETTING

1.1 General introduction

Irrigated agriculture in Africa is under renewed attention in relation to food security and poverty alleviation, as a driver in agricultural development and for transformation of subsistence production. Irrigation is defined as human intervention to modify the spatial or temporal distribution of water occurring in natural channels, depressions, drainage ways, or aquifers, and to manipulate all or part of this water to improve crop growth (Small and Svendsen 1992). Irrigation technology attracts debate on how, as a technology, it supports intensification and pathways out of poverty, or drives commoditisation and differentiation (NEPAD 2002; Scoones *et al*. 2005). New initiatives, with a neo-liberal justification, are very similar to older modernisation policies that aimed to change societal structure to fit a more complex modern production system, with changes and growth in the scale of production to satisfy human needs (Eggink and Ubels 1984). 'Modern' irrigation technologies have been an important tool and force within these wider modernisation and transformation plans. Yet the recent history of irrigation intervention in Africa shows many problems and a complex dynamic of change (Adams and Anderson 1988; Bernstein and Woodhouse 2001).

Public interventions in irrigation schemes have often appeared to stimulate commoditisation and social differentiation. Several authors (Small and Carruthers 1991; Small and Svendsen 1992), point out that we still know little about socioeconomic transformations within irrigation systems, and particularly that we need more research on how agricultural technologies are related to these processes of change. We need to know more about the interrelationships of these technologies with local forms of production and wider processes of change to understand what makes interventions fail or (conversely) useful for users as well as governments. This thesis is an outcome of a study conducted in the Lower Moshi irrigation scheme in Tanzania to understand how irrigation and agricultural technologies have interacted with local society to change production, with particular attention to gender relations and changes for women farmers. The thesis seeks to contribute to a better understanding of livelihood and production changes under 'modernised' irrigation systems, when contrasted with older local irrigation systems.

The Tanzanian government, with the help of international donors, has also used irrigation development to transform local agricultural production, through a raft of policies, acts and interventions. Hyden (1980) is one of a number of commentators who asked why local production and commoditisation has taken such different paths in Africa from Asia, despite the strong incorporation by the Tanzanian government of international and global economic policies. These older studies remain relevant in assessing claims that the twentieth century 'Asian' 'green revolution' has apparently failed in Africa, so that new global policies call for a new agricultural revolution for Africa. Others claim, however, that Africa has had its own indigenous agricultural revolution, as shown by transforming varieties and yields of crops, driving local

transformations in livelihoods and social structures, if only we know where to look. This thesis hopes to throw some light on these conflicting arguments about technology in agricultural transformation. At the same time, attention will also be paid to understanding how irrigation policies and projects influence the livelihood strategies of farmers, and their agricultural productivity. While modernisation policies and modernised irrigation systems are the setting of this study, it is their outcomes in terms of dynamic changes in production and livelihoods that are the specific focus.

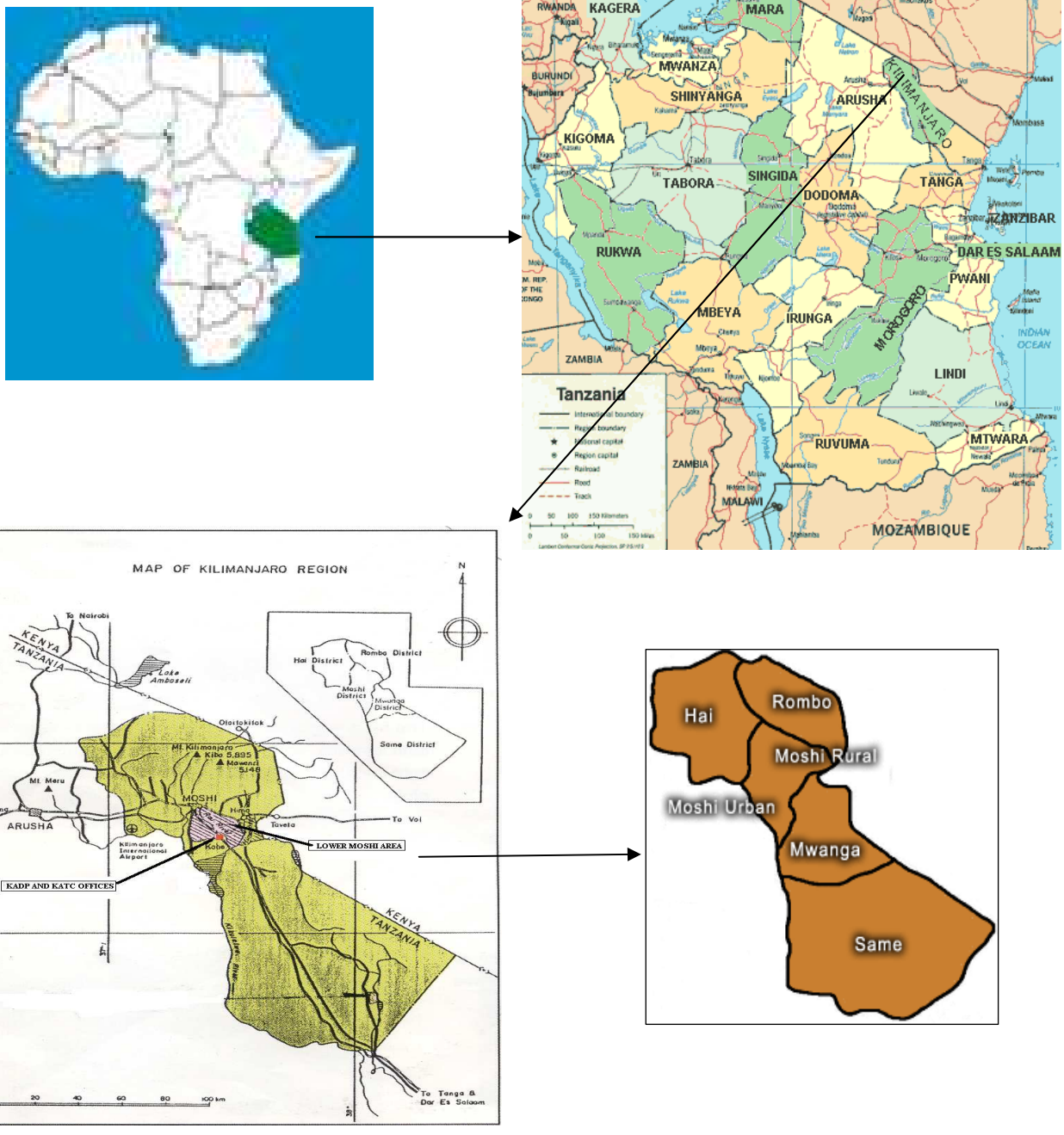
Detailed engineering studies of irrigation modernisation and political analysis of modernisation policies are beyond the scope of the thesis. The theoretical entry point for this study is the interface between modern technologies of land and water management and farmers in the system (especially women farmers). The central question aims to address how and why these technologies have shaped, and have been reshaped by, the livelihood needs and options of water users. The thesis analyses the interactions of actors at various levels – i.e. international, national, community and farm levels – in using and reshaping modern technologies, and the outcomes of these interactions. In general terms, this thesis is guided by the technographic approach, as described by Richards (2002, 2007) and Bolding (2005), while also drawing on socio-technical analyses of irrigation systems. A technographic approach 'focuses on the complex interactions between social groups, collective representations, innovation processes, and technical artefacts and nature' (Technology and Agrarian Development Group 2008).

The remainder of this chapter sets the framework for the study. It first gives an overview of the study areas (Section 1.2). It then (in Section 1.3) reviews debates on irrigation in Africa, followed by a Section (1.4) that provides a description of irrigation development in Tanzania, in order to set the scene for the problem analysis of the Lower Moshi system. Section 1.5 establishes the conceptual framework of the overall thesis. From these sections emerge the research questions presented in Section 1.6. The research methodology of the thesis is described in Section 1.7, and the chapter ends with an overview of the following chapters.

1.2 Background of the study area: the Lower Moshi irrigation scheme

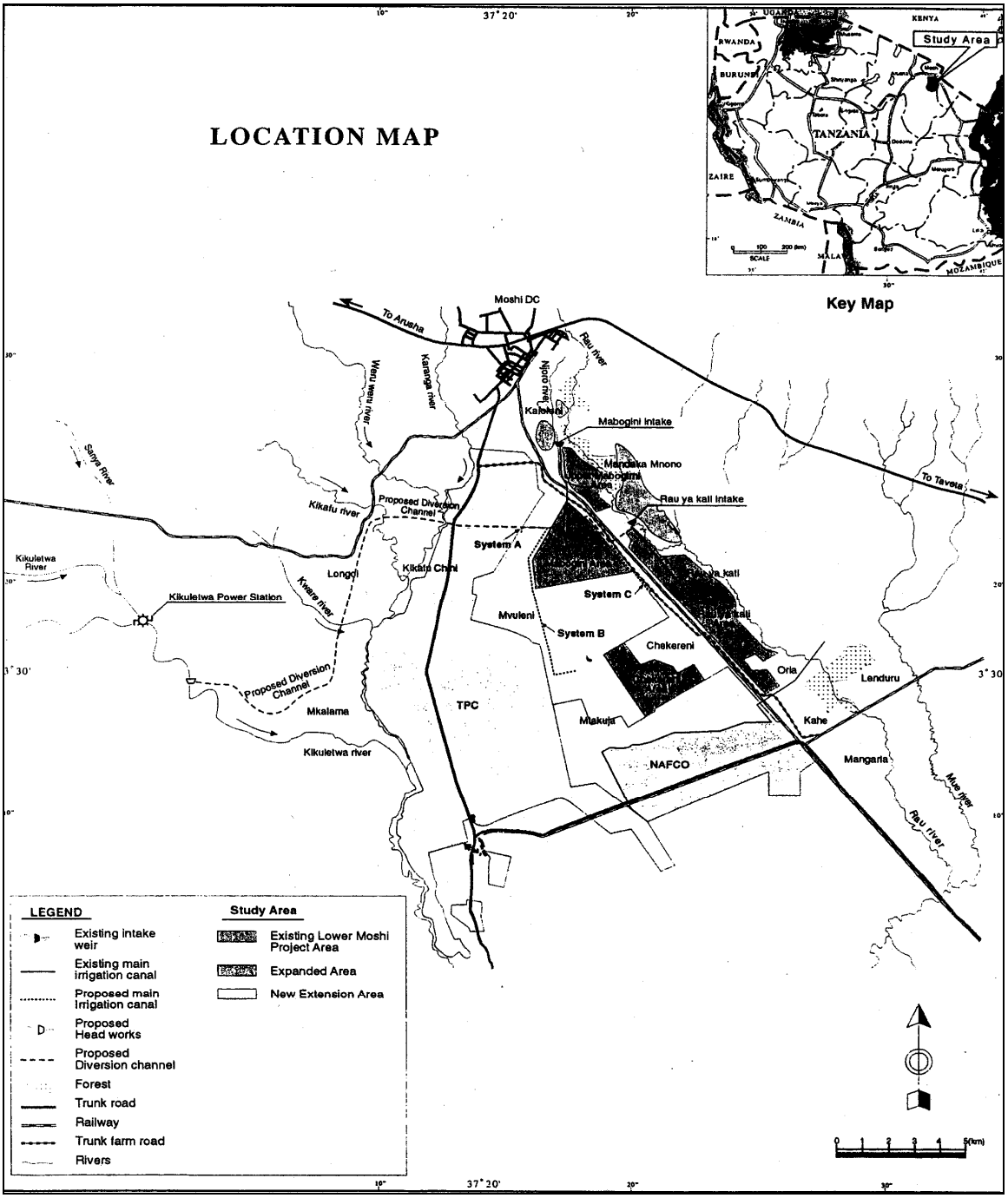
The Lower Moshi irrigation community, considered here as a multi-ethnic society, once practiced local (traditional) irrigation techniques before it was selected by the government and donor agencies for 'modern' irrigation development. The Lower Moshi area lies in the Kilimanjaro region of north-eastern mainland Tanzania, bordering Kenya to the north, the Arusha region to the west, and the Tanga region to the south-east. The region has six districts: Hai, Rombo, Same, Moshi Rural, Moshi Urban and Mwanga (Map 1.1). The Lower Moshi irrigation scheme is located in Moshi Rural, 6-20 km south west of Moshi town, the capital of the Kilimanjaro region of Tanzania. Administratively, Lower Moshi is divided into four villages, namely Mabogini, Chekereni, Rau and Oria. The extent of the local irrigation experience of farmers living in the Kilimanjaro region was revealed by Ikegami (1995) who found 45,100 ha of irrigated land within the Kilimanjaro region, i.e. about 28 percent of the arable land in the region (4 percent of the total arable land of Tanzania). In the Lower Moshi irrigation scheme, the project area consists of a relatively narrow strip of land developed on alluvial plains along the right bank of the Rau River. It is bound by the

Rau River on the east, the sugar plantation of Tanganyika Planting Company (TPC) on the west and north and by the National Agriculture and Food Cooperation Farms (NAFCO) on the southern side (Map 1.2). The rainfall distribution in the area is bimodal, with two distinct seasons (short and long rains): the short rains fall between



Map 1.1 Africa, Tanzania and Kilimanjaro region showing the site of the Lower Moshi Irrigation Project area

Source: JICA 1988 and TNW 2003



Map 1.2 Map of location of Lower Moshi irrigation scheme

Source: JICA 1980

November and February, and this less predictable rainfall season is called *vulli,* while the long rainy season (March and May) is locally termed *masika.* The dry season (*kiangazi)* falls in the period of June to mid-November or December. Mean temperatures range between 21ºC and 26ºC, and are suitable for irrigated paddy cultivation (JICA 1980). Improvements to traditional irrigation systems within the community were first attempted by the British government in the 1930s, so as to attract the Chagga people from the highlands to settle in the lowlands. Traditional irrigation systems were again improved after independence, especially when people

moved from various areas of the country to enter Ujamaa village settlements (late 1960s to early 1970s). In line with the vision of the Tanzanian government to improve irrigated agriculture through development interventions, the Tanzanian and Japanese governments (through the Japanese International Cooperation Agency (JICA) agreed to a plan in 1977 to modernise agricultural and infrastructural technologies within the scheme. The two governments had different levels of power, and different perceptions, needs, goals and experiences, which made it difficult to agree on the implementation of the modernisation of the irrigated rice scheme for farmers within the Lower Moshi community. Technical assistance from JICA was guided by policy and development discourses of Japan as a donor country As will be unfolded in the thesis, the Japanese experience in rice irrigation was considerable, but perhaps not suited to African conditions, while the Tanzanian government failed fully to anticipate what might be suited to local conditions.

The funding for the modernisation of irrigation systems and irrigated rice farming in Lower Moshi was through grant aid from Japan to Tanzania, and was part of a major Japanese aid programme within the country (Ikegami 1994). Before such projects were initiated, the government of Tanzania had started its second Five Year Plan (1969-1974), which sought national development through regional decentralisation coordinated by central government. It was through the plan that the modernisation of irrigation systems was interwoven with the local and national strategy for rural development. The major justification for the plan was to improve water productivity, to increase commercialised irrigated rice production, so as to improve national food security and rural livelihoods in general. The plan for modernisation of the irrigation system was triggered by food shortages in the country; at that time Tanzania was experiencing the first oil price shock and also a serious drought (1975-1978), and agriculture's contribution to GDP was low, averaging only 38 percent over the period 1974-1978 (Mascarenhas *et al*. 1985). Implementation of the Lower Moshi plan began in 1982, and the system started operating on a larger scale from 1987.

The modernisation project, which began during that time, was at first for the 'improvement' of infrastructure technologies of irrigation systems implemented through the private Japanese engineering company Nippon Koei. Out of the net potential irrigation area of approximately 6,320 ha in the four villages the new public irrigation system was designed to supply 2,300 ha (KADP and JICA 2001). The donors planned to use only 1,100 ha for rice production, reorganised into blocks of 0.3 ha plots; the other 1,200 ha was to be used for upland maize, which had to depend on rainfall and drainage water. Since the scheduled area was too small to be used by farmers from all villages, many villagers had to be excluded from irrigated rice farming. The processes of inclusion and exclusion from irrigated water established a dynamic central to the present study. The introduction of irrigated rice production was then followed by an exercise of partial devolution in irrigation management, in the process of which Water Users' Associations (WUAs) were adopted.

Thus the scheme experienced phases of contestation, stabilisation and readjustment, similar to what Bolding (2005) described in his technographic study of an irrigation system in Zimbabwe. Although the scheme has not (yet) received any further interventions consistent with contemporary definitions of modern irrigation technology (see Section 1.5), the term-modernised irrigation is used throughout this thesis as indicative of the scale of technical and managerial changes (upgrading) made when it was implemented. The Lower Moshi area had a low population

density, estimated at 92 people per km^2 in comparison with 500 people per km^2 in the highlands, before the scheme started (KATC 2000).

Population was increasing due to settlement in the lowlands, but the rate increased when the irrigation scheme was introduced. In 2002, the total number of people in the scheme was estimated to be 26,140, distributed across 3,749 households. This comprised 8,453 (32 percent) males and 8,583 (33 percent) females above the age of 35, 4,878 (19 percent) youth (15-35 years) and 4226 (16 percent) children (0-14 years of age) (see Table 1 in Appendix 2). The irrigated area has attracted many immigrants from different tribes, places and ages, seeking to acquire irrigable land, or to find waged employment, often as labourers. The settlements in the area resulted from four waves of immigrants, starting during the colonial periods (as will be discussed in Chapter 2). It was from such settlement processes that the present ethnically mixed society emerged.

Currently, the ethnic make-up is Chagga (57 percent), Pare (25 percent) and other tribes from various regions of Tanzania (18 percent) (see Table 2 in Appendix 2). In addition to local languages, *Kiswahili* is widely spoken, and this has influenced ethnic fusion within settlements, helping to form a new society. The various ethnic groups have intermarried, but since the Chagga were predominant in the area, their cultural and traditional beliefs, values, attitudes and ideas tend to strongly influence this new heterogeneous society. There are also more Christians (66 percent) than Moslems (34 percent) (see Table 2 in Appendix 2), stemming from the activities of European Christian missionaries, who settled in Kilimanjaro region during the colonial period. According to available figures (1, 863 farmers), the on-scheme irrigated rice farmers originate both from within (50.5 percent) and outside (49.5 percent) the Lower Moshi area (Table 1.4); farmers from outside Lower Moshi originate from Moshi town, neighbouring regions and even neighbouring countries (Kenya).

Government, private groups of people and individuals have invested in buildings and in operating public services. These investments include kindergartens, primary and secondary schools, health centres and milling facilities. There are also good village shopping centres, markets, guest houses, and various village level recreation centres; decent communications (road and transport) that make Moshi town easily accessible. The irrigated rice project invested in the improvement of roads and electricity, and in a post harvest centre (for rice milling and storage. There are offices for local government in each village, as well as for the Kilimanjaro Agricultural Development Project (KADP) and the Kilimanjaro Agricultural Training Centre (KATC), a facility with accommodation and classroom facilities for various courses in irrigated rice farming situated at Chekereni village. Most KADP and KATC employees reside in Moshi town, while others have accommodation in the KADP quarters or in private houses within the scheme.

1.3 Irrigation development in the broader African context

Irrigation has its origins in ancient times. Early civilisations developed along the banks of major rivers, e.g. in Egypt, Mesopotamia and parts of India and China. The definition of irrigation (Section 1.1) emphasises that this technology has a particular importance in increasing agricultural production and productivity. Irrigation is still seen to have the potential of social and economic development for poor countries, and thus for economic development and poverty alleviation. It is sometimes assumed that Africa (except Egypt) was historically lacking in irrigation. However,

literature shows that furrow irrigation was practised widely in Africa in pre-colonial times (Wyss 1990). Vincent (1994) notes, however, that irrigation has received special attention as a tool for economic and social change since the 2nd World war. Sub-Saharan Africa (of which Tanzania is a part) lies mainly in the tropics, and nearly 65 percent of all land is arid or semi-arid, thus this region has been targeted for irrigation development in recent times.

At present, the total cultivated area in Africa is estimated at 143.3 million ha, with about 12.2 million ha benefiting from irrigation (FAO 1995). While it is true that considerable potential still exists for future expansion of irrigation, it is also true that water is becoming scarcer in those regions where the need for irrigation is most acute. Recent concern over food security, especially in sub-Saharan Africa, has triggered wide debate on irrigation development as an important venture for countries regularly affected by low yields and crop failure. There is global evidence that irrigation has great potential in increasing agricultural productivity, in improving food security and in poverty reduction (FAO 1996; UNDP 1997; World Bank 1997). Irrigation is also seen as an important technology to ensure food security at local levels. According to FAO (1996), reliable sources of irrigation water in rural Africa, especially in arid and semi-arid areas are well known to reduce risks and stabilise production levels for individual farmers. When Chambers (1994) looked at irrigation and its contribution to poverty reduction and securing better livelihoods he argued that well implemented irrigation development is probably the single most promising direct means of reducing rural deprivation. With irrigation the poor can be provided with employment, income, better livelihoods and security against impoverishment.

Granted this irrigation-development mindset, massive efforts have been undertaken, including investments in projects within irrigation schemes and irrigation as part of programmes of river basin development. Approaches to irrigation development to improve the food situation in Africa have been undertaken by both national and international agencies. Following independence (in the 1960s in most African countries), developments undertaken by both national irrigation agencies and irrigation sections of international aid agencies have been important drivers of projects to increase agricultural production in rural areas.

Involvement by such agencies has varied from small-scale (traditional) to large-scale (modern) irrigation schemes. With the exception of the Nile Delta, large-scale irrigation was unknown in Africa until the 20th century. In contrast, small-scale irrigation has been practiced by local farmers in many varied forms, according to local circumstances from time immemorial (Underhill 1984). The involvement of development agencies has generally been through project schemes and programmes promoting different types of designs for water mobilisation (for example flood water cropping, stream diversion, water harvesting and lift irrigation), different forms of management and ownership of infrastructure (public or private, government or community or individual), and different levels of irrigation water control (in a trajectory from informal self-build to highly engineered structures). Depending on the agencies, many of these designs have been developed using a top down approach, and participatory, bottom-up approaches, to design and implementation have been in the minority. In the whole of sub-Saharan Africa, FAO (1986) estimated 'controlled' irrigation to be 5 million ha, divided into 52 percent modern large-scale systems and 48 percent predominantly traditional, small-scale systems. Many initiatives to irrigation development in Africa have been undertaken through national development plans; though failures have been frequent and irrigation development often negatively affected operations of existing small-scale irrigation

systems (Underhill 1984; Richards 1985). FAO, a major agent in irrigation development projects throughout sub-Saharan Africa, not excluding Tanzania (ID 1985), expressed disappointment on the overall performance of many irrigation projects, which were found to be caused by poor scheme conception, inadequate construction and implementation or ineffective management (FAO 1986)

Much of the concern with the poor performance of irrigation projects has, and with good reasons, focused on the ineffectiveness of large-scale irrigation projects (Moris *et al.* 1990), and not on traditional farmer-managed irrigation systems. Large-scale projects were often developed with major attention to hardware design and construction, but have paid much less attention to operation and maintenance. As stated by Adams (1990), the limited success of large-scale projects has resulted in the idea among development agencies that small-scale approaches to development are more effective in economic terms, less damaging environmentally, and more humane in terms of their impacts on participants. However the failure of large-scale projects does not provide evidence to conclude that small-scale projects are more successful.

Negative experiences of irrigation development

Experiences of irrigation development in Africa show that most public interventions in both small- and large-scale irrigation schemes have not produced intended results (Underhill 1984, 1990; Diemer and Vincent 1992; Rukuni 1995, 1997). A first reason for this failure has been the way national and international agencies tended to conceptualise irrigation development. The overall history of the development of irrigation schemes in Africa is one in which mainly state engineers attempted to modernise African agriculture (Chambers 1969). Government agencies understood development as a means to modernise peasant agricultural technology; replacing indigenous forms of irrigated agriculture was thus regarded as a marker of progress, irrespective of any evidence concerning how badly they functioned (Adams 1992; Diemer and Vincent 1992). At the same time, researchers began to observe and report major differences between indigenous farmer-managed irrigation schemes (as found in parts of eastern and western Africa) and modernised schemes, driven by state imperatives; the most striking examples of which are the Gezira scheme in Sudan (Barbour 1959; Barnett 1977), and the Office du Niger in Mali (Van Beusekom 2000). The issue here was the role and motivation of the state. Local irrigation schemes that had often been operating well changed for the worse when centralised government bureaucracies assumed control of management and operations. (Chambers and Moris 1973; Palmer Jones 1981, 1983; Moris 1987). This has widely been explained in terms of the agencies pursuing a vision of (export) market-oriented production with little concern for repercussions on the peasantry. Many irrigation schemes have experienced such adverse dynamics. Some examples include the Mwea irrigation scheme in Kenya (Hanger and Moris 1973; Kamau 2007), the Nyanyadzi scheme in Zimbabwe (Bolding 2004), and the Bwanje valley of Malawi (Veldwisch *et al.* forthcoming). Life for most farmers within these scheme was sometimes more difficult than for farmers living outside the scheme because of the imposition of bureaucratic controls. On-scheme farmers often, for example, suffered from unequal water distribution due to water abstraction by head-end farmers, and lived with mounting debts as a result of being able grow less than they once had produced. In some cases, farmers then suffered from food insecurity more than they had earlier in the scheme's history (Barnett 1977) due, for instance, to maintenance failures and reduction in water supply.

The present thesis will document similar experiences and dynamics in regard to the Lower Moshi irrigation scheme, while paying close attention to specific social consequences, especially for women. The second reason for failure has been poor planning, which includes failure to contextualise irrigation technology in terms of its local environment, specifically the physical and the social aspects. Part of this is because of a lack of knowledge about how the system is defined and used within its environment by local people, due to the fact that designers focus on technological models developed around quantitative approaches to hydrological and other physical data. Key social and cultural issues are nearly always missed. These include in particular gender tensions, labour constraints, cultural obstacles, agrarian institutional relations (especially land tenure) and awareness of what crops are considered as food by local people. According to Guijt and Thomson (1994), irrigation development interventions have taken on a social dynamic of their own, creating or disrupting certain relations of power among local and outside farmers, and between family members in households. They have also changed patterns of access to and control of vital resources, including land and water, ultimately altering the way those resources are managed and utilised within and between households. Such social impacts have been found to be very serious in some irrigation schemes, resulting in negative effect on equity and livelihoods.

Experiences of other schemes (in the Gambia, Kenya and Cameroon) have shown results comparable with what will be shown to be happening in Lower Moshi. Evidence from such schemes (Hanger and Moris 1973; Jones 1986; Carney 1988; Dey 1990) suggests that establishment of irrigation systems has a tendency to negatively affect entitlements, responsibilities and opportunities within households, with especially serious effects for women. This can be partly attributed to assumptions about the functioning of households that guided irrigation planning; the assumption that the head of a household is a male farmer, and the assumption that production, activities and products are shared equally within households. These assumptions do not apply in many situations. Uncertainty over security of tenure and sharing of proceeds may then tend to undermine commitment by household members to contribute labour to irrigation farming. Since most irrigated farms are owned by men, gender inequities at household level reduced women's time and willingness to work in irrigated farming, causing a negative effect on crop production.

In this way, irrigation developments, in Africa, have increased intra-household tensions and conflicts over the control of resources, labour and incomes, as project designers and managers often failed to recognise the reality of gender relations (Zwarteveen 1994). This failure to recognise existing gender relations, accompanied by a reallocation of land in the favour of men, simultaneously increased the amount of labour that women had to contribute to male-controlled farming enterprises. Two major case studies document the consequences. On the Jahally Pacharr Project in the Gambia, (Carney 1988; Dey 1990) allocation of land by elders of villages resulted in men assuming control of land traditionally controlled by women. Women then refused to contribute labour on men's field, as they did not control or benefit from the results. Husbands retaliated by not always automatically sharing the proceeds of irrigated agriculture with their wives and families. This shift in the balance of power between women and men led, in this instance, to the partial or complete withdrawal of women from irrigated farming. In a second case (Northern Cameroon), similar findings were reported (Jones 1986). Here farmers' interests were not sufficiently incorporated during planning, which, resulted in a failure to cultivate land. Intra-household conflicts and interests with regard to labour allocation, control of crops

and monetary rewards were left unresolved. Before the introduction of the scheme, women usually had their own farms where they could grow sorghum.

Their contribution to newly allocated men's rice plots was not obligatory, since they had to take care of their own farms, which were meant for family consumption. The labour in men's plots depended on women sacrificing care for their own subsistence farms in favour of male cash crops. This is the reason why women were reluctant to engage in this work until they were paid. Unsatisfactory payments led to withdrawal of women working on men's farms. This, as in the case of the Gambia resulted in poor productivity of irrigated plots. It will be shown later in this thesis that the situation is significantly different in the Lower Moshi case, where all plots are considered family plots, but where men usually work with cash crops while women's crops are intended for feeding, and women are obliged to work on both kinds of crops without compensation.

The earliest descriptions of the Mwea Irrigation scheme in Kenya by Hanger and Moris (1973) also brought out the failure to recognise differentials in the intra-household organisation of food production. Here, rain fed plots obtained from husbands at marriage – used by women both to grow food for family consumption and for cash sale – were changed to rice plots and came under the control of men. It was then difficult for women to use the harvest (rice) for food as it was now considered a cash crop. Women had to cultivate food crops outside the irrigation scheme, in order to have a harvest they could use for food and income. The additional plots outside the schemes increased their workload, since they now also had to contribute labour to rice plots belonging to men. Sometimes they had to engage in additional off-farm income generating activities to earn cash income, in order to feel secure and responsible enough to feed their families.

The third reason for failure is the tendency to design infrastructure according to 'engineering thinking', with low levels of cost recovery, poorly executed maintenance and subsequent poor operation of many irrigation schemes, resulting in low irrigation inefficiencies, poor water management (Gutierrez 2005) and low economic performance. The work of Wageningen University (1999) and Ubels and Horst (1993) focused on this problem of design processes for irrigation in Africa. Plans for schemes have often been executed from ready made designs expected to function in a foreign environment. Diemer and Vincent (1992), Adams (1992) and Ubels and Horst (1993) have all criticised such designs for being dominated by engineering thinking with a fixation on physical infrastructure and a failure to grasp social aspects. The problems of planning and design of irrigation systems (Cernea 1991; Galema 1993) left farmers unable to fully realise the planned potential of physical irrigation infrastructure. In this regard Boelens (1998) realised that developing small farmer managed irrigation systems entails an ongoing process of interaction among three main aspects critical to design: generation and reconfirmation of rights (norms), construction and rehabilitation of infrastructure, and creation and strengthening of organisations relevant to the maintenance of local norms. Usually farmers redesign the operational environment when they see new production options, through their capabilities to transform organisational and infrastructural dimensions, and overcome financial and transactional costs involved. Van Halsema (2002) developed the notion of the 'irrigation concept' to show the importance of understanding and defining infrastructure appropriate to local management systems, that could together reach the objectives of farmers as well as donors. However, imposition of too complex an infrastructure and organisational models based on performance ideals different from those of farmers will stall the transformation until farmers can re-appropriate the scheme and make it perform

according to their own criteria and coping capabilities (Levine 1980; Ambler 1993; Steenbergen 2002).

A recent study (Kamau 2007) of the Mwea irrigation scheme in Kenya adds an interesting new finding. The design of the scheme failed to benefit farmers within the scheme, as is well known (see above). But if Mwea had been fundamentally misconceived it would be ignored rather than imitated by adjacent farmers outside the scheme. But this was not Kamau's finding. In fact, farmers outside the scheme with access to informal water supply were adapting scheme technology (rice varieties and cultivation techniques) to their own needs. A sizeable area of so-called *jua kali* rice had been developed by these means. The scheme failed to reach its objectives due to lack of understanding and implementation of a suitable design of infrastructure for the farmers. Kamau suggests, however, that the scheme might learn from the innovation practices of farmers operating outside its limits.

The fourth reason for problems with formal schemes has been the lack of institutional understanding over farmers' water rights and gender relations in irrigation management. Irrigation has often been centrally directed, or farmers have been made to adopt irrigation management reforms (IMR) in a bureaucratic interest. This has been a main obstacle in the attempt to improve management performance of irrigation systems (Repetto 1986; Moore 1989; Svendsen 1993; Zawe 2006). Water rights normally are linked to rights to land, access to infrastructure and a right to participate in decision-making. Studies in some irrigation schemes such as in the Mahaweli in Sri Lanka (Schrijvers 1986), and in West Africa (Jones 1986; Carney 1988) have shown that land was the criterion for claiming a water right, such that water was only given to men who owned land. In some cases participation in construction of infrastructure gives rights to water. Water rights can also be expressed in terms of how much, when and for what crops, water may be used by a particular group of people. Even when water rights are awarded, poor women and men may encounter considerable problems in water delivery, such as not getting it in time or having to rely upon (inconvenient) night turns. Such problems of water allocation and delivery are usually contributed to by power differences reflecting socio-economic, gender and cultural factors (Beccar *et al.* 2002). A study by Gillingham (1997) in the Kilimanjaro region in Tanzania revealed this type of problem, viz. that women were sometimes given night turns and therefore failed to irrigate, and thereby suffering reduced crop production.

The success of irrigation development in raising agricultural productivity also depends on better use of water resource. The rights to use water (its distribution, allocation and proper management) are a function of management organisation and water user representation at various levels (Bos *et al*. 1993; URT 2002). Such levels include the state, where the irrigation sector engages in policy making and planning within ministries, and supported by agencies allocating and managing goods and services in support of the farmer community. Within a community, an irrigation system is managed by an organisation, i.e. a WUA, which is responsible for allocating and distributing of water to the plots of stakeholders. The stakeholders are usually members of farm households, but can also be farmers who are not within the community (JICA 1987). In many societies, processes of acquiring, allocating, distributing and draining the water appear to be strictly male activities (Zwarteveen 1994). This is often justified in terms of the supposed physical strength of men, or their familiarity with technical activities. Women may have water use rights, but they are mostly excluded from the boards of water users' organisations governing the collective water source (Meinzen-Dick and Zwarteveen 1998). Attempts to increase the involvement of women in irrigation projects have shown that their low

involvement is due to norms and perceptions of professionals, and male and female water users, rather than to any obstacle in actual practice.

Women and men themselves may also deny female involvement in irrigation. A study in an irrigation scheme in Kenya (Hulsebosch and Ombara 1995) revealed that the absence of women from the WUA led to poor management. Here, representation and participation of women in the management scheme was the only way to secure their interests and needs, which were sometimes different from those of male water users. Their differences may be with respect to agricultural production responsibilities, which reflect water allocation, labour duties and even land holding. In the same vein, Zwarteveen and Neupane (1996) in their study of the Chhattis Mauja Irrigation scheme have argued the importance of incorporating women as farmers in water users' organisations. In their study, they indicated that although the overall scheme performance did not suffer from lack of user participation, problems of free riding and labour mobilisation in the head end were directly linked to the absence of women in the management of the scheme. These problems created performance weaknesses which in the long run could threaten the sustainability of the whole irrigation system. Studies by van Koppen (1990, 1998, 2000) and Zwarteveen and Neupane (1997) emphasise that women are not only farmers but also irrigators, despite the fact that there are often strong gender differentials in participation in water users' organisations and in access to productive resources (including water).

1.4 Traditional irrigation and public irrigation development in Tanzania

This section provides an overview of the history of traditional irrigation and formal public development within Tanzania. The aim of the section is to relate the country's development with that of other African countries, which will lay a foundation for the study in Lower Moshi irrigation scheme. The general picture painted for Africa applies in several aspects, but differs in degrees for Tanzania. Two phases of irrigation development are discussed: the traditional and the improved systems for agricultural production. A description of the historical trends in Tanzania will cover how irrigation development has been viewed by different actors, and through specific policies and laws that have interacted to influence incentives for irrigation programs aiming to improve livelihoods of the population.

Pre-colonial traditional irrigation

During pre-colonial periods farmers used various forms of traditional irrigation systems, varying according to geographical area and tribe within Tanzania. All farmers used the systems for cultivating subsistence crops. Individual German missionaries first introduced irrigated cash crops, while the Arabs introduced rice during the era of the slave trade. Historical tales and archival documentation indicate that traditional irrigation in Tanzania operated for a long time prior to colonialism, perhaps even dating back to the Old Stone Age. More furrows were definitely established during the centuries prior to colonialism (Kimambo 1969; Masao 1974; Mashauri 1985; Yoshida 1985; Fungameza 1992; Grove 1993; Sheridan 2002; Tagseth 2002; Mvungi *et al*. 2004). During the time when Harry Johnston went on an expedition to the Kilimanjaro in the early 1880s, he noted with interest how the

mountain people of the Chagga tribe, irrigated their hillsides by tiny canals (furrows) of water diverted from the main stream (Ogutu 1972).

Johnson's observations reveal that the Chagga possessed considerable skills and experience in agriculture that proved useful even for other crops like coffee, which was introduced later. The systems were said to flourish during pre- and colonial periods partly because the furrows were owned and managed by tribal lineages. During this time, irrigation was based on gravity, using simple unlined canals to convey water from up-hill sources (normally rivers). Diversion structures or small dams were erected from large rocks strengthened with branches and mud in order to control the water flow (Adams *et al*. 1994). The crops cultivated depended on environment and local cultural preferences. Mixed cropping of home gardens (*vihamba*), for example, was a feature of the wa-Chagga (Moore and Purrit 1977; Okting'ati and Mongi 1983; Fernandes *et al*. 1984; Moore 1986). Coffee was introduced in Kilema mission sometime in the 1890s (Grove 1993), but became common all over the mountain after the Kilimanjaro Native Planters Association was established. In the Kilimanjaro region local people grew coffee in the highlands while maize; bananas were also grown in the lowlands.

There have been many accounts of indigenous pre-colonial irrigation practices throughout the whole of East Africa as reported by archaeologists (for a review see Anderson and Adams 1988). It has for instance been proved that irrigation activities were undertaken in West Kilimanjaro by the Enkangaruka people before the 1930s (Sasson 1967; Fosbrooke 1938; Sutton 1990). This group cultivated various types of crops, such as maize, bananas and vegetables for food. Gray (1963) offered a detailed account of irrigation in Kheri village, as practised by the Sonjo people, and also refers to traditional irrigation practices in the Pare and Kilimanjaro mountain systems (see also Sheridan 2002). The Shambaa people, who live in the Usambara Mountains, also have a long history of using extensive hill furrow irrigation systems to facilitate banana production in particular, although other crops like maize and vegetables were also grown (Feierman 1968). Traditional irrigation was also common for irrigated rice among the Wanyamwezi of the Kahama in Tabora region, the Wasangu of Usangu, the Wanyakyusa of Mbeya and the Wabena of Iringa in the southern part of Tanzania. It was the Arabs who introduced irrigated rice in these areas during the era of the slave trade (Burra and Van den Heuvel 1987). Subsistence farming of irrigated maize was common among the Wamatengo of Mbinga district in Songea region in the southern part of Tanzania. Other parts of Tanzania, such as Morogoro, also have a long history of subsistence-irrigated agriculture, but these areas remain to be documented. Most of these traditional systems survived until the German missionaries came to make settlements in parts of Tanzania – including the Kilimanjaro region, Usambara Mountains, Mbinga district and the southern highlands, in Mbeya, Njombe and Tukuyu. It was during their time in Tanzania that they introduced cash crops like coffee and tea, and applied irrigation to these export crops. Introduced irrigation techniques were developed or improved by colonial governments and commercial crop production became more widespread.

Irrigation during the colonial period: 1900-1961

Improved and 'modern' irrigated agriculture in Tanzania began in the 19th Century, during the era of German colonialism. During the colonial period the economy was organised to export tropical agricultural products to the metropolis, to yield the revenues to pay for colonial administration (Bernstein and Woodhouse 2001). The colonialists introduced new crops and improved the irrigation systems in area where

there were successful traditional irrigation systems. They also introduced irrigation schemes where commercial crops were to be cultivated in large quantities for export. During the German period (1900-1918), settlers introduced significant changes in a number of farming systems through the introduction of coffee and tea. For example, in 1904 tea was introduced into the Southern highlands of Tanzania (Mufindi, Njombe and Tukuyu) and in 1926, commercial irrigated production (using drip feed) was introduced (Carr *et al.* 1988). In the British period (1918-1961), the government was not impressed with Chagga land management practices on the slopes of Kilimanjaro. It was argued that the Chagga cultivation system caused soil erosion, and that protection measures were required. This led to the introduction of a series of unpopular measure to protect the mountain catchment areas. In order to conserve the mountain environment the British colonial government increasingly encouraged the Chagga to settle down in the plains. However, such requests were unpopular due to the harsh (semi-arid) climate in Lower Moshi. The majority of the Chagga refused to move. Later the colonial government began to realise the importance of irrigated agriculture, and the danger of upsetting such a densely populated and influential area. In 1923 the government prohibited the hill furrow constructions because African and European settlers downstream were experiencing shortages of water (Gray 1963). So, from the mid 1930s the colonial government involved itself in furrow construction and improvement projects in an attempt to minimise water shortages in the lowlands where there were White settlers (Burra and Van den Heuvel 1987). The Europeans drove out the warring Maasai who used to be a threat to the Chagga and went further into the lowlands. They also ensured that as land use was extended down below 900 m, large areas of the bush were cleared to eradicate the tsetse flies threatening livestock and people with trypanosomiasis infections. The settlement of the Europeans in the lowlands, therefore, marked the end of Wa-Chagga isolation in the highlands.

There were German missionary settlements in the Usangu where small furrows were built to provide domestic water to the mission station and to irrigate vegetable gardens. Thereafter the Baluchis (from Baluchistan) arrived in Usangu in 1920s and introduced paddy irrigation in the 1940s (SMUWC 2001). They came to Tanzania as traders and decided to settle. The practice spread rapidly among local farmers. The Baluchis still currently operate several large, family paddy farms, with their own furrows. They apply relatively improved crop and irrigation management practices, and are renowned as traders in the Usangu area.

Apart from local individual irrigation systems, some government irrigation schemes were established for the purpose of large-scale export and commercial production. Investment in formal irrigation development started in the 1930s, with support for private colonial estates (ID 1985; Carter 1989). The Tanganyika Planting Company established an irrigated sugar estate near Moshi in Kilimanjaro region that by 1960 covered 7,500 acres and employed 3,000 labourers (Mascarenhas *et al.* 1985). The colonial government also became more involved in irrigated agriculture after the Second World War, e.g. establishing a 1000 ha rice farm at Kilangali, Morogoro in 1948. During the 1950s more attention (in irrigation activities) was paid to the native (i.e. Tanganyikans, which are now called Tanzanians) farmers. A Water Development Division was formed under the Ministry of Agriculture and a small holder advisory service established. The service was directed towards improving traditional or indigenous irrigation systems in Kilimanjaro, Meru, Usambara, Sumbawanga, Tukuyu, Kasulu, Dabaga, Kyela, Korogwe, Usangu Plainsetc (ID 1985). From 1955, a number of minor construction works were carried out on the existing furrows, and flood control and storage dams were built (ID 1985). In 1958

the colonial government observed that the whole of East Africa was characterised by unreliability of rainfall, which was a constraint to agricultural production, and recommended a change from the Water Development Division to the formation of a Water Development (WD) and an Irrigation Division (ID) (Mascarenhas *et al.* 1985), which was responsible for irrigation development activities.

After independence: 1961-1979

The post independence government under the late President Mwalimu Julius K. Nyerere[1] gave priority to development of 'modern village irrigation schemes' (Nyerere 1967). This policy became even stronger after the 1967 Arusha Declaration[2] (Nationalisation), and the Ujamaa Villagization[3] process in the early 1970s. During the period 1965-1973 a total of some 5,650 ha of irrigation schemes were developed, with a variety of control structures and water provided through pumps or gravity (Mascarenhas *et al.* 1985). Many such systems were transferred to villages and ran into problems of mismanagement and misuse, being rehabilitated later, through the Ministry of Agriculture and Water Development. The development was slow because of a lack of trained engineers, agronomists, and other field staff, and because of rising costs. After 1973, the improvement of traditional irrigation systems was highlighted, as a means to meet the food needs of the people. Improvement and expansion of irrigation development was then established in most regions in Tanzania from 1975, funded through loans and grants from various donor agencies and non-governmental organisations (Mascarenhas *et al.* 1985). In such schemes, the type of crop to be cultivated was usually determined by the government or donor agency. The Tanzanian government was in charge of the operation and maintenance of existing irrigation schemes until it agreed to Structural Adjustment Policies (SAPs) in 1980s, at which point responsibility was devolved to WUAs within communities (Mascarenhas *et al.* 1985; Speelman 1990). The farmers themselves were thereafter expected to be responsible for care of the systems through monetary and labour contributions towards operations and maintenance.

Irrigation development for improving agricultural productivity in Tanzania was first considered a national priority following the food crisis of 1974-1975 (Mascarenhas *et al.* 1985). As a result of this, the irrigation development programme was established under the Irrigation Division of the Ministry of Agriculture and Cooperatives (MOAC). It proposed the improvement of traditional irrigation systems, believed to be incapable of meeting the needs of the irrigators (farmers) themselves and the nation at large without modernisation. Following the decentralisation in 1975 the responsibility for small-scale irrigation projects was placed under the Regional Administration, and a small-scale irrigation unit under the Regional Agricultural Development Officer was established (ID 1985). The

[1] Tanganyika became independent on 9 December 1961, and Julius Nyerere became its first prime minister. In December 1962, Tanganyika became a republic within the British Commonwealth of Nations, and Nyerere was made president. On 26 April 1964 - shortly after a Leftist revolution in newly independent Zanzibar - Tanganyika and Zanzibar merged to form Tanzania; Nyerere became the new country's first president.

[2] The Arusha Declaration (1967) was a major policy statement calling for egalitarianism, socialism, and self-reliance. It promised a decentralised government and a program of rural development called *ujamaa* ('pulling together') that involved the creation of cooperative farm villages.

[3] Ujamaa Villagization was a policy pursued throughout Tanzania between 1968 and 1973. The policy involved the establishment of nucleated villages and cooperative enterprises.

responsibility for development of new large-scale and 'green field' systems remained in the hands of the national irrigation department.

The role of irrigation and development interventions: 1980-2007

From the 1980s until now, irrigation development interventions for crop production have remained important in the country. The main reason is that agriculture is the backbone of the economy and rural livelihoods (49 percent of GDP in 1998, and 56 percent in 2000) while much of Tanzania is subject to unreliable rainfall. Agriculture provides work for 14.7 million people or 79 percent of the total economically active population. 54 percent of all agricultural workers are female (TNW 2003). A great deal of poverty is found in rural areas, where the majority of the population continues to earn a living from unreliable rain fed subsistence farming, animal husbandry and related activities; output is often not enough for household needs. The rural areas have absorbed 84 percent of a fast growing population; 12.4 million in 1967 to 37.7 million in 2003 (National Bureau of Statistics 2002; TNW 2003). The main food crops are maize, sorghum, millet, paddy, wheat, sweet and Irish potatoes, cassava, pulses and bananas. Maize is the dominant crop, planted on over 1.5 million ha, followed by paddy (rice) with more than 0.5 million ha (TNW 2003). The greater area of Tanzania has diverse climates, ranging from tropical in the coastal zones to temperate in the highlands, but about one third of the total is arid or semi arid, receiving less than 800 mm of rainfall per year (FAO 1995). Although most of the country has a bimodal rainfall pattern, rainfall has been very unpredictable since 1974, with droughts occurring almost after every two years, sometimes worsening to a point where many families had extremely low production. In connection to this problem, the government laid out approaches to water resources development so as to:

1. Satisfy subsistence requirements in many parts of the country, and thus increase food security at community and household level.
2. Generate local surpluses of main staples, particularly rice in order to achieve (national) food security
3. Ensure the production of much needed dietary supplements such as vegetables, fruits and pulses.

Given these basic aims, the irrigation sector developed a strategy under the National Irrigation Development Plan (NIDP), the planning and coordination framework. The decision to implement irrigation development interventions to solve the problems of food insecurity and poverty reflects the long experience of both government and farmers in irrigation activities. The country has a total irrigation development potential of 29.4 million ha at various productivity levels. The irrigation potential is estimated at 7.8 percent, 16.3 percent and 75.9 percent of high, medium and low potential respectively. The area under formal public irrigation currently is estimated to be only 7.7 percent [4] (JICA and MAFS 2003).

Common types of irrigation systems in Tanzania include surface irrigation, conventional sprinkler irrigation and drip irrigation, with surface irrigation methods most commonly used among smallholder farmers. Surface irrigation supplied from direct river diversion is commonly practiced in Tanzania (60 percent), with

[4] The irrigation potential is estimated at 2.3 million, 4.8 million and 22.3 million ha of high, medium and low potential respectively. The area under formal public irrigation currently is estimated to be only 227,486 ha.

distribution of water by lined or unlined canals. The surface category is mostly found in Arusha, Iringa, Kigoma, Kilimanjaro, Lindi, Mara, Mbeya, Morogoro, Mtwara, Rukwa, Ruvuma and Tanga regions (see Map 1.1).

However, also included in this 'surface' category are water harvesting and flood recession water control methods, which although informal, are still considered surface irrigation methods. The furrows and basins widely used in water harvesting[5] (capturing floods from seasonal rivers via bunds, dams or flood diversion for gravity) is common in Dodoma, Tabora, Singida, Mwanza, and Shinyanga regions, overall accounting for 30 percent. Pumping is used in coastal regions such as Mwanza, Mara and Dar-es-Salaam (accounting for 10 percent). Conventional sprinkler irrigation is widely used by large-scale commercial farmers (both government-owned and private). For example, about 19 percent of Tanzania's total tea area is irrigated by overhead sprinklers (mostly hand-moved) systems, (Mizambwa 2002). The conventional sprinkler irrigation system is not common among smallholder farmers, as these have many mechanical parts potentially subject to breakage or loss. Commercial farmers in the sugarcane, tea and coffee estates, horticultural and floricultural farms, use sprinkler methods. Although drip irrigation is widely used on coffee or tea, this is rare in Tanzania. Recently a new drip irrigation system has been introduced in commercial tea production in the Southern highlands and is in the process of replacing the traditional overhead sprinklers (Möller and Weatherhead 2007). Since it is considered affordable by small farmers, the Arid Lands Information Network in Eastern Africa (ALIN-EA) has started introducing it in other parts of Tanzania (ALIN-EA 2002). Irrigation water on the Tanzania mainland is predominantly surface water; groundwater is utilised on only 0.2 percent of irrigated areas.

The greatest expansion of irrigated rice took place in the late 1980s, after Tanzania adopted a policy of trade liberalisation, and when a number of private traders began to operate in food grains. During the 1980s, it was clear that the economic policies set out by the Arusha Declaration had failed. The economy continued to deteriorate under cycles of alternating floods and droughts, which reduced agricultural production and exports. The establishment of commercial public irrigation schemes, like the large-scale[6] Mbarali and Kapunga schemes, and various smallholder schemes, such as those at Majengo, Kimani and Motombaya, attracted immigrant farmers from highland regions, and northern and central Tanzania (Mbonile *et al*. 1997). This led to further expansion of the area under rice production. Although the government was responsible for developing medium and large irrigation schemes (under the Irrigation Division), at that time it had no capacity to reach lower levels such as the districts. In order to reach these lower levels, Zonal Irrigation Units (ZIU) were established under the national Irrigation Department in 1986.

In the 1980s, the National Village Irrigation Development Programme (NVIDP) was initiated to promote irrigated agriculture at village level (MALD 1990). Some small-scale irrigation schemes had started operating as government programmes prior to 1980, and these became a focus for enlargement and improvement. The crops in small-scale irrigation intervention schemes were (and remain) mainly rice and maize. Such intervention schemes included the Usangu Village Irrigation Project

[5] This is a process whereby rainfall is concentrated or captured as runoff from a large area and collected for use in a smaller target area. Water application is essentially uncontrolled and dependent on rainfall.

[6] Large-scale irrigation schemes in Tanzania are formal irrigation schemes developed from public investments and managed through agencies. Schemes considered large-scale are those of more than 1000 ha.

(UVIP) of 1985-1996 in the Mbeya region (UVIP 1993), funded and implemented with UNDP/FAO assistance. It aimed to upgrade six indigenous furrows, but work was completed in only three of them.

Other interventions were the Women Irrigation Association (WIA) in Mbeya, the Mkindo smallholder scheme in Morogoro region and the Malolo scheme at Iringa, Dodoma and Morogoro regions, which were rehabilitated by the Dutch Development Organisation (SNV 1995). In all the three projects, rice was cultivated by smallholder farmers. Other irrigation improvement programmes funded by various donors, included:

- The Kapunga Irrigation project, funded by DANIDA (1998), was implemented in 1988-1992. This project had three components: the building of a parastatal farm, the building of a smallholder scheme and improving the existing smallholder irrigation systems by abstracting water from four intakes on the Chimala River.
- The Kimani irrigation project (KIP), 1991-1994 (WER 1993) was funded by the Canadian International Development Agency (CIDA). It planned to upgrade 4300 ha of irrigated agriculture, of which only 500 ha was completed.
- The Smallholder Irrigation Improvement Component (SIIC), 1997-2001, a part of the World Bank-funded River Basin Management and Smallholder Irrigation Improvement Programme (RBMSIIP). Under this programme, up to two indigenous furrows were upgraded.
- Finally, the Lower Moshi Irrigation Project in Kilimanjaro region (the subject of this thesis). This was 'improved' by JICA over the period 1983-1987 (KATC 2000).

The major aim of all these programmes was to improve agricultural production by increasing yields of maize or rice and to increase the efficiency of water use. Improvement involved both infrastructure and organisation. In all schemes, although average yields increased, designs had serious negative impact on downstream users, especially during dry season. There were also complaints about unequal benefit distribution between male and female farmers (Mwaipopo 1994; Mhina and Sekwao 1994; SIDA 1994; SNV 1995).`

Table 1.1 Estimates of irrigated areas developed in 1982 based on FAO 1986 – Tanzania

Irrigation Potential (x 1,000 ha)	Modern	Small-scale or traditional	Total	Developed as % of potential
2,300	25	115	140	6

Source: FAO 1986

At the time of the Traditional Irrigation Project (TIPs) inventory study in 1986-1987, the involvement of the government in traditional irrigation remained small, and as shown in Table 1.1, the traditional sector still accounted for a massive 80 percent of the actual irrigated area in Tanzania (FAO 1986). Over time, government support for irrigation development shifted in focus. Table 1.2 shows a trend from a focus on private colonial estates and small-scale farmer irrigation[7], to modern public schemes. After the failure of these large modern schemes, from the 1990s onwards,

[7] Small-scale farmer, village and smallholder irrigation schemes are those managed exclusively by farmers.

the government started recognising the importance of farmer-managed traditional irrigation systems.

With this recognition came a shift towards upgrading of traditional irrigation systems, but this also had implications for schemes transformed earlier under public intervention, since it led to a new focus on institutional development.

Table 1.2 Tanzanian government support to irrigation development activities 1930s-1990s

Year	Type of system development
1930s	Private colonial estates
1950s	Small- farmer irrigation
1960s	Modern irrigation schemes
1970s	Village and large-scale schemes
1980s	Small-holder and large-scale schemes
1990s	Traditional irrigation schemes

Source: ID 1985; Mascarenhas et al. 1985; Carter 1989

The mechanism by which the country's irrigation potential could be developed was outlined in the National Irrigation Development Plan (NIDP), prepared in 1994 and aimed at stabilizing and increasing food production (URT 1994b). Having seen the poor performance of larger schemes, three kinds of interventions were envisaged and prioritised (ASPS 2000; JICA 2001; Kalinga *et al.* 2001):

1. Rehabilitation or upgrading of traditional irrigation schemes (156 of them)[8]
2. Upgrading of water harvesting technology where irrigation was not possible (this is applicable especially to marginal areas)[9]
3. Development of new smallholder schemes, where demand exists and conditions are appropriate[10]

As indicated in the updated NIDP (Kalinga *et al.* 2001), the government of Tanzania has emphasized only priority (1) and (2), and allowed private sector involvement in irrigation either through privatising existing irrigated state farms (NAFCO) or through construction of new irrigation schemes. Also a new National Irrigation Master Plan (NIMP) (JICA 2001) was formulated in 2002, when the government of Tanzania asked Japanese help in reviewing existing policies and lessons learned in order to establish new processes for irrigation development.

Policies toward irrigation development

Over time, a number of policies have directly and indirectly played an important role in irrigation development within the country. Both the 1983 and 1997 National Agricultural Policy statements put a stronger emphasis on the importance of irrigation for increasing agricultural productivity and ensuring food security (URT and MOA 1983, 1993; URT and MACD 1997). The National Irrigation Development

[8] This will help to increase water use efficiency. In this aspect improved river basin water management was seen to be central in this upgrading.

[9] The advantage is that producers need only to be provided with appropriate technology. This means, a minimum technical intervention using simple flood management is required. Infrastructure is required simply to divert flood peaks from rivers into fields. Such technology is simple and cheap and involves little operational sophistication. It is practiced in the central regions of Tanzania.

[10] In this aspect farmers are required to be sensitised and organised into workable Water Users Associations (WUAs). Having achieved this target, construction of a new scheme can commence.

Plan (1994-2014) and the National Irrigation Policy (1994b) documents laid down the strategy for achieving these developments. The NIDP aimed at stability in crop production and increase of food output through developments of irrigation activities. However, improvement of irrigation systems was still focused mainly on physical infrastructure development (engineering works). Less attention was given to agronomic skills and practices, and to social-economic and ecological issues. This preoccupation with large-scale projects was later recognised. The new Agricultural Policy of 1997 (URT 1997c and MACD 1997) admitted that older irrigation plans were irrelevant to smallholder farmers, and that improvements were needed. Although the country at that time lacked a specific Irrigation Policy, irrigation development issues were addressed in a number of related development policies, such as national agricultural, land, and water policies. Ministries of Agriculture and Land and Human Settlements (URT 1983, 1993, 1995, 1997a, 1997b) have addressed irrigation plans, issues and activities for development (URT and MAFS 2004). For example, the Water Policy statements of 1997 and 2002 (URT 1997cand MACD 1997, 2002b) consider giving irrigation water some priority because it provides food for the community.

Table 1.3 Policies relevant to irrigation development

Policies	Major objectives related to agricultural/irrigation development
Tanzania Development vision 2025 started in 2000	Food self-sufficiency and food security are articulated as top goal of the first attribute, high quality livelihood
Tanzania Assistance strategy (TAS) given in 2000	Management of external resources to achieve the development strategies.
National Poverty Eradication Strategy (NPES) in 1998	Encouragement of increased investment in smallholder irrigation systems
Poverty reduction Strategy paper, 2000	Development of irrigated farming by communities under support of the government
Rural Development Strategy (RDS) in 2001	Promotion of profitable irrigation infrastructure
Agricultural Sector Development Strategy (ASDS) in 2002	Encouragement of farmers towards integrated soil and water management by sub-soiling water harvesting, and by use of appropriate husbandry practices to promote optimum use of water resources. Formulation of National Irrigation Master Plan
Agricultural Sector Development Programme (ASDP) in 2003	Reduction of overdependence on rain fed agriculture through rehabilitation and management of low-cost smallholder irrigation schemes including rain water harvesting, to reduce fluctuation in production.

Source: Chiza 2005

In this case both the Ministry of Agriculture and Food security (MAFS) and Ministry of Water and Livestock Development (MWLD) have developed relevant programmes, while the government facilitated implementation through provision of technical advice towards these goals (URT and MAFS 2004) . Irrigation was also addressed in other policy documents (see Table 1.3), such as those of the National Poverty Eradication Strategy (URT 1998), the Tanzania Development Vision (URT 2000a), the Poverty Reduction Strategy Paper (URT 2000b), the Tanzania Assistance Strategy (URT 2000c), the Agricultural Sector Development Strategy (URT 2002a), the

Agricultural Sector Development Programme (URT 2003) and the Rural Development Strategy Paper (URT 2001). Such documents, as shown in Table 1.3, convey messages that the government takes a lead in interventionist role in irrigation development.

Land and water policies (URT and MLHS 1997; URT 2002b) and associated laws (URT 1974, 1981, 1994a, 1999a, 1999b) are considered intrinsically important in irrigation, because they define resource access, and are thus the backbone of the total irrigation development process. On the one hand, the Land Policy of 1997 (URT 1997 and MLHS 1997) sees land use practices in terms of village land use and settlement planning, but also encompasses concern that these might be threats to basin/catchments land and water management approaches. The National Land Policy in Tanzania stipulates that all lands in Tanzania belong to the Republic and are vested in the President as the trustee for, and on behalf of, all citizens. People cannot own land privately, but instead can obtain the right to use and occupy land through a system that assigns a right of occupancy, granted by the government. The policy is also responsible to ensure that irrigation interventions do not cause damage to the environment or cause land degradation (URT and MLHS 1997). The National Land Policy was designed to promote and ensure security of tenure for all citizens. Specific objectives of the Land Policy include providing equitable access to land, while ensuring that customary land rights are recognised, clarified and secured, and protecting land resources. The policy recognises that customary laws tend to discriminate against women and stipulates that every citizen shall have equal and equitable access to land:

> *In order to ensure and guarantee women access to land and security of tenure, women will be entitled to acquire land on their own right, not only through purchase, but also through allocation. However, inheritance of clan land will continue to be governed by customs and traditions provided such customs and traditions is [sic.] not contrary to the constitution and is not repugnant to principle of natural justice. (URT and MHLS 1997: 13)*

Although made clear in the Land Policy, the actual implementation with regard to women's right to land is still limited, as most land in rural areas is controlled by men who have already occupied it. Moreover, acquiring land through allocation is difficult for rural women because most of them are unable to pay the costs involved in acquiring a formal land right.

The Water Policy of 2002 (URT 2002b) forms a basis for the institutional framework to ensure sustainable development and management of water resources and participatory agreements on the allocation of water. Water is a basic resource meeting various social and economic needs, especially agricultural livelihoods for populations in rural areas. So the policy has also its laws regulating rights and management of irrigation, at national, basin, community and individual levels, to make sure water is properly utilised. The major statutory water management instrument is the Water Utilization (Control and Regulation) Act No 42 of 1974 (URT 1974); this regulates water management through various institutions at all levels. Central statements of the Water Policy 2002 are that 'water will be subject to social, economic and environmental 'criteria' and that 'every water use permit shall be issued for a specific duration'. This could mean that irrigation might have to compete with the industrial sector, and that irrigation water supply might not be guaranteed in perpetuity, should as yet unforeseen competition arise.

Responsibility for water management

The responsibility for managing water resources, which used to be with the Ministry of Water and Livestock Development (MWLD, 1990), is now with the new Ministry of Water and Irrigation (Mtanzania, 2008). The Tanzanian water policy (URT 2002b), among other things, encourages water management approaches and economic incentives which facilitate productive water use. It stresses the importance of water in producing high value crops to increase productivity of irrigation water. It also works hand in hand with the Agricultural Sector Development Strategy (ASDS), which aims to enhance the efficiency of water utilization through the promotion of better management practices (URT 2002a). Water resource management involves water resource development, water allocation, pollution control and environmental protection. Before the 1990s water was managed by Ministry of Water and Livestock Development on the basis of administrative regions. Since the early 1990s the emphasis has changed to managing water resources on the basis of river basins.

To strengthen river basin management, MWLD implemented the river basin management component of the RBMSIIP in the Rufiji and Pangani basins. Project implementation began in December 1996, and was intended to deal effectively with water management problems and improve the performance of smallholder irrigation. Improved water management has been controlled by water utilization (control and regulation) Act of 1974 of Tanzania, which was amended in 1981, and 1994 (URT 1974, 1981, 1994a). Also there were the regulations of 1975, 1996 and 1997, which confirmed water allocation procedures (URT 2002b). Regulatory bodies instituted by mentioned laws are located in basin offices, which have statutory obligations to water rights. Irrigators' Associations (IA), or Irrigators' Groups (IG), have been formed from early 1990s onwards, for example in the Pangani basin (Chiza 2005). They are expected to become the main actor in the irrigation sector, also representing part of the private sector. The rights and obligations of these groups are not always clearly and uniformly defined under the present legal framework. A new legal framework for the Irrigators' Groups is an important requirement, for reasons that will become apparent in later chapters.

1.5 Conceptual framework of the thesis

This research is based on an interdisciplinary approach, informed by the notion that irrigation systems are not only physical, but also socio-technical systems, since most of the activities within the irrigation scheme are not self-contained, isolated activities, but part of wider processes and circumstances involving people and environment. The conceptual approach adopted in this study involves technographic analysis, typologies of irrigation systems, and sociotechnical analysis of irrigation, using related methodologies to study the systems.

General technographic analysis of irrigation systems

Within the general technographic approach, Richards (2002, 2007) defines technography as an attempt to map the actors, processes and client groups in such a way that the analyst can see beyond the technology itself, to the problems technological applications are supposed to solve and to understand what parties and

interests are being mobilised in arriving at solutions. Technography aims at understanding the interactions between various components of socio-technical systems. In technographic analysis, various elements that make up a socio-technical system must be identified and explanation made as regards to the interactions among these components.

It identifies the main components of the socio-technical system or process, boundaries of the system or process, how components are related, how system and process are performed and how the system or process is changing. Technographic approaches make use of different methods of observation and analysis, as well as frameworks, so as to arrive at descriptions of mechanisms affecting modernisation, technological processes and participation of farmers. The framework for linking a technography to its broader context was adapted to the needs of this thesis from Pawson and Tilley (1997), where an analytical approach to social policy evaluation is advocated based on the context-mechanism-outcome configuration (CMOC), under (philosophical) realist assumptions (Sayer 1992).

Realism is a philosophical doctrine reconciling the real, independent, objective nature of the world with a due appreciation of the mind-dependence of the sensory experiences whereby we know about it (Sayer 1992). In realism the mind knows the world only by means of a medium or vehicle of perception and thought. It involves giving an account of the relationship between the medium and what it represents. Realism is presently most commonly associated with the work of Bhaskar (1975) and Harre (1972). They developed a general philosophy of science sometimes described as transcendental realism and a specific philosophy of the human sciences termed 'critical naturalism'. This resulted in the development of critical realism, a philosophical approach that defends the critical and emancipatory potential of rational (scientific and philosophical) enquiry against both positivist, broadly defined, and 'postmodern' challenges. Its conception of philosophy and social science is as socially situated, but not socially determined. Sayer (1992) refers to the embeddedness of human action within a wider range of social processes. In this case realism tends to address the real and uncover mechanisms, which can explain what is happening in their causal relationships. It is therefore the task of the researcher to decide to use a methodology that will capture such mechanisms to enable interpretation of study.

Realistic evaluation is a form of applied research pursued in order to inform the thinking of policy makers, practitioners, programme participants and the public. With this orientation, Pawson and Tilley's realistic evaluation (1997) present an analytical framework to evaluate how social programmes and interventions work through the application of what they term a 'context-mechanism-outcome framework' or configuration. Programmes assume that the impact of any initiative will depend on a fixed pattern of opportunities and constraints governing outcomes. But such outcomes can take on many different forms. These will in turn depend on the cultural, social and economic circumstances in which constraints are embedded. Both social programmes and interventions, therefore, are real, because they deal with real events. For example, on one hand the real conditions, such as a lack of land or water in an irrigation scheme, may produce effects by activating causal mechanisms, to influence farmers to respond accordingly. On the other hand, interventions may be products of human plans that are made for development or improvement of the farmer livelihoods. Such interventions are most of the time shaped by visions of change for the better, but success and failure may depend upon elements that either exist or do not exist. Problems may arise, for example, as a result of ineffective surveys before initiating the programs, failing to reveal important dimensions of real

lives of people and the state of the environment. In such a case the purpose of realistic evaluation is to test the theories of the programs or interventions, whether they have failed or succeeded. Usually the evaluation comes out with answers that the intervention and programs have been useful or not, and fulfilled the initial purpose or not.

This may be known through the environment and circumstances of the beneficiaries themselves. The important point here is that the context of the program causes interrelationships among processes (mechanisms) responsible for outcomes. The CMOC framework in this case seeks to capture which underlying mechanisms actually existed and were triggered by the development process in question. In short, if irrigation succeeds, CMOC helps identify which of a range of candidate mechanisms actually came into play.

The key point espoused by realism is that the world contains real entities and processes, even where these are difficult to capture by human observation or control, and that it is the objective of science (including social science) to provide warranted inferences concerning such real objects and processes (Sayer 1992). It is important to make clear to the reader that the CMOC realist evaluation framework is not a research technique, but a form of (or format for) inquiry that can be applied to any social program, in order to grasp underlying mechanisms and outcomes shaped within certain specific social and technical contexts.

Context, in realist terms, it is the contextual conditioning of causal mechanisms which turns (or fails to turn) causal potential into a causal outcome. Social programs (and here we treat irrigation as a social programme, as well as a technical intervention) wrestle with prevailing contextual conditions. Programmes or interventions are always introduced into a pre-existing social context, which is crucially important when it comes to explaining successes and failures. Programmes or interventions often introduce new ideas and sometimes-new resources into existing set of social relationships. Yet, the social contexts of geographical or institutional locations in which programmes are embedded are often ignored by engineers (Bolding, 2005). The prior sets of rules, norms, values and the interrelationships gathered within places are the ones limiting the efficacy of programme mechanisms.

Realism utilises contextual thinking to address the issues of what, for whom, and in what circumstances a certain programme or intervention might work. For example, introduction of rice farming in a small area where men only own resources will not (cannot) benefit female livelihoods automatically if women are excluded from resource ownership. Also introduction of a cash crop where the same crop has hitherto been known as a food crop may trigger a set of market mechanisms affecting farmers in diverse economic categories differently, and thus cause extreme and unanticipated socio-economic differentiation.

Mechanism should be understood broadly as an account of the make up, behaviour and interrelationships of any set of processes responsible for outcomes. In this case a mechanism can refer to the interrelationships of the effects that have been brought about by the introduced programme or intervention in an area. Mechanism captures the idea that we often explain how things work by going beneath the surface (of what can be observed) and go into inner (hidden) workings. Ideas or functions that are captured by the notion of a mechanism can never be understood by examining the outside only. Sometimes they are too complicated to be readily noticed or examined, especially if preliminary study was lacking on social relations and patterns of behaviour, beliefs, values and relations. In the case of the topic of this thesis, without study of mechanisms of household food allocation it would be

difficult to understand why some families lack food at home when they are involved in rice cultivation and appear to have an abundant harvest. It takes understanding of mechanisms of gender relations, as regards the use of benefits within households, to penetrate to causes. Realistic evaluation, therefore, seeks to see how a programme has worked, why and for which people.

In realistic evaluation, the term *outcome* or outcome pattern is usually used to describe a change over time. It is such outcomes that constitute the explanatory goal of evaluation research. The programmes or interventions initiated in existing social systems are usually anticipated to bring improvements, according to their aims. By use of a realistic evaluation it can be known whether goals were attained through looking at outcomes, which might be labelled success or failure. The evaluation further seeks to know what the outcomes are, and how they have been achieved, eventually causing change or reshaping people's lives and opportunities. In the case of the present thesis, a key outcome of concern is that income distribution among farmers has become skewed by irrigation development. Only a small percentage of farmers have become rich through irrigated rice, while the rest remain poor (or have become poor) and have therefore devised other livelihood strategies, at times defeating project aims. The task of realistic evaluation here is to look at the totality of context-mechanism-outcome configurations (CMOC) to see why people are experiencing these differentiated changes in livelihood strategies and results. Such examination will help the researcher identify policy implications to help both government and donor agencies.

Typologies of irrigation systems and frameworks to study their transformation

Modernised irrigation systems

The Lower Moshi system is characterised here as a modernised irrigation system. Irrigation modernisation is discussed here as a process of technical and managerial upgrading (as opposed to mere rehabilitation) of irrigation schemes combined with institutional reforms, with the objective to improve resource utilisation (labour, water, economic, environmental) and water delivery service to farms (FAO 1997). To modernise, according to the Collins English dictionary (1995), means to change something by replacing old equipment or methods with new ones. Irrigation modernisation is a long-standing term used as a basis for planned interventions in irrigation systems in order to overcome underperformance and constraints (Prieto 2006). Such interventions have been characterised by high financial requirements, and so have been planned by national governments and supported by international loans (as discussed earlier in this chapter). This means that there has been dominant participation by the international irrigation community, reflecting their approaches and interests. Irrigation modernisation was originally restricted to the introduction of new physical structures and equipment; more recently concepts have broadened to included managerial upgrading and changes from supply to service orientation (Prieto 2006).

Modernisation is therefore to be understood as a fundamental transformation of the management of irrigation water resources aiming at improving the utilisation of resources and services provided to farmers. The transformation combines changes of rights, rules, organisational structures, water delivery services and irrigation scheduling, and upgrading of technical, managerial, advisory and training services – all in addition to introduction of modern infrastructure to improve water control. Specific objectives of modernisation include: increasing water productivity,

increasing the cost effectiveness of funds, increasing the reliability and flexibility of irrigation delivery, integrating the demand of other users, and meeting environmental requirements.

Eggink and Ubels (1984) noted how 'modern' irrigation development often seems to stimulate commoditisation and differentiation, through the interaction of government policy on rural development, technology and local forms of production and society. Studies of these interactions can reveal mechanisms by which commoditisation and social differentiation are enhanced by irrigation. These authors have argued that the character of the technology – and especially the effects of scarcity of water – influence likelihood of commoditisation. They call for case studies to help understand these relations and to learn more about the effects of public interventions on local forms of production. The present thesis is such a study. Moreover, as the large body of literature on the impacts and dynamic of the Green Revolution has shown, agricultural modernisation tends to intensify socio-economic differentiation (Patnaik 1990) to the effect that poor farm households become poorer and rich farm households become richer. Although irrigation is often intended to stabilise agricultural yields, life in irrigation schemes has become more risky for many, and in some cases it is a cause of poverty for some of the intended beneficiaries.

Irrigation technology as a sociotechnical system

Irrigation systems are infra-structured networks, consisting of canals where water is diverted from a source, e.g. river or spring to fields by the use of canals. They are set with regulating and division structures, which serve to spread water in space leading to different agricultural holdings. The spread of water is by means of irrigation infrastructure, but application of water (a labour process) to soils and crops is done by both farmers and irrigation system managers, who are the main actors. Irrigation systems are socio-technical systems (Uphoff 1986; Kloezen and Mollinga 1992; Vincent 1997; Mollinga 1998; Vincent 2001a; Mollinga 2003), i.e. systems embracing both social and technical components and subsystems (Huppert 1989). The term 'socio-technical' is not new to irrigation studies. Uphoff (1986), for example, used the term (applied to both systems and processes) to cover situations in which human and physical elements in a system interact continually and profoundly. Socio-technical systems are often characterised by close interrelationships between structural, social and technological features, by openness of systems to their environments, and by an emphasis on conversion processes in which inputs imported from the system environment are transformed and exported to the system environment as outputs.

In order to build a bridge over gaps in older research, Vincent (1997, 2001a) and Mollinga (1998, 2003) both applied another definition. These researchers realised that older studies employing the term 'socio-technical' were not supported by a critical investigation of the concept of technology and its role in shaping the field of the socio-technical. They eventually defined irrigation systems as sociotechnical systems (without a hyphen) in which technologies not only mediate the relationships of people with biophysical processes, but also shape people-to-people relationships integral to the operation of irrigation systems. These people-to-people relationships are an inherent part of irrigation, because irrigation in most cases involves more than one user. Cooperation among users, and often between users and government or other agency personnel, is necessary in order to make use of the basic engineering infrastructure. Mollinga (1998) identified three ways in which irrigation is social. The

first one is *social construction*, expressing the idea that technology development and design result from a social process (or set of such processes) in which different stakeholders interact (communicate, negotiate, take decisions, struggle etc).

The nature of the process, and varying perceptions and interests of stakeholders, influences the technical characteristics of the actual schemes (together with the properties of the materials used, and the nature of the (bio) physical mechanisms involved). In this case, the engineering knowledge that provided the basis for the design of the Lower Moshi scheme was developed for centrally run plantations in Asia. It shared many of its central features with other schemes in Africa, with an organisational set-up that followed the flow of water through the canal network, and with operation and management responsibilities assumed by technically trained staff. In this set-up, farmers were like plantation workers, who were expected to obey the rules and follow the prescriptions laid down by the scheme management. Planting dates, cropping patterns, water distribution schedules and much else were centrally determined, and often input distribution and marketing were also arranged by staff of the scheme.

Secondly, Mollinga refers to s*ocial requirements for use*, meaning that particular social conditions have to be fulfilled for the technology to work effectively, and that different technologies require different enabling conditions. This means that different designs allow different types of operation and regulation of water supply. For example, non-adjustable structures are easy to handle, as they measure the required water level and therefore are resistant to mismanagement. They also require few staff, but have low operation flexibility and lead to low water use efficiencies. To a considerable degree, the source of water (river, dam or ground water) and canal system in use determines the type of social organisation needed in an irrigation system (also see Horst 1998). Different sources of water may require different forms of management. In the Lower Moshi scheme, water sources include both water springs and rivers; water is transported through an artery of main, secondary and tertiary canals to the plots. A specific kind of management organisation is needed, capable of determining how much water is needed for irrigable land across the scheme as a whole, and how this is then to be distributed. It has to be noted that unreliable water supply will have a negative effect on the management of an irrigation system. Lack of water supply also may cause farmers to react in such a way that they lose confidence in system management and seek their own individual solutions.

A third way in which irrigation systems are social is that they have *social effects*. Through its effects on crop production, irrigation affects livelihoods. Most of these effects are dependent on technology. For example, irrigation allows more intensive cropping systems and may thus generate economic growth and employment, but may also create socio-economic differentiation, as a result of which the poor may become poorer and the rich richer (Patnaik 1990). Within the irrigation scheme studied in this thesis, farmers were affected differently; depending on how they were able acquires water to irrigate their plots (see Chapter 3). Farmers who failed to get water experienced livelihood insecurity, compared to those who were successful. Vincent (1997) adds that the technologies installed mediate between natural supply and demand, affecting in major ways the negotiating power of farmers and relative scarcity of water. It is also important to assess the working of irrigation systems from a livelihoods perspective, since the degree of stakeholder interest in committing themselves to management rules or to invest in maintenance, for example, will reflect or depend on the scheme's capacity to enhance or diminish livelihood options. As Uphoff (1991) has argued, if irrigated agriculture is profitable for water users then

they are more likely to be willing to participate and cooperate in irrigation management activities. In most cases, farmers will only participate and invest resources when it is clear they will benefit from such commitments.

In the case of the Lower Moshi, farmers who had non-irrigated land participated less than those who had plots within the scheme. The socio-technical nature of irrigation systems refers to structurally embedded irrigation activities at different levels, as distinguished by Uphoff and Mollinga (Uphoff 1986; Mollinga 2003). Both these writers distinguish three types of irrigation activities, namely (1) control structure activities (design, construction, operation, and maintenance), (2) water use activities (acquisition, allocation, distribution, and drainage) and (3) organisational activities (decision-making, resource mobilisation, communication, and conflict management). These are not self-contained, isolated activities, but part of wider processes. There are contextual requirements (both social and material) for these activities to take place (Mollinga 2003). Material contextual conditions include the agro-ecological system and the technical infrastructure. The social conditions include agrarian structure and institutions. For example, regulation of efficient use implies a functioning legal system of property rights. Prevailing gender, ethnic and other social relations (including the state of or possibility for cooperation among farmers) are of undoubted importance when trying to understand water distribution and management within a community setting. Irrigation systems also consist of a number of levels, comprising different canals usually connected by the outlet and division structures. On this basis; primary, secondary and tertiary levels can be distinguished. Outlets and divisions can be characterised as social-technical points. 'Social' in this term refers to the fact that people are involved in operations and functions. At each level different institutions are invoked in relation to water flow at that level. For example collective (system-wide) action may be needed at canal system level, while field irrigation may involve intra-household cooperation.

These various social levels depend on organisational links, much as hydraulic levels depend on technical and physical linkages. For example, the connection of a secondary and a tertiary canal is not only a division structure with gates and locks. There is also a person acting as a water distributor, who may have different institutional attributes, in relation to his or her appointment and payment, and in terms of accountability to farmers, the government or other irrigation agencies. Thus Vincent (1997) argues that irrigation systems should be regarded both as a physical infrastructure of works and a social infrastructure of rules and procedures (i.e. in terms of the CMOC outlined above different families – social and technical – of mechanisms are at work simultaneously and in interaction). Without sociotechnical coordination, technological operations and water delivery cease. The social dimensions, she argues, are those that involve social regulation, including the laws and rules, which govern access to and use of resources, and the distribution of benefits. Often, however, the documented laws and rules are not the ones implemented (Gillingham 1997). In many cases users adapt rules to suit their conditions. Gillingham (1997) terms these 'working rules', i.e. the (often) tacit rules that determine what is really happening in terms of access to water.

Bureaucratic-Communal irrigation systems

As opposed to purely communal irrigation schemes, most initiated by the government or modernised schemes are characterised by a bureaucratic management organisation. From the work of Eggink and Ubels (1984), the Lower Moshi irrigation system is characterised as a Bureaucratic-Communal system, where new public system develops over and incorporates indigenous systems. In these kinds of

systems there are two important forces interacting: government efforts to influence local production systems, and the internal dynamics of the local community.

Eggink and Ubels (1984) proposed an analytical framework to study these Bureaucratic-Communal irrigation systems, which was amended by Prieto (2006), as shown in Figure 1.1 and which will be followed in this thesis. For large systems, Prieto added an organisational component of irrigation management at farm level. This is where farmers' decisions are highly determined by water management upstream, but under specific circumstances farmers can as well decide alternative conditions that then may influence higher levels.

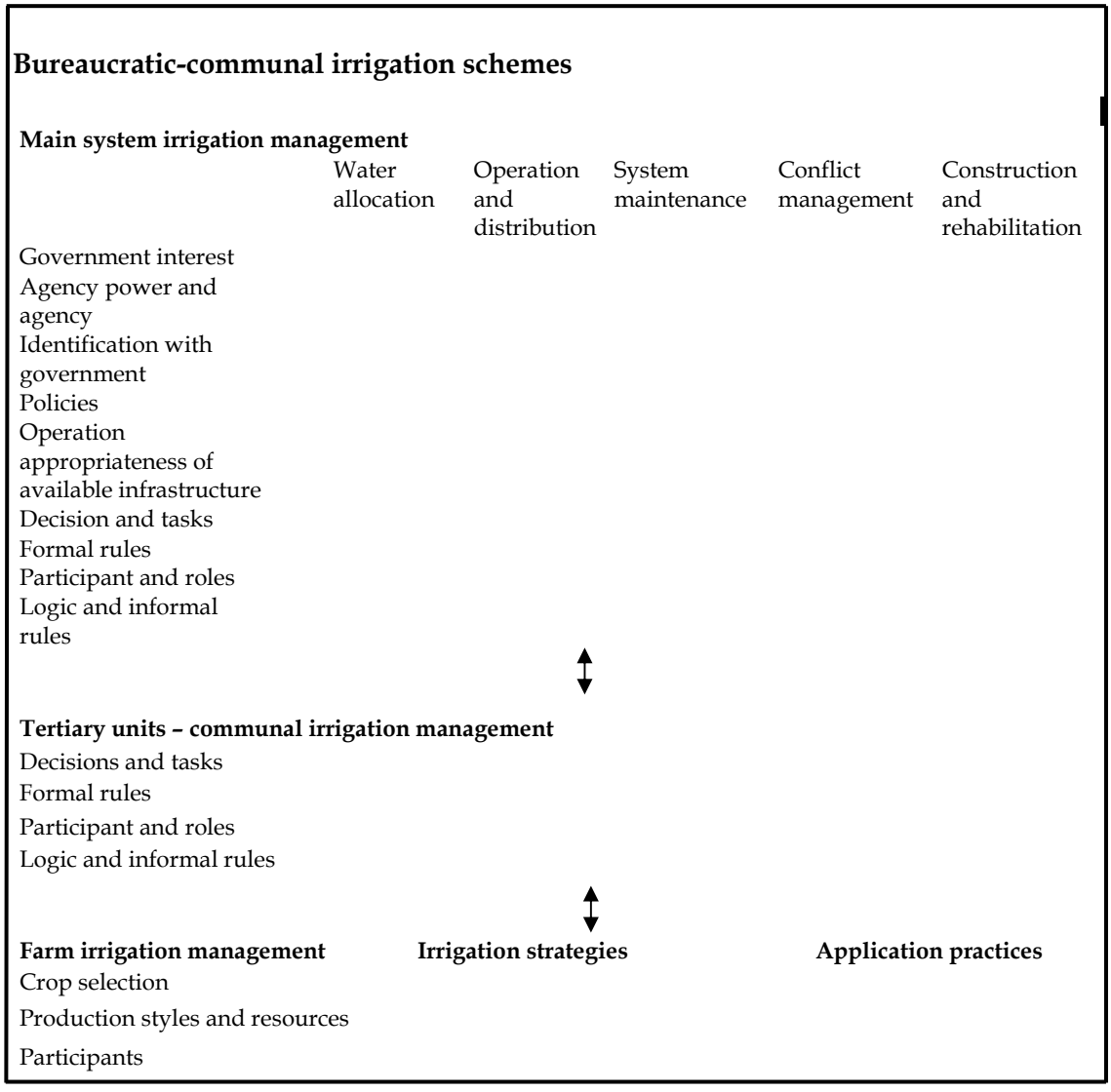


Figure 1.1 Analytical framework of the PRD

Source: Prieto 2006

The organisational component brings in two elements, viz. the functioning of irrigation at farm level and the interaction of farmers' decisions and upstream components. In the new analytical framework, the main system irrigation management component has been expanded by including government interest in irrigation issues (already discussed by Eggink and Ubels 1984), agency power,

agency identification with government policies and operational appropriateness of available infrastructure.

Although the irrigation agencies are usually seen as the operational arm of the government in the implementation of official irrigation policies, most of the time the connections are too weak to empower agencies enough to lead the proposed intervention effectively. The component of 'operational appropriateness and available infrastructure' – which deals with the relationship between the infrastructure itself and water delivery method, operation and maintenance – depends on the capability of operators' skills, organisation, and general irrigation management principles like equity, transparency and accountability (Horst and Ubels 1993; Lankford and Gowing 1996; Horst 1998; Renault 1999; Chidenga 2003).

Technographic methodologies to study irrigation systems

Bolding (2005) conceives technography as emerging from three methodological principles: *interdisciplinary study,* where physical/technical and social are analyzed simultaneously and internally related dimensions of an object), *interactive design processes,* where use is studied alongside (re-) design, and *contested stabilisation*, in which more focused studies on the use of a scheme are made. These principles are translated into concrete contexts and linkages in this study. Richards (Personal communication 2008) adds a further aspect – materiality. Technography is specifically concerned (by contrast with ethnography) with describing ways in which humans engage with material (i.e. how making is achieved). This is not easily rendered into a discursive account (such as a thesis), and often requires from the researcher special observational and descriptive methods (e.g. embodied participation, i.e. learning a specific skill) (Richards 1986).

In studies of irrigation schemes, a longitudinal interdisciplinary approach is often important because of the dynamic dimensions. This approach is able to capture changes of infrastructure, activities and the lives of the inhabitants over a period of time. Iterative design and ongoing conflict resolution is often a fact of life, since irrigation settlement schemes comprise composite technologies amenable to change, with multiple uses affect a multitude of users. These changes are not only response to problems on the ground but are also often related to policy discourse, which may be global or local. For example, at one time most irrigation schemes in Africa were managed by state bureaucracies, but were then subject to the 1980-1990s economic reform policy (so-called Washington Consensus). Although under the reform policy, turnover to stakeholder management was the universal watchword, irrespective of actual conditions, but changes can as well be brought up by actions of the people who use the technology. They may decide to work or re-work the systems for the sake of improving it, or as an aspect of ongoing water conflict among themselves. For example trying to get the water by force some users may end up destroying gates or other structures, or tapping water illegally (e.g. night time theft). Sometimes changing access to water within a scheme, as a result of such contestation, can enable some people to expand their cultivation areas at the expense of others.

Bolding (2005) has noted that after irrigation schemes are built, changes do not occur continuously; sometimes there is a degree of periodic stability, or change is gradual. Schemes have a life cycle (like humans, they age!) and step changes are often related to these various phases, and in themselves take time to reach maturity. Three main phases of life of settlement schemes have been identified by Chambers (1969, cited in Bolding 2005). They include, *first,* the phases of pre-settlement, including political pressure and technical activities; *second*, settlement and

organisation, with emphasis on welfare and production; and *third* the withdrawal phase in which the centre of attention is specialisation and devolution. These phases correspond well with the three conceptually distinct spheres that Mackay and Gillespie (1992) proposed for analysis of technology development i.e. (1) conception, invention, development and design, (2) marketing and (3) appropriation by users. Appropriation may also take place by the staff in water management, as seen in a case of an irrigation scheme in Mexico, where gate keepers were able to distribute the water after internalising the network (Van der Zaag 1992a, 1992b).

The discussed changes and continuity of life of scheme can be conceptualised by first assessing the forces of change responsible for iterative processes of (re-) design, and second by presenting the forces of continuity responsible for relatively stable periods of (contested) use. The process of design can be conceptualised as a negotiating process between relevant social groups, involved and concerned in conceiving, building and modifying water networks in a system. Such groups include not only the originators of the scheme, but also (inter) national policy makers, donor agencies, engineers, administrators and actual users. Understanding the strategy of various parties is helped by the notion degrees of interpretive flexibility concerning the nature of the artefact (Chambers 1969; Moris and Chambers 1973; Pinch and Bijker 1984). At any point it is important to know the group of actors responsible for the (ongoing) (re-) design process of the system, since this has major influence over the overall pattern of use. These are forces of continuity when technology is in use, whether they constrain or enable actors in their scope for reshaping use, and analysis of this aspect helps explain the control or stabilisation of objects.

'Black boxes' in conventional studies and critical sociotechnical linkages

Discussion in this sub-section will address some of the factors and socio-technical links needed to explain the operation and performance of the irrigation scheme studied. Technography here aims to uncover interdisciplinary links and to identify basic (unexamined) assumptions (known, analytically, as 'black boxes'), in order to contribute new entry points for improving performance of water networks. Comparative analysis allows identification and opening up a number of common black boxes that inhabit the imaginations of management and policy maker of irrigation schemes (i.e. the 'black boxes' in question contain no real mechanisms). Technographic analysis therefore aims to unpack and critically examine these factors (and actors) to locate the real context-mechanism-outcome configurations relevant to the functionality of schemes.

Critical factors include water, settlers/households, user organisation, the management, physical network and the market. W*ater* is a critical factor, for many researchers, managers or policy makers have not been able to establish where it stays when conveyed by the scheme canal network. When water is associated with people – such as the farmers themselves, or gatekeepers – then it becomes easy to identify the problems within the system. An intention of this research is to analyse how the various actors establish everyday control over the use of irrigation water (Long 2001). The notion of sociotechnical control implies that water management is practiced through both human and non-human networks. The humans managing or controlling water have some capacity to manipulate the flow through the canals of the system, but the materiality of the system (including its intractability) must also be recognised (water cannot flow up hill, while much engineers, or potential thieves, want it to flow up hill).

In many cases a s*ettler/settler household* has been conceived in terms of a male – head of a nuclear household to whom land is allocated, who commands an amount of labour, produces food and is responsible for family welfare. Since this is not true in every community, technographic analysis shows the responsible people. The *user organisation*s (whether a cooperative, WUA or irrigation management committee) are in a position to communicate with settlers (farmers) and facilitate effective technologies of control. It is, therefore, important to analyze and know the decisions of the organisation in relation to the management of water supplies and activities of the irrigation system. Within *management*, organograms can be manipulated or reconfigured, as when the Office du Niger management tried to postpone and resist reform in the period of 1982-1994 (van Beusekom 2000). Streams of new organograms have been produced to reflect new idealised orders, while the same people manned the posts and actual organisational practices remained unaffected (Musch 2001).

Although *the physical system/network* is important in the real life of irrigation schemes, it is often not considered important in analyses. Since there are usually no physical boundaries that prohibit people to penetrate inside or outside schemes and since people are interrelated, it has been difficult to control movements or activities. Thus the permeability of supposed boundaries is an issue for study. Similarly, a socio-technical conception of the *market* in irrigation schemes ought to pay attention to price differentials, strategies of storage and transaction modalities from harvested paddy to sold rice. These transactions can be between farmers and buyer directly, or between farmer, middleman and buyer. Economic liberalisation has caused problems in various irrigation schemes, since traders do not always compete, but engage in various price fixing arrangements (including tying down producers with expensive credit), so buy rice at their own prices and leave farmers with little profit.

Other *critical socio-technical linkages* Bolding (2005) considered important for the success of the irrigation schemes include labour, land and crop management in kinship based networks, physical water control, managerial water control, technological control and market chains. In this study the labour, land and crop management issues centred on intra-household gender relations are crucial for study, as distinct from kinship. It is not commonly known how these critical linkages produce success or failure in irrigation schemes, but answering such questions can help explain the social, political and technical components that influence success or failure:

1) Technologies of control: The history of irrigation development in Africa shows that irrigation schemes constructed under so-called improvement or modernisation programmes technologies of control (re) structured relationships between farmers, land, market and allocation of labour. Power or control comes within irrigation schemes when managers seek to impose new ways of access to resources and agricultural practices. For example, irrigated plots have been distributed to a number of farmers who are instructed to grow a certain type of crop (like rice) in seasons according to water allocation, and were expected to produce a certain amount of rice. This means, farmers may then have to wait for customers who have varying demands, which include setting of prices for the produce.

At times management control and market power may, in fact, clash, e.g. where farmers have to follow a production schedule, with a fixed cost schedule, but prices fluctuate with seasons.

2) Physical water control: Usually when there is plenty of water within a scheme, the question of water control (allocation and distribution) is not a problem. Experience (as discussed in Section 1.3) shows that, most of the time a traditional

irrigation scheme may not experience water scarcity, but this may change when it is 'modernised' and a new type of crop is introduced.

One example is the Mwea irrigation scheme (Moris and Chambers 1973) where physical water control became a big issue as the supplies became limited as soon as rice farming commenced. In the Nyanyadzi scheme, according to Bolding (2004), physical water became a problem in the 1930s, after the system infrastructure was rehabilitated and a night storage dam constructed. Users had to struggle with outside competitors who were up-stream of the system.

3) Labour, land and crop management in intra-household gender relations: These are considered critical interactions to success or failure in irrigated agriculture. Gender relations are relations of power between women and men which are not only revealed in the division of labour and resources, but also in ideas and representations, which ascribe different abilities, attitudes, desires, personality traits, and behaviour patterns to men and women (Agarwal 1997). Gender relations are both constituted by and help constitute these practices and ideologies in interaction with other structures of social hierarchy such as class, caste and race. According to Agarwal, (ibid) gender as race, class or caste is known to define perceptions about abilities and may lead to discrimination or exclusions. According to Niehof and Price (2001), gender is a strong organising principle within households and intersects with ethnicity, class and other variables like age and wealth. Gender roles and behaviour for men and women may change with time and vary across culture and economic status. Gender may also influence men and women as well as boys and girls to have different roles and responsibilities. Moser (1993) has argued that across low-income households, labour contributed by men is usually centred on productive activities, while that which is contributed by women combines both productive and reproductive activities.

Gender relations are therefore considered important because they are the foundation of household livelihoods strategies (Burton and White 1984; Guyer 1988; Netting 1993). Previous discussions in Section 1.3 highlighted faulty understandings of gender relations, and how these can interact with irrigation interventions to affect outcomes. Male and females decide within households over issues, according to their rights, responsibilities and power relations. Decisions include those relating to labour allocation, crop choice, and allocation of crop proceeds, and vary according to socio-economic status of households. Gender relations in labour, land and crop management within and between households have been shown to be difficult to change. The outcomes shape livelihoods, defined by Vincent (2001b) as the means people use to support themselves, to survive and prosper. Gender has also been found to differentiate household headships with different economic abilities in relation to tenure (Varley 1996) which as well play a major role in livelihood of families among households. This influences their differences in abilities to acquire productive and economic resources support and take care of their families within households. There are also social and economic differences among female-headed households (Chant 1997) depending on the resources they own and dependants, which can be outcome of success or failure of irrigated agricultural development interventions.

4) Staff-user interactions in managerial water control: Interactions, as regards managerial water control, are important for the objective and success of the scheme.

Studies on the behaviour of irrigation bureaucracies towards irrigators (Small and Carruthers 1991; Merrey 1996) have shown that problems in irrigation management are caused by the lack of voice of water users toward the wrong doing of bureaucracies, a major factor in poor water management. Other studies have also

shown problems of corruption and bribery (Wade 1982; Repetto 1986; Tendler 1997) as well as poor operational and financial control (Kloezen 2002). When all these problems are at work the interaction between water users and bureaucracies is usually distorted. The approach to addressing problems changes and becomes top down. Responding to such approaches and problems the water users often fail or refuse to cooperate. It is these critical sociotechnical linkages, often treated as black boxes that influence the research questions to be stated and discussed in the next section.

1.6 Research questions and objectives

In reference to the discussions in Section 1.4, a top down approach has characterised the nature of irrigation development programmes in Tanzania. Most were implemented without investigating the environment and social-cultural complexities of the people and community at large. The Lower Moshi irrigation scheme was implemented in a region where, historically, many inhabitants obtained land from their clans during the chiefdom era, and who therefore enjoyed traditional ownership over natural resources including land and water. Such customary rights to resources were recognised during the colonial period, and remain recognised by government up to the present time (URT and MHLS 1997). It is also a region where traditionally, land was distributed to heads of households including single women, but married women owned land resources through their husbands. This tradition was also incorporated in national land policies, but changed in the 1990s. It is also a community that has a history of traditional irrigation, which considers only men to be members of relevant water management organisations, while women have to contribute labour in cultivating family plots and participating in irrigation activities (Masao 1974). Within the community, men and women have different rights and responsibilities in households. Men as heads of households are responsible for cash crops, while women are responsible for food crops so that they can feed their families. Many households therefore have two types of family plots where women have to contribute labour to both plots, engage in other income-generating activities and perform household chores, while men only occasionally cultivate plots, but engage in other income-generating activities including migration for work and trade. The main crops used for staple food in the community are maize, plantains and root crops. Taking into consideration these complexities, the study questions the planned goals of irrigation intervention, with improved infrastructure and new irrigation management.

Research Objective

The main objective of the research is to analyze and come to a better understanding of how irrigation development modernisation has affected livelihood opportunities for men and women. This research aims to understand the impacts of irrigation modernisation on farmers, households and their livelihoods.

Study objectives include:

1. To provide a technographic description of the irrigation scheme
2. To examine how gender and intra-household relations affect and are affected by irrigated agriculture
3. To examine how project interventions and policies have influenced livelihood strategies of farmers

4. To contribute to theoretical and empirical debate on irrigation and livelihoods

Research questions

How has the Lower Moshi irrigation scheme evolved over time and which mechanisms have shaped livelihood opportunities of women and men?

In order to unravel the context-mechanism-outcome, relations involved in irrigation on the Lower Moshi the following sub questions are posed:

1. What policies and programs are being used in irrigation development?
2. What changes have taken place in irrigation infrastructure and water allocation and who has shaped these changes?
3. How have livelihoods changed with access to irrigation?
4. How has participation in water management changed under irrigation modernisation?
5. How has irrigation development affected and been affected by gender relations?

1.7 Research methodology

The research was carried out in four villages of the Lower Moshi irrigation scheme in Kilimanjaro region in Tanzania. The scheme was selected purposively in line with the debate over irrigation development interventions aimed at improving food security and livelihoods. The scheme is one of the older improved systems modernised through a loan from a donor agency to the Tanzanian government. It is a jointly managed (government/farmer) scheme that has not received any previous detailed research of the kind here presented. The whole scheme is treated as a case study site, focusing on the four villages within scheme villages, Mabogini, Rau, Oria and Chekereni. The scheme is characterised by farmers who are residents and non-residents, as shown in Table 1.4. In Oria and Mabogini, for example, there are many WUA members who are not residents in the area, because they are town-dwellers granted plots under earlier settlement awards (for further discussion, see Chapter 4). There are also adjacent (off-scheme) villages playing an important role in the outcome of the scheme. Together with the on-scheme villages they provide an interesting site for the study. The methodology chosen to address the research question involves an interdisciplinary combination of qualitative and quantitative approaches.

Table 1.4 Characteristics of resident and non-resident farmers and water users in the Lower Moshi irrigation scheme (N = 1,863)

Villages	All farmers			Resident farmers			Water Users' Association members		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
Mabogini	601	185	786	176	100	276	154	29	**183**
Rau River	278	54	332	248	49	297	73	10	**83**
Chekereni	411	137	548	240	92	332	181	52	**233**
Oria	186	11	197	33	2	35	132	8	**140**
Total	1,476	387	1,863	697	243	940	540	99	**639**
Percentage	**79%**	**21%**	**100%**	**74.0%**	**26.0%**	**100%**	**84.5%**	**15.5%**	**100%**

Resident farmers: farmers who live in the scheme villages (the ones included in the study)
Non-resident farmers: farmers with plots in the scheme but residing outside the scheme in other villages, in Moshi town, other regions and neighbouring countries, but own plots within scheme

Source: Field data and scheme documents 2001-2004

Intensive in-depth case studies and gender analysis within the scheme and within households was combined with surveys. The methods were chosen in order to give information about the history of the scheme, intervention process and lives of the people, improvement of irrigation infrastructure, irrigation management, agricultural production and benefits, management actors and water users and their relationships. It also includes gender relations and livelihoods in general. The use of multiple methods reflects an attempt to secure an in-depth understanding of underlying mechanisms shaping irrigation and the links between contexts, mechanisms and outcomes of technological processes in the irrigation scheme.

Case studies

A case study method was adopted to bring out the realities of history, everyday activities and actors' relationships within scheme and households. In order to build up case studies, different interview techniques and forms of analysis were used. Smith (in May 1997) argues that analysis of interviews should focus not only on motivations and reasons, but also social identities and how these are constructed within the social settings in which people live and work. Case studies of aspects of everyday life reveal social dynamics and the complexity of the ongoing social process. They highlight how everyday life is patterned by set of social relationships and the networks to which people belong (Vijfhuizen 1998). Yin (1989) argues that case studies are generally a preferred strategy when 'how' and 'why' questions are being posed, when the investigator has little control over events and when the focus is on contemporary phenomena within a real-life dynamic context, subject to change even as research is being carried out.

Techniques used in the case studies are those of: life histories (biographical and oral history interviews, (Plummer 1983; May 1997) focused on critical life experiences. Also social network analysis (Mitchell 1969), focused on how networks (especially in the web of kinship) evolve over time, and how different households, state agencies and relationships interlock. In the present study this kind of approach focuses on access to plots and investments among families in the irrigation scheme. The researcher also sought to become familiar with informants on a daily basis, in order to contextualise interview data (Spradley 1979; May 1997).

This ethnographic work was also an opportunity to take account of events associated with, and the typical experience of life on an irrigation scheme. This was through an in depth study longitudinal approach described earlier on by Bolding (2005) and Chambers (1969).

Gender analysis

This important methodological aspect of the work made use of a framework proposed by Feldstein and Poats (1993), which provides a basic understanding of intra-household decision-making. The framework proposes four areas of analysis for which analysis is done according to gender, age and other factors: l*abour or activities*, which includes who does what, r*esources,* which includes who owns and controls what, *benefits* analysis, to show who benefits from an enterprise, and *incentives* associated with the production characteristics of an enterprise such as increase in yields or income etc. These four areas were used to describe production organisation, consumption and investments. Inclusion analysis, which studied the cultivation collaboration of farmers, explained which farmers were included and how farmers were included in each activity. By using the Feldstein and Poats framework, a good deal of information was generated in relation to the central theme of the research. This included data on gender differences with respect to allocation of labour, land, water and other resources for cultivation of crops, participation in meetings, and maintenance of activities in irrigation systems, and impact on agricultural production. Different, gendered use of the outputs of irrigated agriculture may also have effects on household food security. Gender analysis in the context of irrigation management thus also needs to address questions regarding how policies, institutions and practices affect gender relations and how gender relations affect achievements of irrigation performance objectives. This implies exploring if and how meeting gender needs and interests are compatible with meeting the objectives of the irrigation system. The gender planning methodology of Moser (1989) was used to identify gender needs and interests. This is based on identification of the triple roles of women in society, i.e. reproductive, productive and community management tasks, and on an analytical distinction between practical and strategic gender needs.

Methods of data collection

Preliminary and actual data collection for the present study was undertaken over a period of about two and a half years (October 2001 to January 2004). Before the exercise was carried out, sources and type of information to be collected and techniques to be used was identified (Table 1.5). The process of data collection composed of three major phases. The first phase included the preliminary general survey, which enabled to get general primary and secondary information of the farmers about the irrigation scheme, the people, environment and livelihood activities. The second phase involved participatory rural appraisal for more information from farmers through meetings and discussions. Participatory rural appraisal exercises allowed to categorising households (Table 1.6), ranking farm household on the basis of wealth (1.7) and helped in the selection and sampling of households for both the main survey within scheme and the case studies. It was also during this second phase when the focus groups were selected and research assistants were trained to help in research activities. The third phase was mainly for preparation of questionnaires, conducting the study and analyse data.

Table 1.5 Sources, type of information and methods used to obtain information

Source from which information was obtained	Type of information on	Method used (sample N = 300): Focus groups, informants and case study households
Ministry of Agriculture Zonal irrigation Unit KADP/KATC- representatives Water Users' Group Women groups Irrigated farmers Non-irrigated farmers	History of the scheme and improvement made (infrastructure) and water management organisation Operation and maintenance of irrigation systems Command area/cultivated area Irrigated rice production (Secondary and primary data)	Focus group meetings/ discussions (use checklist questions and discussions were recorded) Transect walk Preliminary general survey (participatory rural appraisal)
KADP- Representative Water Users' Group members Water users members (males and females) Block leaders and water distributors Technicians and field officer	Participation in water management (decision making and meetings) Water allocation and distribution logistics Field infrastructure inventories (for defects) from irrigation scheme	Focus group interviews Surveying the irrigation system (by walking and use of motor bike)
Irrigated rice (plot holder) farmers (commercial and subsistence) Non-plot holder farmers (males and females)	How to obtain sample of farmers and criteria to be used Items to be used as criteria in wealth ranking exercise Information on: Plot acquisition and ownership, rice production / amount use of inputs Staple crops for food production Marketing Non-farm and on-farm income activities (livelihood activities)	Meetings and discussions Random sample of farmers Wealth ranking exercise of sample farmers. Questionnaire administration to sample farmers Interviews (Structured/ semi structured questions) with a sample of respondents.
Male and female-headed households (Commercial and subsistence farmers)	Gender relations in irrigated agriculture (water management and agricultural activities). Who did what in farms and other activities	Case studies of subset of sample farmers Detailed interviews with case study farmers
The old/present village chairmen and committees Elderly men and women (plot holder and non-plot holder farmers)	The history of Lower Moshi settlements Historical and traditional information regarding traditional irrigation and livelihood activities	Interviews : Detailed interviews and discussions

Source: Field data 2001-2004

Before data collection exercises were commenced, the author undertook a familiarisation tour to lay strategies for commencing research in an area. Less secondary data for the scheme were there than expected, especially considering the age of the scheme itself. The secondary data was collected mainly through a literature review of published and *grey* materials (O'Laughlin 1998). These included archival documents, unpublished reports, research papers, and scheme manuals and records. These were obtained from scheme officers, the Ministry of Agriculture and Irrigation Department in Dar-es-Salaam, libraries and the Zonal Irrigation Unit (ZIU) in Kilimanjaro region. Some documents from the donor agency were consulted in the library of the Kilimanjaro Agricultural Development Project office at Chekereni in Lower Moshi. These documents were reviewed to ascertain the design process and irrigation system intervention. Such data were important in order to understand institutional discourses and developments associated with the irrigation scheme, environment and local populations (Chambers and Moris 1973).

This information was used to supplement the primary data collected from the scheme through fieldwork. In October 2001 I obtained a permission to conduct research in Lower Moshi. I visited the area on a preliminary survey. I introduced myself to the director of the Kilimanjaro Agricultural Development Project (KADP), the principal of Kilimanjaro Agricultural Training Centre (KATC) and village leaders, who later on informed villagers that I was to spend time for research and they should support me. In the middle of October I went back to the area for a period of one month to get to know the villages through observation and learning about the community itself. Items observed included social cultural and political events and interactions, how people engaged in economic activities (agricultural/animal production), their cropping patterns, types of plots, animals reared, and marketing and off farm income activities. Agricultural production activities included how the irrigation system was managed; how agricultural crops were produced, and how irrigation was practiced by individuals within plots. The physical structure of the irrigation system included the diversions, water flow canals. Irrigation committees were observed and understood. Communication facilities (types of roads, transport and village location) and availability and use of public facilities (markets, shops, health centres, schools and environmental resources) were also noted. Observation was done on types of houses and movements of different members living in households (men, women, and children) and their involvement in income activities within the irrigation scheme.

Participatory rural appraisal

During the month of November 2001 I had time for a of participatory rural appraisal exercise to further complement information already collected on the situation of people in the irrigation scheme. In addition to first hand learning, a *transect walk* was included to gain a sense of variation within the scheme and its environment.

Table 1.6 Categorisation of farmer households used for study

Characteristics	Production categories		
	Commercial	Subsistence	Non-plot holders
1. Gender of household head			
Male	*	*	*
Female	*	*	*
2. Irrigated plot holding			
7 or more plots	*		
1-6 plots		*	
No plot			*
3. Access to water			
Good amount	*		
Average		*	
Less water		*	

Source: Field data 2001-2003

This was undertaken together with village representatives from different sectors. These facilitators included village leaders, WUA members, teachers, health workers, women's group members, elders of the villages, and other village water user representatives, and community development and extension workers. The *transect walk* involved selecting a route jointly with local people and facilitators to allow observation of physical characteristics (e.g., condition of irrigation infrastructure, plots and cropping patterns, and different resources and their condition, such as public lands, forest lands grazing areas, canals and gullies). Such information from observation was supplemented with discussions from the villagers, village government leaders, the management and obtained secondary data. The transect walk exercise, which involved discussions on peoples' perceptions of agricultural issues and information of irrigation scheme was collected before farmers were followed to their plots. After this exercise, ten influential villagers were selected for further facilitation of the exercise through two meetings that were planned and held in each village. Towards the end of December 2001, I also trained two full-time research assistants for the third, detailed round of survey after the preliminary.

The first meeting was held in early January 2002, with the village committee and village leaders, to explain why and arrange how the research exercise was to be carried out. During this month, a second round of meetings was held again in each village to explain the research study. In mid-January 2002, a third meeting was again organised in each village, where villagers were involved in PRA techniques to collect general information about the community. With the help of village chairmen and research assistants (RA) farmers were divided into three groups of 10-30 people and asked to identify and write down or draw various patterns as regards to changes brought by the irrigation scheme compared to older patterns, changes in the seasonal calendar and mobility maps. During meetings, *participatory mapping* of the irrigation scheme was carried out by villagers, for the purpose of identifying types of households, irrigation system, land use patterns, tenure, and location of adoption and adaptation of new technologies, location of public facilities etc. *Seasonal calendars* were prepared by them showing seasonal variations in labour demands, income and expenditure, cropping patterns etc. Seasonal changes in water availability and

demand were also identified. In *mobility maps* villagers indicated changes in migration patterns, changes in access to markets, external information and resources. Labour opportunities before and after establishment of the irrigation project were also noted.

During this time the information from farmers enabled the researcher identify three categories of farm households and farmers in relation to their involvements in irrigated agriculture and other non farm income activities. With the help of farmers' information three categories of farm households (commercial, subsistence and non-plot holders) were formulated (see Table 1.6). This was through the use characteristics identified by farmers and researcher, which included gender of household heads, plot holding (of more than seven plots, one to six plots and non plot holders) and access to water (good, average and less) for rice farming. After the categorisation exercise, p*articipatory wealth ranking* was used to indicate differences in welfare across farm families, and the distribution of outcomes and impacts on various farm families and individuals from different wealth categories. As shown in Table 1.7, wealth ranking criteria were established by farmers and researcher for selection of farmers for the survey interviews and case studies.

Table 1.7 Criteria for participatory wealth ranking among farmers in the Lower Moshi irrigation scheme

	Rich		Average		Poor	
Description	Plot holders	Non-plot holders	Plot holders	Non-plot holders	Plot holders	Non-plot holders
1. Rice plot holdings						
Own 7 or more plots	***					
Own 1-6 plots			***			
Own less than 0.3 ha plot					***	
2. Food security						
Produce sufficient food for year for 3 meals a day	***	***	***			
Produce insufficient food for year but can purchase additional food for 2-3 meals a day				***		
Produce insufficient food for year and can only purchase additional food for 1-2 meals a days					***	***
3. Livestock farming						
Keep ≥10 milk cows	***	***				
Keep 2-4 cows/goats			***	***		
No cows/goats					***	***
4 Quality of housing						
Modern big concrete block House. Iron roofed, with electricity	***	***				
Modern average concrete Block house, with electricity, iron roofed			***	***		
Small burnt brick house, Iron roofed, no electricity			***	***		
Small mud brick house, iron					***	***
5. Additional income activities						
High wage employment	***	***				
Labourer wage employment			***	***		
On-farm labourer				***	***	***
High income business	***	***				
Low income petty trade			***	***		
6. Spouse employment						
Both husband and wife employed-high income	***	***				
Both husband and wife employed – low income			***			
Wife /woman not employed				***	***	***
7. Health expenses						
Can afford	***	***	***	***		
Cannot afford					***	***
8. Schooling of children						
Go to better schools	***	***				
Go to average schools			***	***		
Dropped out from school Due lack of school fees					***	***
9. Polygyny common						
Husband working with wives			***	***		
Husband not working with wives					***	***

Source: Field data 2001-2004

Farmers from the four villages formulated wealth ranking under categories of plot holdings and harvests, livestock farming, type of non-farm income activities, size of household compared to income, schooling of children, ability to get health treatments, quality of houses, food sufficiency and polygny. It was within the wealth ranking criteria and the categorisation of farm households and farmers that the sample of both survey and case studies were extracted. The whole exercise enabled us to also identify focus groups participants and key informants within the sub-villages who were to provide needed information. After completing the interview meetings at about end of January 2002, the researcher and research assistants arranged to meet identified focus group members and key informants.

These were the village chairman, sub village leaders, village elders, the director and members of staff of KATC, KADP, WUA representatives and committees. Others were business men, teachers, extension officers in community and agriculture development, medical doctors, nurses, religious leaders, women's group members, water men, groups of male and female youths, and other employees. It was arranged that these people were to be met at times convenient to them. A checklist of items for guiding discussions was made after the surveys mentioned earlier were completed. Tape recording was used to capture information during discussions. All the information collected throughout the preliminary survey was important and was used for the formulation of questionnaires, checklists (see appendices) and strategies of how to obtain data from various sources as shown in Table 1.5.

Sample selection

The selection of farmers was through stratified random sampling[11] guided by the village registry[12], which started in March 2002. The objective (i.e. purpose) of the sampling was to have a representative a group as possible in terms of gender and categories of farmers existing within scheme. It emerged that only 30 percent of villagers had become rice farmers as compared to 70 percent of residents who did not have irrigated land, so it was important to properly represent the non-plot holders (non-irrigators). From this percentage we therefore used the registers for quota sampling[13], and random selection within quotas; 300 farmers were included in the formal survey, overall. From this sample, guided by later field visits, 20 male and female farmers (five male and female farmers from each of four villages) with irrigated plots were selected for further detailed study according to the number of plots that they owned and the location of their plots. We used this sample to represent what happened in plot reallocation to a small percentage (30 percent) of farmers in the villages. The questionnaire used with the 300 farmers is given in Appendix 1. The survey with questionnaires, follow up interviews and case studies took place from the end of March 2002 to December 2003 with breaks in between months due to bad weather and to allow report writing. The sample also included 128 male and 83 female-headed households that were non-plot holders (non-irrigators) (Table 1.8).

[11] In a stratified sample the sampling frame is divided into non-overlapping groups or strata, e.g. non-plot holders, plot holders of specific number of plots and gender. A sample is taken from each stratum, and when this sample is a simple random sample it is referred to as stratified random sampling.

[12] A village ledger book, found in the village government office, which has a list of all village members and number of plots that they own.

[13] Quota sampling: There are similarities with stratified or purposive sampling. In quota sampling the selection of the sample is non-random.

Table 1.8 Number of resident farmers categorised by production, village and gender of household head (N = 300)

Village	Mabogini		Rau		Chekereni		Oria		Total
Production system	Male	Female	Male	Female	Male	Female	Male	Female	
Commercial	15	2	14	2	2	1	1	1	38
Subsistence	3	1	15	2	15	6	8	1	51
Non-plot holders	22	15	32	21	42	26	32	21	211
Total	40	18	61	25	59	33	41	23	300

Rice plot holders:
- Number of male household heads in sample: 73
- Number of female household heads in sample : 16

Non-plot holders
- Number of male household heads: 128
- Number of Female household heads: 83

Source: Field data 2001-2004

Random selection and the nature of time and pattern of settlement within the sub villages caused the differences in number of farmers included to the study. Some of the sub villages had more farmers of a certain category than others. Farmers owning more irrigated plots were found in Mabogini and Rau villages compared Oria and Chekereni villages, where people settled later (discussed in Chapter 2). The samples also revealed that the number of women was greater among the non-plot holder group of farmers than in the group of plot-holders. This was because only married women had rights to use men's plots, and most of those who were single could not afford to own plots of their own. It is important for the reader to realise that while we later say a good deal about gender contrasts within irrigated farming, the difference between plot-holder and non-plot holder farmers on the scheme is already strongly gendered.

After the researcher identified the randomly selected sample of 300 farming households, days were set for short quantitative interviews in a village meeting in each village. This was followed by a long time qualitative data collection from the three categories of farmers in male and female-headed households. Although we began with 20 farming households as case study sample, this number changed over time. Earlier on, two farming households excluded themselves from research, which is why 18 remained for later queries. Later, and as contacts developed, six additional farming households wanted to be included that is why in the study of the division of labour there were 24 farming households (see Table 5.3). Researchers had a routine of visiting village elders' households especially during evenings for informal talks about histories of origins, the Chagga traditional irrigation system compared to the new irrigation systems, and the villages and people in Lower Moshi. This was done towards the end of the research, when we were very familiar with the area and people. The quantitative and qualitative materials collected from the villagers during the research period were analysed to formulate a report of the study. Quantitative data analysis was done through a statistical programme, SPSS according to Griffiths, Sterling & Weldon (1998).

By use of the quantitative data analysed description of households and populations were made mostly by use of means and percentages data in tables. Such

data was supplemented by qualitative analysis, which is explanatory. Focusing on the main research question of the present study, the qualitative data analysis was mainly done through framework analysis. It is a type of qualitative analysis that was explicitly developed in the context of applied policy research with an aim to meet specific information needs and provide outcomes and recommendations (Lacey & Luff, 2001). The framework analysis itself provides clear and systematic stages toward the analysis process. It helps one to know the stages by which the results were obtained from the data and also allows the inclusion of prior, as well as emergent concepts to be addressed. This analysis therefore provides a simple description of statistical data to enable discussions and conclusions.

1.8 Organisation of the thesis

The thesis consists of seven chapters.

Chapter 1 has reviewed relevant debates on irrigation development interventions in Africa, then narrowing to Tanzania, where a history of traditional and irrigation development has been discussed. Methodology has been explained, research questions stated and an account given of the actual data collection and analysis exercise.

Chapter 2 introduces the technical designs for water allocation, distribution and production in the Lower Moshi irrigation scheme brought about by the modernisation and improvement of the irrigation systems, and their imposition across and within the older communities. Later chapters then focus on contestation and stabilisation of different effects in different networks and levels of the scheme, seen in terms of critical sociotechnical linkages.

Chapter 3 focuses on the changes in water allocation and irrigation access resulting from main system management. It shows the water scarcity emerging for would-be irrigators, and inequity in water allocation in the modernised irrigation system, pointing out the emerging conflicts and contradictions. The chapter describes the mechanisms involved in system management, and the role of farmers within and outside scheme in their interactions with the modernisation process.

Chapter 4 looks below the outlet into dynamic changes in irrigated production and at users of the system, and changes have affected farmers' livelihood strategies, to grasp the new reality brought about by the modernisation process. A study on farmers' behaviour after the reallocation of land was made is reported, as well as commentary on the introduction of new agricultural technology. Impacts or changes in relation to crop production, hired employment and other production strategies, and income distribution among population are discussed, along with impact on livelihoods.

Chapter 5 focuses into intra-household gender relations shaping and being shaped by access to irrigated agriculture, and the contexts of diversified livelihood activities after irrigation was modernised. The chapter discusses the intensifying effects on existing gender relations in ownership of plots, agricultural production and division of labour, decision-making, control and use of benefits.

Chapter 6 presents findings on irrigation management responsibilities from the state to the Water Users' Groups within the community, where gender participation in water management was minimal due to both traditions and the modernisation intervention. The chapter discusses the implications of gender differentials in water rights, for participation in water management organisation, management of water distribution and other uses of water within the irrigation system.

Chapter 7 offers some conclusions. In relation to the findings, the theoretical and methodological approaches used in the study are revisited and discussed and a synthesis of major findings is offered. The chapter also discusses some implications of the findings for gender equality and irrigation development.

CHAPTER 2

THE DEVELOPMENT OF THE LOWER MOSHI IRRIGATION SYSTEM

2.1 Introduction

This chapter outlines the development of irrigation systems in the Lower Moshi areas, showing how a new public irrigation system was developed over and incorporated elements of indigenous systems. In methodological terms, it offers a technographic overview of the context within which irrigation operates in Lower Moshi (see Chapter 1).

Technography is a reasoned description of a technical system. In this case, there are two such systems to be described and explained. First, there is the modified traditional irrigation system that farmers developed when they moved into the Lower Moshi, in Moshi Rural district from the crowded uplands on the lower slopes of Kilimanjaro. They brought with them an experience of furrow irrigation and developed numerous such intakes along the rivers flowing through Lower Moshi district. It was over this local irrigation infrastructure (including institutions) that the Tanzanian government and Japanese aid attempted to develop a modernised system in the 1980s. This chapter draws largely on documentary sources, but supplemented with testimony from actors within the scheme. For evidence on the older system we are limited to surviving records and the memories of older informants. Distance lends enchantment, and informants may have idealised some of the institutional arrangements. But the basic picture they paint seems to coincide with other accounts of furrow irrigation for the region (Gray 1963; Masao 1974; Adams *et al*. 1994; Grove 1994). The modern scheme is amply documented, and this chapter relies heavily on this documentation in explaining design and implementation of the scheme.

The government of Tanzania, and the Japanese International Cooperation Agency (JICA) as the donor agency, used a top down approach to implement this irrigation development intervention across existing irrigated settlements. Experiences of implementing irrigation development intervention schemes in Africa have shown how schemes develop 'real lives', passing through changes from initiation or 'birth'. For example, Chambers (1969) identifies three phases: pre-settlement with its political pressures and technical activities, settlement and organisation with an emphasis on welfare and production and withdrawal, in which the centre of attention is specialisation and devolution. After irrigation schemes are implemented, they usually experience different configurations, influenced by state and society over time, which may also lead to success or failure according to original objectives. This means the operations of the schemes are never static, but keep on changing, due to interactions between the people, the government, the environment and the technology itself. This chapter introduces the scheme and certain mechanisms more commonly treated as 'black boxes' (Bolding 2005), to be studied in more detail in following chapters. The present chapter attempts to establish the context, as required for technography, as described by Richards (2002), Richards (2007) and Bolding

(2005). Section 2.2 provides additional conceptual discussion of development interventions. Section 2.3 describes the evolution of settlement and irrigation practices in the High and Lower Moshi districts before the project was introduced. Section 2.4 outlines the existed traditional irrigation technology and related livelihoods and water management practices. Section 2.5 describes the political interactions between the Japanese and Tanzanian governments over feasibility studies and plans leading to approval of the project between 1977 and 1983. Section 2.6 presents the technological changes anticipated with the modernisation of irrigation and the introduction of the new formal public scheme from the early 1980s, and the new organisations developed to steer this modernisation.

Section 2.7 outlines the water users' organisations developed under a second phase of modernisation in 1990 (a topic more fully considered in Chapter 6). Other changes are reviewed in Chapters 3 to 5. Section 2.8 sums up the chapter by identifying some key mechanisms.

2.2 Irrigation development interventions

This section defines and describes concepts of irrigation development intervention, in order to lay a foundation for understanding the interrelationships between the development intervention programme/agencies, and people within the irrigation scheme.

Development intervention, property rights and governance

'Development intervention' can be defined as an arena in which infusion of resources takes place in order to improve difficult situations such as drought, lack of food etc. According to Long (2001), such interventions are arenas (i.e. spaces) in which contests over issues, claims, resources, values, meanings and representations unfold; they are also sites of struggle within and across domains. In this case the Lower Moshi scheme is a site of struggle in which scheme settlers contest for natural resources (principally, water) with neighbouring villages. Long and Van der Ploeg (1989) argue that intervention implies the confrontation or interpenetration of different life worlds and socio-political experiences, which may be significant for generating new forms of social practice and ideology. Here we adopt a technographic and realist approach (Chapter 1) to analyse these contested processes of change initiated by governments through irrigation intervention.

Farmers are not passive recipients of an intervention. Planners may assume that projects will gain full acceptance by beneficiaries. But as Long and Van der Ploeg (1994) note, farmers always try to create space for their own interests so that they can benefit from or, if need be, neutralise interventions by outside groups or agencies. This interaction among social actors is dynamic and entails the shaping and reshaping of planned interventions. Within the targeted population there can be different responses: adoption, transformation or rejection of the intervention. Such results, which require to be carefully analysed in terms of their technical consequences via technography, are the outcome of power play by and negotiation among social actors. The concept of a social interface thus emerges, and is important for exploring planned interventions and the realities faced by irrigators. 'Social interface' as defined by Long (2001) refers to the critical points of intersection between different social fields, domains or life worlds, where social discontinuities, based upon differences in values, social interests and power, are to be found. In

supporting such a definition, Vincent (2001) states that the concept of social interface has been used to explore the role and significance of irrigation infrastructure and institutions in social action and at the interface between irrigators and engineers.

According to Coward (1984), 'interventions' can be distinguished according to whether there is direct or indirect investment. Under direct investment, the agency takes full control of implementation activities, including design and construction. In this case the agency manages the system, although it may be later turned over to farmers for operation and maintenance, once construction is complete. Under the indirect investment approach, the agency provides resources (finances, technical assistance, and materials) to an existing irrigation organisation in the form of grants, subsidised loans and technical assistance, which supports the improvement of the irrigation system. Management control remains with farmers. In the case of the modernisation of the Lower Moshi scheme, the investment approach can be considered as a direct investment, because it was the donors who were responsible for design and construction, although the management control of the system was (partially) in the hands of the farmers. In this direct approach, Coward (1986) argues that the state or property-based local irrigation groups are reinforced.

Governance by agencies in irrigation systems cannot be undertaken without the institution of rules to control operation and management. There are a number of typical rules and restrictions in effect to make operation and management attain targeted efficiencies. According to Ostrom (1992), three types of rules cumulatively affect irrigation systems. These are operational rules, collective-choice rules and constitutional rules. The operational rules refer to decisions such as when, where, and how to withdraw water, the monitoring of such actions, and the rewards and sanctions to be assigned to such actions. Rules of this sort are directed to both irrigated and non-irrigated farmers. Collective-choice rules are used by irrigators, their officials, and by external authorities, to shape management policies. These policies cover the development of rules and sanctions for operation and maintenance of the irrigation system, irrigation costs, disputed settlement, and modernisation and improvement of the system. Constitutional-choice rules determine who is eligible to participate in the system and what specific rules will be used to craft the set of collective–choice rules.

2.3 Evolution of settlements and reflections on irrigation practices in the Kilimanjaro highlands

This section describes the evolution of settlements and irrigation practices within the irrigation community of Lower Moshi from the colonial era. It shows how different groups of people settled in the area, acquired land and practiced traditional irrigation. The section has two parts. The first covers the pre-colonial and colonial periods, and the second the post-independence and villagization period up to the present. The aim is to lay a foundation for understanding problems in the Lower Moshi Irrigation scheme. This background information will be used to compare periods and analyze changes brought about after modernisation.

Settlements and community irrigation practices: 1923-1960

In 1923 the British colonial government prohibited hill furrow constructions in the overpopulated highlands, since these were thought to be causing European settlers

downstream to experience water shortage (Gray 1963). In order to solve such water problem the British increasingly encouraged the Chagga to re-settle in the plains, alongside a group of White settlers (Griffiths 1936). Such requests proved unpopular, due to a hostile climate, tsetse flies and presence of Maasai warriors. However, as outlined in Chapter 1, a combination of government actions, in furrow construction, driving out warring Maasai, and bush clearance to eliminate tsetse fly, changed options in the Lower Moshi area. Settlement in the lowlands spelt the beginning of the end for Wa-Chagga[14] confinement in the highlands. The first group of people were highland Wa-Chagga who settled around Mabogini village.

Table 2.1 Evolution of settlements and irrigation practices in Lower Moshi: 1923-1981

Year	Period	People who moved to the settlement	Irrigation practices
1923-1930	Colonial/Chiefdom Era	The Chagga people from highlands	Traditional improved /Furrows
1932-1950s		Workers and labourers of colonial Sisal Estates Workers and labourers of Sugar Estates	Traditional improved
1950s-1960		Chagga people from highlands	
1961-1968	Post independence	Private groups of people Flood victims from nearby villages	Traditional improved
1969-1981	Ujamaa villagization	Ujamaa village people Flood victims Sugar planting company workers	Traditional improved
	After villagization	Private groups of people (land seekers)	Traditional improved

Source: Author's compilation (2002)

Colonial government observed customary laws, and therefore land resources were distributed only to (predominantly male) heads of households. Some heads acquired land by bush clearing or through allocation from local government. At the time, very few people were able to purchase cleared and developed land. But the state recognised the right of occupancy by individuals, and married women were thus able to own land through their husbands. In those days there were very few female headed-households, but some women were allocated land for their families. Most of them were widows, while unmarried women and divorcees were rare, due to traditions such as the levirate.

The second group of immigrants to the area were male labourers and workers from different regions who moved to work in the colonial sisal and sugar estates in the lowlands. The Gynja sisal and Tanganyika Sugar Company estates acquired land from the native authority under an imperial ordinance enacted by the German Colonial Government (interviews 2002). According to respondents, the labourers who settled in the villages, sometime in 1932, acquired land by clearing it, but without permission from chief Mangoto who held the customary right of land allocation within the area. The chiefs (called *Mangi* in Chagga) Sabas and Mangoto, who ruled at the time, allocated new land for them in the area. Farmers said that *Mangi* Sabas, who was the chief of the northern part of Moshi, made two allocations.

[14] Wa-Chagga = Chagga people.

The first one was in the 1950, when allocation was made in the areas of Mabogini village. The second allocation took place ten years later (in 1960); this one covered the Chekereni, Oria and Rau village areas. For African farmers[15], both the highlands and the lowlands remained under the dominion of the tribal chiefs, who held the right to distribute land to the different clans within their territories. The process of the Chagga traditional land access enabled early migrant households to acquire free land for cultivation. The process included allocation by the chief (Mangi), while detailed subdivision was organised by the sub-village leader (called *Mchili)*. Although bush clearing took place by owners (men), confirmation by the *Mangi* was important. Among the first immigrant groups to gain land in this way were families moving mainly from the Marangu and Uru highlands. They were keen to seek irrigable land since their areas of the highlands were highly overpopulated. During this period, many farmers moving to the lowlands still retained a residence in the highlands and continued using their furrow systems for agricultural production. Some male respondents claimed that they still had wives and families living in the highlands that they still visit from time to time. Some men moved to the underutilised lowlands to fulfil the cultural obligation of providing a land inheritance for male children.

The Chagga furrow irrigation system in the highlands

Probably 300-400 years ago, the Wa-Chagga's, who are a Bantu group, settled on the western, southern and eastern slopes of Mount Kilimanjaro to which they were attracted by rich volcanic soils (Masao 1974; Grove 1993). Since that time, the Wa-Chagga appear to have used the water flowing from the mountain to irrigate their crops and for other household needs. Fertile volcanic soils and nutrient recycling has been the mainstay of Wa-Chagga home gardens, while the availability of water for irrigation ensured high productivity. The irrigation system of the Wa-Chagga has been cited as a good example of sustainable water harvesting (O'Kting'ati and Mongi 1983; Fernandes *et al.* 1984). Through a high level of labour organisation the Chagga managed to construct effective irrigation systems with only the most basic tools, and these have lasted for centuries. These systems consisted of networks of hill furrows, locally known as '*mifongo*'(Pike 1965). The furrows collect water from streams flowing off Kilimanjaro and transported it to the fields. Most furrows seem originally to have been built for domestic water supply and were subsequently adapted to irrigate coffee, bananas, finger millet and vegetables.

Irrigated agriculture

The Wa-Chagga have a long experience of irrigated agriculture in compact mixed crops holdings locally known as Vihamba[16]. The land tenure of the patrilineal Chagga (Moore and Purrit 1977) consisted of two types, vihamba and shamba land. A Chagga man traditionally was granted a plot to live on by his chief where he could establish his kihamba. The kihamba are permanently cultivated plots on which the owning householder normally builds his hut and lives (Moore and Purrit 1977). It is also where permanent crops and trees are grown. In Wa-Chagga custom, trees are connected to land holding. The shamba or kishamba is usually in the lowland, far from the site of residence. Shamba crops include maize, beans and fodder. Finger millet (Eleusine coracana), was another lowland crop that was grown and used for brewing beer and making porridge.

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[15] During this time there were European farmers as well (i.e. White settlers). This is the reason why the term African farmers is used instead of 'farmers'.

[16] *Vihamba* is plural, *kihamba* singular.

The development of irrigated farming systems was usually labour intensive, and the plots, generally small, were made close to the homesteads. Due to the nature of home gardens, trees and coffee trees are mixed with other crops, all farm operations were performed by hand, as opposed to work in the lowlands where tractors were sometimes used for ploughing. The intensive land use and cropping in the highlands was also characterised by a clear division of labour by gender. Men cleared the bush fields while women sowed and cultivated land. Men were responsible for lopping the fuel and fodder trees while women harvested fodder grass and herbs.

Cattle were kept for milk, and goats and pigs reared for meat, either for sale or home consumption. The interviewed farmers said that a farmer had an average of three cows, two goats and six chickens (interviews 2002). Livestock are stall-fed with fodder from trees and shrubs, banana plants, medicinal plants and grass grown on homestead. Stall-feeding within highlands was common due to the problem of tsetse flies. Supplementary feed was harvested from kishamba in the plains. Although both men and women used to irrigate, men did more of it, while women were very much involved in cultivating and harvesting. The peak labour period between January and March affected the gender division of responsibilities as well as labour. This is because coffee harvesting coincides with land preparation and planting of crops, both in home gardens and on the lowland kishamba. In contrast, April to June is a slack labour period before the harvesting maize, beans and finger millet in the lowlands. Division of labour also explains women's responsibilities in marketing surplus bananas, vegetables and milk, the proceeds from which they keep so as to meet the needs of their families, while men are responsible for marketing coffee, poultry and eggs, and keep the income for the family.

Water management

According to informants, access to irrigation water used to be strictly dependent upon clan membership, and was achieved through association with a local furrow board(interviews 2002). The furrow elders were responsible for the regulation of water supplies within the irrigation system. Many furrows on Kilimanjaro were named after the owner, whether clan or individual. A single furrow might be named after a person e.g. Lema's furrow (*Mfongo-woko-Lema*). But joint forces were applied in making a system of furrows a collective name (clan) name might be given, e.g. Maera's furrows. The name of the furrow signifies the people responsible. The furrow elders (*men, only*), were responsible for the regulation of water supplies within the irrigation system. When Wa-Chagga wished to use water they had to join a furrow board, run by elders. The furrow elders (called *wameku wa mfongo* in Chagga) arranged schedules in such a way that one person at a time had an irrigation turn. The turn lasted from early in the morning to afternoon and thereafter the water in the furrow was available for domestic purposes. Any person was allowed to use the water during the night providing the flow was returned at around 4.00 am. In case there was more than one person needing water in the night, they would divide the time among themselves, for each to have a turn before morning. The irrigation activities of the Wa-Chagga shaped their life patterns, including collective action aimed at keeping the furrows in good order. The operation of the irrigation system was said to run smoothly with little conflict over water because the furrow elders were highly respected and farmers obeyed the regulations, backed by traditions and sanctions of ancestral spirits. Going against the regulations set, risked punishment from the spirits. Many people feared such punishments might include death.

Maintenance of furrow systems

The cooperative nature of Wa-Chagga society was associated with the need to keep the irrigation furrows in good order, to maintain maximum water flow, to repair the banks, and to regulate the use of the furrow (Huxley 1956, in Masao 1974). As regards to the maintenance of the irrigation system, all adults had to take their turn in repairing and cleaning the furrows. The repair work and governing the use of the furrow strengthened local cohesion.

Furrow board elders possessed the authority and responsibility to mobilise members to maintain and clean furrows. Chiefs were able to call up obligatory labour to undertake construction of new furrows; it was men who did this while youths gathered materials for construction. In this case, women took part only in weeding and hoeing. Men who failed to participate in collective work had to pay a heavy fine of several barrels of beer. In maintenance work, sometimes, if furrows were damaged as a result of an accident, one of the elders would sound a horn in the evening. This was known as 'ole lo mfongo' – a public announcement to assemble for furrow work. The next morning, the men (mainly) were expected to leave normal work and set to repair the damage. Anyone who did not take part without a good reason was fined.

Settlements and irrigation practices within irrigation-based communities: 1961-1981

Chiefdom and clan powers were abolished after the British colonial period ended. When the country became independent (1961), the state declared ownership of all land and natural resources. The chiefs were still ruling communities until 1963, and had significant powers in the Kilimanjaro region, where customarily clan land belonged (ultimately) to them. But when land was nationalised through the 1963 Freehold Titles Act (Convention and Government Leases), all freehold titles within country (by then, Tanganyika) were converted into 99 years of governmental leaseholds (Shivji 1998). This policy was meant to readdress colonial expropriation and inequitable controls over land, and was implemented without much conflict. The local government became responsible for land allocation, and resource ownership was changed so that it came under the existing local government.

In the 1970s, during the time of Ujamaa Villages (Act was enacted in 1975) (Nyerere 1967,. 1968; Raikes 1975), the system of resource ownership was changed, so that it was based on communal principles. The policy of Villagization, however, was built around promoting communal production. People lived on and cultivated village communal plots, and divided the benefits among themselves. The Ujamaa Village Act was established and intended by President Nyerere to eradicate household food insecurity. During Ujamaa Villagization, other groups of people moved into the Lower Moshi area (especially in Chekereni) to join Ujamaa villages, both from various areas within Kilimanjaro region and also from other regions of the country. Most of these people registered to join a village where they were allocated land for cultivation and for residence. Village committees were responsible for land allocation, and land was still mostly allocated to men, as heads of households (most heads of households were in fact men). The approach completely disregarded the existing customary land tenure systems, while the future land tenure requirements of the newly established villages were also ignored (Shivji 1998). Villagization in effect meant abolition of customary rights and the compulsory expropriation of land previously administered under custom. The process reinforced the belief among politicians and bureaucrats that all lands not occupied under granted rights of public

occupancy were public lands at the disposal of the state. The relocation of villages and the redrawing of boundaries gave rise to boundary problems that continue today, including litigation to reclaim lost customary rights (Shivji 1998). This land redistribution process within country undermined the capacity of Tanzanians to produce their own food and made the country a net food importer, dependent on the benevolence of humanitarian aid.

Another group of immigrants were those affected by floods (interviews 2002). The villagers said that there were two major settlements of such immigrants (especially in Chekereni village). The first settlement emerged from the resettlement of flood victims in the area during 1965. The second came after severe floods, caused by three consecutive days of non-stop rainfall that hit the *Mkonga* settlement across Rau River in *Kahe* ward in 1968. As a result of these floods over forty families lost their houses, belongings and farms. The families were rescued and resettled in unclaimed land at *Mtakuja* sub-village close to Chekereni in Lower Moshi. The land was cleared by the farmers after being allocated by village leaders and subdivided into one-acre plots for cultivating crops, with 0.25 acre assigned for building a house. After these resettlement activities most land in Chekereni was claimed and owned in accordance with the land rights under the Villagization Act of 1975. At this point in time, no one owned land outright in Tanzania, as it was declared public property vested in the President as trustee on behalf of all citizens. This means the state was owner, while land users were responsible for any development on their allocated land.

Women and land resources

Traditional land tenure discriminated against women, since it was governed by laws of patriarchy. In most cases women did not own or inherit land. A woman would generally live with her husband on marriage, and was treated as a 'stranger'. Property passed from the husband to male children. Wives were not treated as members of the husband's family for land holding purposes, and the contribution of her labour was not seen as forming joint property. Access to land could be through inheritance, allocation, purchase or right of occupancy, but women rarely had money to buy, and accessed land only via their relationship to men as daughters, wives and sisters (Howard 1994). According to Fimbo and James (1973), however, this discrimination is now breaking down in many areas, and females are now more likely to gain inheritance rights over the self-acquired property of their deceased fathers. Such changes have also been found in Lower Moshi where farmers clearly indicated to have changed the tradition and that both male and female children are able to inherit land equally.

2.4 Traditional irrigation technology, practices and livelihoods in Lower Moshi

When people moved from the crowded highlands to settle the lowlands of Lower Moshi (from the 1920s onwards) they brought with them traditional (furrow) irrigation techniques. Although somewhat modified during the later part of the colonial period this system will be described (from memories supplied by older informants in this study) as a 'base line' against which the changes introduced by the later Japanese funded scheme can be understood. The traditional furrow systems, characterised by temporary and sometimes permanent constructions, were able to

service simple agricultural systems. These irrigation systems were farmer built and operated run-of-river gravity types, with temporary diversion structures, and conveyance from the source to the irrigated areas. There were about 35 of such water intakes within the area before the inception of the Lower Moshi Irrigation Project (LMIP) (KATC 2000). These intakes were used for much smaller irrigated areas than the present irrigation scheme. Out of the 35 water intakes, 23 were found along the Rau River and 12 along the Njoro River. The Njoro River was the source for furrows and settlements around Mabogini village, while the Rau River, below its confluence with the Njoro River, supplied settlements developing around Rau, Chekereni and Oria villages. The water source was from direct river diversions using Njoro and Rau rivers. The original technology of water diversion and conveyance was initially rudimentary, without gates or water control structures. Locally available materials were used including branches of trees, stones and bags full of sand in order to divert water into a system or canals. During rainy season floods, the low technology intake structures were often damaged or washed away, and this sometimes required farmers to rebuild the infrastructures each season, and sometimes more often. In 1935, the government initiated improvements of these intakes as part of a programme in the Kilimanjaro region, and there were some further repairs after Independence. However, by the 1970s (the time of the project) most local intakes were in need of repair, with poor concrete structures. Below these aging concrete structures, between the main and secondary canals, there were various traditional mud division structures, operated by local gatekeepers. Such structures controlled the direction of water flow to secondary canals within a village and tertiary canals to individual plots. The main problem was loss of water, because canals were not lined with cement and the drainage was inadequate. This problem did not cause too much difficulty to farmers because the type of crops they cultivated did not use much water and individual plots were small. Some irrigated water was always available, and especially after rainy season it was plentiful.

Water management

The involvement of local organisations in irrigation management was very much a manifestation of post independence socio-political ideology. The mixed group of people who moved to the area from various regions had to form new local governments within villages. These consisted of a village council responsible for various committees. The committee for economic development and planning was where allocation of plots and access of water was decided. Both men and women (from female and male headed households) with fields in irrigated areas were accounted holders of water rights. Married women were often counted as members in the name of their husbands (as discussed in Section 2.3). Although there were women members, the furrow committee (*wameku wa mfongo*) representatives consisted of only men as a sub-committee of the main village government committee. The local village government committee within each village appointed members of furrow committee, usually endorsed by farmers in sub-villages (*Vitongoji*). The village government comprised a chairman, secretary, and development committees, and used the sub-village leaders *(viongozi wa vitongoji*) to arrange for the election of a furrow man (*mzee wa mfongo*) from among local farmers. The irrigation farmers using the water resource canals generally elected this water manager and distributor; he was usually an elderly and respected man (furrow man or *mzee wa mfongo*) whose task was to organise daily water distribution. The position was put up for election after every three years. The exercise was done in each village within the Lower

Moshi community, since each village once had its own government. In each system they had a common water committee of about fifteen people, working with a representative from the village council under the leadership of the furrow man (*Mzee wa mfongo*), responsible for water management. Under his guidance, the committee accepted responsibility to prepare water schedules and organise canal maintenance. The local waterman selected by the board of elders helped the furrow man to allocate irrigated water.

The water committee respected the rights of village members. The social position of the water committee, and especially furrow men, was in return highly respected by everyone in the village. Its leaders were not paid in terms of cash but respect. Governance worked because it was appropriately low cost for the system and based on honour. But the obverse side is that social norms rooted in intergenerational cultures and traditions often reinforced unequal participation patterns in water management between women and men. According to Wa-Chagga traditions, women are excluded from becoming members of water organisation committees because this activity is a man's duty and affair. Women were said to be free to attend the meetings, but the heavy workload in plots and households prevented them, and so they more or less accepted these committees to be men's work. As a result, men became the main decision makers in irrigation, even when women were the major irrigators and cultivators in irrigated plots.

Water distribution

The existing water committee within the village government was responsible for allocation of water from furrows and its distribution to the secondary and tertiary canals. Their responsibilities also included maintenance of intake weirs, canals and the rotation of water between irrigated areas within the village. There were a number of watermen who worked under the committee to make sure that the allocation and distribution activities were carried out effectively. The furrow men and water committees organised rotation and distribution of water by roster, allowing farmers to know when and where water was to be allocated within the scheme. The furrow man (*Mzee wa mfongo*) was responsible for water allocation and distribution according to four 6-hour schedules (i.e. 6.00 am, 12.00 am, 6.00 pm, 12.00 pm); these were the times that different farmers were supposed to get water to irrigate their crops. When farmers knew their turns they attended promptly so that other farmers could get their own turns on time too. Farmers had to see the *mzee wa mfongo* to register and to know their assigned turns. A few watermen were also selected to help the furrow man especially in opening and closing the water gates, made locally by villagers. The water schedule was without favour to either men or women. Sometimes women, especially from female-headed households, might get night shifts, but men were cooperative, and escorted them. This water sharing behaviour was based on cultural norms stressing cooperation, even under increasingly mixed tribal community conditions. These norms remained strong enough at times of stress to counterbalance any incentives for defecting or acting against the norms, such as stealing water or in the case of water committees, demanding high payments for repairs. Sometimes it used to be the case that such individuals would face opposition from the whole society for the antisocial behaviours. There were few complaints about inequalities of water distribution because male and female farmers were given the water service equally. Apart from the responsibility of regulating water distribution in the furrows, the furrow man and the furrow board also monitored

furrow erosion, and arranged irrigation days for each household to diverted water and maintained furrows. The furrow man also solved water conflicts and other inequalities between individuals. There were fines (paid in terms of animals or other assets) for anyone caught irrigating on the wrong day.

Maintenance of traditional irrigation systems

Cultural values were respected within the traditional system, especially on maintenance days. Both men and women, as a community and water users, participated as needed in cleaning and maintaining the canals, but women had nothing to do with the intake weir. Women were strictly forbidden to enter the intake, since it was believed that to do so would cause the water to dry up, and a goat would have to be sacrificed to restore the flow. Communal work was done on specific days during the year after end of rainy season, when there was accumulation of silt in canals, or growth of grass on canal banks that is when elders would remind people through announcements. The village council and the water committee had to make sure that adequate labour was found for maintaining the furrows. The job was made possible because the tradition of communal labour existed, backed by community laws. Usually a day a month was set aside for communal irrigation system cleaning. In the evening of the day before work was required, a horn (*baragum*u) would be blown and an announcement made to remind all the villagers. The communal work, known as *Mtharagambo* within irrigation system used to involve men, women and youth. If any adult fail to attend they might then send children or a relative, to avoid punishment.

Involvement in the task was regardless of age or gender, but there was division of labour for specific tasks. For example, construction of furrows was men's work, while weeding and hoeing of fields was women's work, and gathering of materials for construction work was a task for youths. Communal furrow construction was regarded as a heavy task; therefore males (including young men) were designated for the work. It was the role of water committee to organise for intake and canal maintenance. Farmers who contributed to the designated work, had a right to use water, but if a family failed to contribute to work they would be prohibited access to water. Few people, who missed participation in communal works used to ask special permission from *Mzee wa mfongo* or board elders beforehand. In short, when performing irrigation activities, villagers worked together as a family with the same aim of getting good water, both for crop production and for domestic use such as cooking, drinking, washing, tending animals, mixing mud for buildings etc. The scheme was owned, managed and maintained by farmers themselves via the village government.

Livelihood activities

Being used to home gardens *(vihamba*) in the highlands with plenty of water (Okting'ati and Mongi 1983; Fernandes *et al.* 1984) the Wa-Chagga had to change their farming systems to fit the climate, soil and water availability of the lowland areas where they resettled. They transferred their irrigated farming system of mixed cropping to the lowland scheme, and these farms (*shamba),* were far from their homesteads. Within the *shamba* system, they cultivated maize, local rice, cassava, sweet potatoes, mixed with other crops like beans, various types of vegetables and sugarcane. The decision to cultivate such types of crops within farming systems was made according to household interests and type of soils. For example in Mabogini

village, where land was fertile and swampy, farmers cultivated local rice, sugar cane, although other crops like maize, beans, vegetables and plantains were also cultivated.

In Oria and Rau, where land was also fertile but river flow more unpredictable and seasonal (see Chapter 3), the major crops included maize, with only a little rice, vegetables and beans. Sisal was also cultivated in this area by the sisal company. It was different again in Chekereni village, where land was less fertile and the Rau River was less predictable. In this village, farmers cultivated maize, cassava, sweet potatoes, plantains, vegetables and sugar cane as irrigated crops, with finger millet, some maize, sunflower and cotton on rain fed land. In addition to irrigated agriculture, farmers also kept livestock (as a form of capital). Ikegami (1995) described the old Lower Moshi irrigation community as an area where most farmers were involved in irrigated agriculture, but where basic staples were raised mainly under rain fed conditions, and where the major crops cultivated were maize and sunflower. This was not what was stated when farmers were interviewed because they said that they cultivated all types of crops in irrigated plots.

Informants said that the pre-modernisation irrigation community on the lowlands operated at low levels of productivity, due to unreliable rainfall and infertile plots. Although some of the irrigated plots were small, farmers were able to secure basic subsistence throughout the year. Sizes ranged from 0.4 ha to above 1.0 ha depending on how and when the farmers acquired land. There were farmers who came earlier to the area and acquired more land through bush clearing while later arrivals were allocated one acre by the village government. The harvests of maize from such small-irrigated plots were on average about one to two bags[17] twice a year per plot (0.4 ha), but other mentioned crops were harvested throughout the year. Farmers also had other rain fed plots where they grew maize and cotton as cash crops. Although the plots were sometimes larger than 0.8-1.2 ha[18], yield was very low due to unreliability of rain and infertile soil. Sometimes the total yield of maize would be between half and four bags per acre; not enough to cater for the family for the whole year.

In addition to crops for subsistence and commercial purposes, keeping cows, goats and chicken was part of the tradition of many of the ethnic groups of people moving to the Lower Moshi area. Animals provided income, household food supplement and savings. Live animals served as 'money in the bank'. Income was generated when farmers bought animals following their harvests and then sold them during the time people needed meat for ceremonies. They served as food supplement when an animal was slaughtered and part of the meat sold and the other part consumed. Although animals belonged to the head of the households, it was the responsibility of women and young boys to take care of them, cut fodder and take them out for grazing, and also to do the milking. Where there were several wives women took turns in caring for animals and milking them. Milk was used for home consumption and was also taken by young men for sale in town. It was common that chicken and ducks were kept by women and boys, which were sold for cash when need arise or kept for home consumption. Often traders came from town to buy chickens, ducks and eggs. The (small) income from milk, eggs etc was used by women for personal or kitchen necessities.

[17] One bag of maize is equal to about 100 kg, depending on size of empty bag that is used.
[18] 2.47 acres is equal to 1 ha.

2.5 Irrigation modernisation plan: 1969-1978

This section describes the interactions between the government of Tanzania and the Japanese agency regarding the preliminary steps in the modernisation of the Lower Moshi irrigation scheme.

The two governments negotiated terms, aims and conditions and made agreements on loan aid. Factors leading to the decision to modernise the system are described, and plans for modernisation are shown. The description in this section supports the analysis of the outcome of the modernised scheme. Although the Japanese referred to the changes as introducing an improved irrigation system, the modifications were far reaching in their upgrading and the complete reconfiguration of technical and managerial structures are thus henceforth referred to as modernisation of the system.

Photo 2.1 Late President Julius K. Nyerere and a Japanese representative at Lower Moshi

Source: KADP office photos

Under late president Nyerere, Tanzania became one of the largest recipients of development assistance in sub-Saharan Africa (Ampiah 1996). Japan's economic assistance to Tanzania was mainly in the form of grant aid and technical assistance (Ministry of Foreign Affairs of Japan 1990). The modernisation of irrigation systems and irrigated rice farming in Lower Moshi through grant aid was one among several major Japanese aid projects linked to the food shortages of the 1970s and 1980s (Ikegami 1994). Before the project was initiated the government of Tanzania had started its second 5-year plan for the period of 1969-1974, which sought national development through regional decentralisation coordinated by central government. In 1970, the government of Tanzania requested the government of Japan to assist in the establishment of an integrated development plan for the Kilimanjaro region. In response to this request, JICA undertook preliminary research from 1974 and submitted a report on the Kilimanjaro Integrated Development Plan in 1977, indicating a variety of possible projects with regard to agriculture, small-scale industry, water resources and education. In order to implement the plans, the two governments signed an agreement providing for completed projects to be handed over to the government. The Japanese government through its aid agency JICA gave loans to about 16 projects. The first two projects under the Kilimanjaro Regional Integrated Development Plan (KRIDP) were the Kilimanjaro Industrial Development

Centre (KIDC) and the Kilimanjaro Agricultural Development Centre (KADC). The decision to modernise the Lower Moshi irrigation scheme was in line with the central government's National Development Plan, to modernise various schemes as part of the decentralisation initiative. The aim was to achieve improvement in infrastructure, operation and management, to ensure stable production of food crops for food security.

The plan to modernise the scheme, drawn up by the regional authorities of Kilimanjaro, was among a portfolio of eight agricultural projects in the 1979 Integrated Development Plan for Kilimanjaro Region (JICA 1980). These projects were incorporated into the third National Five Year Development Plan (1976-1981), with an objective to increase food production for the country. The two viewpoints (local food security and an increase in national food supply) were reconciled in the development models adopted for the Japan-Tanzania cooperation program: plans were made, feasibility studies executed and designs implemented.

Table 2.2 Activity events of irrigation modernisation: 1969-1987

Year of event	Activities
1969-1975	The government of Tanzania started its second Five Year Plan for 1969-1974. Tanzania government requested the government of Japan to assist with Establishment of Integrated Development Plan for Kilimanjaro region
1975-1978	In response there was technical cooperation. Japan undertook preliminary research and submitted a report on the Kilimanjaro Integrated Development Plan in 1977 indicating a variety of projects
1979-1982	Phase 1: Feasibility study was carried out by JICA. Technical cooperation was initiated and 38 projects were proposed. Both governments agreed on six high priority projects, one of the six was Lower Moshi Agricultural Development Project
1984-1987	Construction of Lower Moshi scheme Rice cultivation on communal farm (trials)/ teaching farmers Formation of Water Users' Associations Production of irrigated rice
March, 1993	End of the Japanese contract Kilimanjaro Agricultural Development Project (KADP) had its staff remain to run and manage project facilities.

Source: Author's data compilation 2003

The modernisation work on the Lower Moshi irrigation scheme, initiated in 1978 and completed in 1987, required a loan of 3.3 billion Yen[19] from the Japanese government and a contribution of US $104,815.00 (128,398,744 million Tanzanian shillings) from the Tanzanian government (KADP and JICA 2001). The government and JICA decided that the existing infrastructure and management institutions were not suitable for intensive irrigated rice cultivation (JICA 1980). It was made clear that the traditional system was only capable to contribute a limited amount to year round food harvests, barely meeting farmer livelihood requirements. JICA and the government argued that lack of surplus for sale limited the capacity of households to meet other needs. As discussed in Chapter 1, the planned irrigation development interventions in Tanzania focused on commercial crops rather than subsistence, to boost farmer income for improvement of livelihoods. The plan for modernisation of

[19] In 1987: Exchange rate of 1 US dollar to Japanese yen was an average of 132.68 (Source: Japan/US Foreign Exchange Rate (Board of Governors of the Federal Reserve System)).

the irrigation system was also triggered by food shortages resulting from the oil price shock in 1975-1978. Agriculture's share of GDP was low; averaging only 38 percent in 1974-1978 (Mascarenhas *et al.* 1985) and the collapse of the East African Community in 1977 increased the burden on public spending. The brief war with Uganda in 1978, a second oil price shock in 1979, and a general decline in world prices for agricultural commodities further eroded the value of export earnings.

A food crisis in 1977 caused the country to spend US $187,755.00 (230 million Tanzanian shillings) importing maize, rice and wheat (Morrissey 1995). At later stages, the project aligned with the 1983 National Agricultural Policy emphasising increased food production through improved irrigation systems (URT 1983). Planning and implementation of the project was achieved in phases. The first phase (1978-1986) included feasibility study by JICA and the initiation of technical cooperation. The purpose of the feasibility study was to assess economic feasibility and whether the scheme was sustainable without detriment to water supply (JICA 1980; Nippon Koei and Pasco International 1998). The design was assumed to have a possible life of at least 50 years without major changes. An area of 6,320 ha was identified as potentially good for project irrigation in JICA studies. Out of this total, only 2,300 ha were used when the project was established (KADP and JICA 2001). According to the feasibility study report, the area was suitable because it involved a large contiguous area skirting the southeast of Kilimanjaro Mountain at an altitude of 700-800 m above sea level, suitable for paddy cultivation (KATC 2000). Accessibility was also regarded as good in terms of distance and communications to rice markets.

The soils in the lowland area were considered adequately fertile and suitable for rice cultivation. Most of the central part fell into the category of medium fertility. The Kilimanjaro Agricultural Training Centre (KATC) (KATC 2000) identified a small tip towards the north with medium-high fertile soils around the Mabogini sub-villages, while considerable parts, towards the southern boundary around Chekereni, are rated as having low fertile soils. These include the dystric cambisols derived from alluvial materials with generally a silty-clay or clay structure. These are neutral or slightly acidic soils. Mollic greysols, developed in the narrow depressions of old river channels) along the Rau River are also encountered. These have a clay or silty-clay texture, and are slightly saline. Eutric greysols are found along the upper reaches of Rau River. These are of clay texture and mostly found in Mabogini, where local rice was formerly introduced by farmers who came from the highlands. Since the irrigation scheme was planned for cultivation by individual farmers, smallholder capacity was taken into account. Positive aspects included the introduction of cash crop would be facilitated by farmers being accustomed to growing cash crops like cotton, and coffee (in the highlands since the 1930s). They were therefore expected to be able to apply their experience in managing input supply and marketing aspects of cash crop production to rice. Secondly, irrigation activities in Kilimanjaro region had a history of more than a century, so farmers were used to irrigation practices.

The irrigation project was planned on the basis of estimated water availability, demand for the anticipated crop pattern and matching of water supply with demand. The identified area was found to depend on irrigation water supply from both rivers and rainfall for the whole cropping plan. Since the average rainfall would not exceed 590 mm per annum, the surface water resources of both the Rau and Njoro rivers were needed for irrigation. It was proposed to transform the intakes and trunk water canals of both the Rau ya Kati and Mabogini systems, and to use these to supply a unified canal system to replace the many intakes along the rivers. The rebuilt intake at Mabogini supplied water to the upper and lower areas of the village, but also passed flow downstream that was then augmented by the Rau intake flow to supply

Rau, Chekereni and Oria village lands. Given these changes, that might magnify effects of water flow variations especially during wet years and dry seasons, villages at the tail end would be affected. Therefore the design also proposed additional measures to enhance water utilisation efficiency, especially upstream, for example through 'fair' water distribution, construction of small dams to catch and store water during the March-May long rains, and drilling boreholes to 50-100 m to tap the available ground water for pumping to reservoirs. It was proposed that six and eight bore holes would be dug on the Rau ya Kati and Mabogini systems respectively. It was envisaged that reservoir dams would be constructed after electricity was supplied to the area. The proposed crop for cultivation in the irrigated area was rice. Initially, 80 ha were planned for the Rau ya Kati and 120 ha for Mabogini, and then was to be increased over time. It was planned that other crops like beans and maize were to be cultivated by use of rainfall and /or drainage of water.

2.6 Modernisation of the scheme: 1984-1987

Technological improvements

For the second, phase (March 1984 - April 1987), the Japanese private engineering company (Nippon Koei) was invited by JICA for the actual construction (Takeda 1999; KATC 2000). The implementation first transformed the infrastructure and agricultural technology, and was followed later by attempts to devolve irrigation management and improve water and financial services. Implementation also involved changes to irrigation and agricultural technology at farm level. These included farm levelling, reduction of cultivated area, reallocation of plots, and introduction of new agricultural technologies and forms of irrigation. The impact of these changes will be discussed in forthcoming chapters (3, 4, 5 and 6), where the goals and objectives of the modernisation scheme will be discussed.

Table 2.3 Improved structures

Type of Structures	Specifications
1. Type of canal	**Length in km**
Main canal	10.1
Secondary canal	24.6
Tertiary canals	65.6
Drainage main canals	16.2
Drainage Secondary	32.0
Tertiary canals	40.9
Flood dyke	15.7
2. Farm roads	**Length in km**
Trunk roads	16.1
Main roads	18.1
Secondary roads	38.7
Tertiary roads	35.6
3. On farm works	**Length in km**
Water courses	72.9
Field drain	64.4
Field road	77.8
4. Type of structure	**Number**
Water gates	150
Intake weirs	2
Division box turnouts	11
Culverts	Many
Aqueduct	1

Source: Tamura, KATC 1996

Both designs and materials were 'improved' to change the use of water from the sources of Njoro and Rau rivers as planned. The major intakes on both rivers were newly constructed in concrete to make them floating types of weirs. Various canals were laid out from these two main intakes, which then became the major sources of irrigation water supply within the Lower Moshi irrigation system area. Table 2.3 shows the changes in terms of the number of infrastructural developments intended to improve water productivity, allocation and distribution among farmers. The main canals of both Mabogini and Rau-ya-Kati to a length of 10.1 km, and a total of 24.6 km of secondary canals as well as 65.6 km of tertiary canals were concrete lined. Within these canals, division boxes turnouts/ diversion structures, and cross-regulators were placed to make it easier to distribute water among the four villages. The Mabogini intake system was designed with seven turnouts and the Rau system with four turnouts, with one aqueduct to enhance the distribution, as well as many culverts for drainage. Previously, there were 12 independent off takes along the Njoro River and 23 along the Rau River; some remained outside this new system, others became assimilated within it and dependent on the water released and controlled across the system. Most of the drainage systems were made of earth. The main drains totalled a length of 16.2 km, the secondary drainage some 32.0 km and tertiary drainage canals some 40.9 km. Flood dikes were installed along 15.7 km to control floods. There were a number of other structures improved in all villages, including 150 water gates. According to respondents, construction tasks were already completed by September 1982 and the traditional irrigation furrows incorporated into the project canal system. But it is noteworthy that not all the plans for the improvement of the infrastructure were implemented. Unexecuted plans

included construction of reservoir dams and drilling of boreholes to help the future dryness in the area. Reasons for failure to implement these plans were not disclosed.

Village farms converted to paddy plots[20]; command area and land use patterns
In order to attain the target, a small piece of land (initially) was demarcated for cultivation of high yielding varieties of rice. Farmers never participated in the decision to convert their farms to paddy plots. The farmers remember being called to a public meeting held in Chekereni village in December 1984. It was announced there that paddy cultivation had already been established on the communal village farm and was then supposed to be introduced on villagers' farms. Respondents reported that all farmers within the demarcated area were asked to harvest all their crops at once so that the levelling process could begin. Some women explained bitterly:

> *It was like a nightmare to see farmers up rooting crops like cassava, sweet potatoes, plantains and maize, which were well established. Most of us did not know what was happening. We saw many Japanese directing the tractor drivers to start levelling our plots. Many people were against it, but did not know what to do. Some people went to consult witch doctors to stop the Japanese from invading their farms. They buried a live goat at the intake, as witchcraft to stop them, but could not help. Some men farmers went to report to the Area Commissioner in Moshi and that is where they were told about the plan of rice farming in our farms. (Interviews 2002)*

Only part of the Lower Moshi scheme (2,300 ha out of approximately 6,320 ha) was demarcated for the project main activity (rice). The donor agency decided to reduce the irrigated area so that the available water would be enough to ensure cultivation of an irrigated rice crop, which needed plenty of water. After the cultivated area was reduced and old farms levelled to 0.3 ha plots sizes, they were redistributed to the farm owners occupying the land before the inception of irrigated rice cultivation plan. The farmers to whom land was redistributed were mostly male heads of households who got their original land allocation from the existing village government. As explained above, traditional land allocation was through heads of households (mostly men, though including a few women who were either widows, unmarried and divorced). The land within the scheme was divided into a number of irrigation blocks according to the plans; each was subdivided into farm plots (see Figure 2.1 and as shown in Map 1.2 in Chapter 1). There were 70 standard plots of 0.3 ha (30 m x 100 m) in one standard irrigation block (21 ha). There are 3,787 plots within the scheme and a total of 43 blocks in the project area distributed among the four villages; Mabogini village has 1,639 plots spread across 472.67 ha and Rau, Chekereni and Oria villages together have 2,148 plots (as shown in Table 2.4), spread across 284 ha and 14 blocks in Rau, 263 ha in 12 blocks in Chekereni, and 104 ha in four blocks in Oria (KADP 2001).

Table 2.4 Total numbers of plots within villages[21]

Canal	Location	No. of plots	Average plot size
Mabogini	Mabogini village	1,639	0.3 ha
Rau ya kati	Rau, Chekereni and Oria villages	2,148	0.3 ha
Total		3,787	0.3 ha

Source: KADP 2001

[20] Paddy plots are locally called "maboda" in plural, "boda" in singular
[21] Due to changes of irrigated areas, the recorded figures in KADP vary among documents.

One tertiary canal, drain and farm road were planned to serve one irrigation block. Field channels, drains and farm roads are aligned along the width of every plot. Farm roads were also constructed so as to make it easy for the vehicles and tractor to move about during ploughing, puddling or transporting harvest. As shown in Table 2.5, Mabogini as a section of the scheme currently commands a net potential irrigable land of 955 ha. The Mabogini system is subdivided into upper and lower Mabogini.

Table 2.5 Command areas and land use pattern in the LMIP (ha)

River system	Paddy Season Wet and (Dry)	Maize and other upland crops	Non-smallholder farms	Total
Mabogini (Upper/Lower	490 (350)	395	Usagara 70	955
Rau ya kati, Oria & Chekereni	610 (450)	655	Pilot farm 80	1,345
Total	1,100 (800)	1,050	150	2,300

Source: KATC 2000

Out of 955 ha, 490 ha are used for paddy production; 395 ha is supposed to be for maize and other upland crops. It was also planned that 70 ha be used for sugar cane for non-smallholder farms and pilot farm production. The Rau system receives irrigation water from an intake located on the Rau River. It commands a net potential irrigation area of 1,345 ha across the three villages (Rau, Oria and Chekereni).

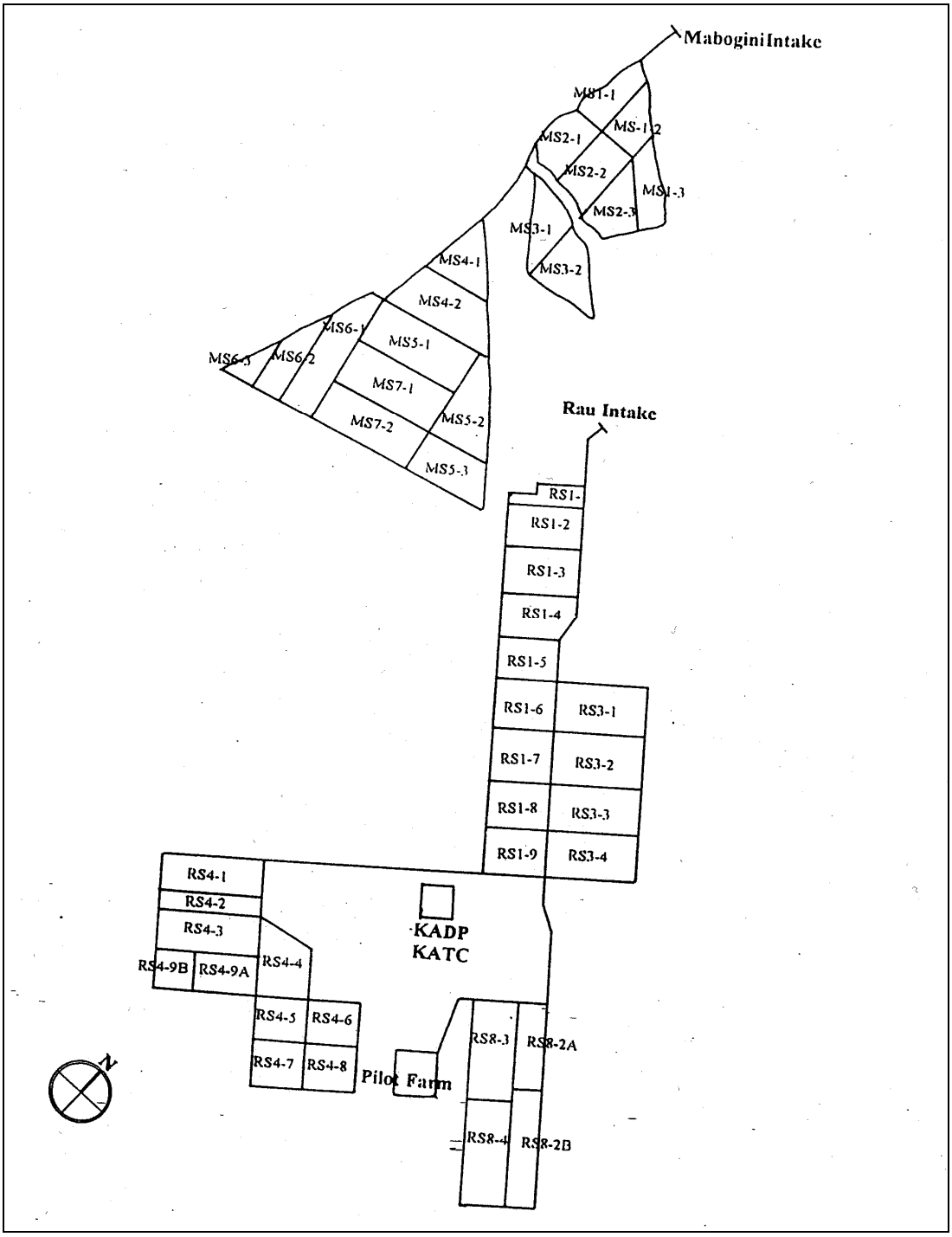

Figure 2.1 The command area of Lower Moshi irrigation scheme, showing plots

Source: Tamura, KATC 1996

Of this total area, 610 ha are for paddy cultivation, 655 ha were supposed to be for maize only, and 80 ha for sugar cane (pilot farm) production (KATC 2000). Out of the net irrigation area of 2,300 ha (within four villages), the whole scheme was initially designed to irrigate 1,100 ha of rice during the wet season, as supplementary irrigation, while in the dry season the area had to be reduced to 800 ha due to water shortages. This means that out of 2,300, only 1,900 ha were being cultivated per year. There are also 1,200 ha of upland plots using either drainage water or rainfall.

The total irrigated water within scheme supports a small fraction of households out of those in the four villages of scheme, while other farmers live in outlying the villages. The data indicate that there are more cultivated plots in Mabogini system, where there is plenty of water, compared to the other villages. The Mabogini system uses the Njoro River intake; the Njoro is a more reliable source than the Rau River, and irrigates a larger area. During dry season, flow in the Rau system is merged with that from the Njoro to enable effective irrigation. The land area to be irrigated is reduced (over original plans) because of shortage of water, especially during dry season.

Agricultural technology improvements

Training of farmers to adopt irrigated rice farming

While construction was taking place other aspects of modernisation were implemented. This included agricultural technology. In 1982, the existing communal farms of the villagers were turned into project trial farms where farmers were trained to adopt agronomic practices associated with irrigated agriculture. A rice cultivation package was developed by the paddy section of KADC, taking account of the rice ecosystem in the area. The high yielding variety of rice IR54 was introduced after trials of varieties of IR20, IR54, IR56 and various local types at the pilot farm within Chekereni village (KATC 2000). The testing involved variety spacing, fertilizer rates, and time of application, bird control methods, insect, pest and disease control methods etc. Variety selection was based on early maturity (3-4 months), high fertilizer response, large and heavy grains, resistance to disease and insect damage, low temperature tolerance, suitability for manual threshing, semi-dwarf stature, palatability and cook ability. When compared to local varieties, IR54 was preferred because management said small farmers preferred it, due to ease in de-husking.

Although the aroma is not rated highly the variety yields abundantly (up to 6.5 tons/ha). Reasons given by farmer-informants contradict this picture. Farmers say the project office (research section) made the choice because the major aim was to increase output. Farmers were informed about the production capacity and other characteristics of the introduced variety, and accepted it because they wanted to produce more for sale. As a result, most farmers were willing to be trained and then to cultivate the crop, especially after demonstrations proved successful (yielding about 30 bags of rice per plot of 0.3 ha). Farmers were attracted by this higher yield, and neglected other types of food crops. Training was based on trials to establish crop husbandry systems and irrigation management. These trials included irrigation methods suitable for local conditions. The project staff then provided training in improved methods, so that they would be able to manage according to plans, ensuring the system was run in the ways described in donor documents. A factor in training was to ensure visible technology transfer (e.g. Japanese style straight line transplanting, tractor cultivation, use of chemical fertilizers and pesticide application) (Ikegami 1995). It was mostly men, the landholders, who were recruited for training. According to respondents only a few female household heads were also trained because they were landowners.

Introduction of the high yielding variety rice; a package approach

The high yielding rice variety was introduced as a package together with other facilities including tractors, fertilizers, pesticides, supplemented by a post harvest centre (go downs, drying areas, processing equipment), a farmer's training centre and trucks to transport harvest. The high yielding variety took a key place in this package because donors were fixed on the idea of dramatic yield increase.

Even though the irrigated area was smaller than originally envisaged the donors were still confident that variety and fertilizer use, plus irrigation water, would bring about a dramatic increment, enough for subsistence and sales. They also imagined rice could now be cultivated two to three times a year. Farmers were expected to produce, store and process more because of their access to knowledge from the training and extension facilities provided. Even those without plots were expected to benefit through on farm employment and cheaper food.

Seeds and fertilizers

Initially it was decided that specific farmers were to be selected from each village and assigned to produce IR54 seed for the whole village. Seeds were to be thoroughly checked and recommended by Kilimanjaro Agricultural Development Project (KADP) extension staff before planting by the community. Later, KADP advised the Farmers' Cooperative to obtain seeds from other sources and to sell to farmers. Agro-chemical inputs (e.g. Urea (46 percent N) and TSP (Triple Super Phosphate (45 percent P and 20 percent P) were distributed either through the Kilimanjaro Native Cooperative Union or branches of the Tanzania Farmers Association (KATC 2000). Supplies were not always consistent due to late delivery, and the price was too high for small farmers. Later inputs were sold at cooperative shops, and sometimes it was provided to by credit (repaying the money after harvest). In order to minimise crop losses, mainly caused by insect pests, diseases and weed competition, a crop protection package was disseminated (KATC 2000). Other crop losses from birds and wild rats were controlled physically by farmers themselves through hiring young boys to scare birds especially during the ripening period of crop before harvesting. It was recommended that weeds were to be controlled by proper land preparation, good water management (flooding), and both hand and mechanical weeding. No chemical weeding was recommended; hand weeding at approximately 15 days after transplanting was considered the best practice. Farmers found chemical application troublesome. For example, the Urea (46 percent N) was to be applied three times to the rice plot (0.3 ha) in split doses, 50 kg during the last course of puddling[22], 25 kg at commencement of tillering[23] (14 days after transplanting) and 25 kg at panicle initiation (booting) stage (56 days after transplanting). Fertilizers were to be applied in shallow water and the soil allowed drying until two weeks before harvesting. This proved a real challenge to many poor farmers (as will be discussed in Chapter 4).

Tractor hiring service

In 1985 a total of 35 Kubota tractors and their implements were received by the Regional Development Director (RDD), Kilimanjaro region, for the planned rice farming in Lower Moshi. This was a loan by the government of Japan to KADP (KATC 2000). A tractor hiring service within the scheme began to operate in 1985-

[22] The flooding of paddy fields.

[23] The stage a plant goes through when side shoots are developing which each may carry its own flower and ear. Each such shoot is a tiller.

1986. The tractors arrived before the start of the first rice cultivation season. The main objective was to meet the requirements of the originally planned levelling and block cropping pattern, since this would make utilisation of available water more efficient. Taking into consideration ready labour availability and the economic conditions of the people of Lower Moshi, it was decided that the only field operations to be mechanised would be rotary ploughing and puddling. This meant that farmers were supposed to pay for the service. In order to avoid delays in farming within time allocated; the price for tractor hiring was combined with water charges. The farmer was required to pay for both before each season began, and in advance, to avoid those likely to default. After suffering much damage and wear-and-tear, the tractors were replaced in 1993 and 1994 with 16 new tractor units and implements (KATC 2000). By December 1995, out of 35 Kubota tractors received in 1985, only 15 were still in good working condition; 18 were serviceable condition if spare parts were available, while the remaining two tractors were beyond repair. At the time of this research, most tractors were broken down, with only eight out of the initial number of 51 remaining functional.

Cropping pattern of paddy

It was important for the cropping pattern to be understood by farmers so that the operation and maintenance of the irrigation system would run smoothly. The cropping pattern was therefore prepared in such a way that the crop development stages did not coincide with the period when temperatures fall below 15°C, to avoid cold injury to the crop. At the beginning it was decided to have two growing seasons per year (January to June and July to December).

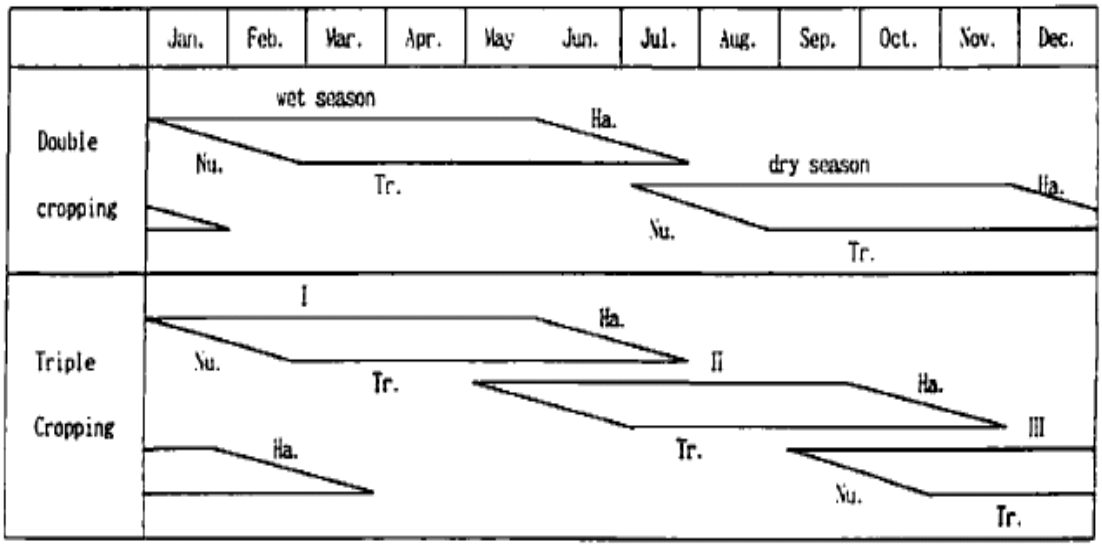

Figure 2.2 Cropping pattern of paddy at Lower Moshi

Source: KADP 1989

Later, three seasons were adopted (January to June, May to October and September to February). These changes were made by KADP after experience of water shortage in 1988. As shown in the Figure 2.2, it was planned that during rainy season (January-June) more rice would be cultivated compared to during the dry season (July–December) when water is scarce. Each field is rotated or left dry for at least five months. It was planned that the whole paddy area of 1,100 ha would be planted with rice during the rainy season and 800 ha in the dry. No irrigated upland

maize was planned for the dry season because water was considered insufficient. The whole area for upland maize (1,200 ha) was cultivated during the rainy season on the assumption that supplementary irrigation would be possible using surplus water.

The 150 ha of the Usagara area in Mabogini and the pilot farm, which used to be communal farm during Ujamaa village operation (at Chekereni) were also used for upland maize cultivation.

Labour and income estimates for farm plans
In conformity with the plan, a total of 1,900 ha of paddy was to be cultivated each year with an expected annual harvest of 8,550 tons at an average yield of 4.5 to 6.5 tonnes per ha (estimated from trials with technology introduced on communal farms (KATC 2000). It was expected that individual farmers would harvest about 25 bags (a bag weighs 100 kg, thus 2.5 tones) of paddy from each 0.3 ha plot, giving a net income of 73,000 Tanzanian shillings[24] (US $73.00) after land rent is deducted. It was different when the farmer owned the plot (net income becomes US $143.00 per plot in 2001).

Table 2.6 Average costs and incomes for rice cultivation per plot of 0.3 ha (Tsh.)

Items/Activity	Costs	Income
To hire a plot	70,000	
Plot cleaning	7,000	
Tractor hire, water fee and office management fee	35,000	
Canal maintenance fee	2,000	
Seeds (12 kg) for Tsh 300	3,600	
Preparation of seed beds	2,100	
Nursing of seeds beds	1,000	
Fertilizer application	3,000	
Pesticide application	3,000	
Weeding	12,000	
Seedling preparations	4,000	
Transplanting	12,000	
Bird scaring	10,000	
Fertilizer (Urea)-two bags	26,000	
Pesticide	4,000	
Harvesting costs (25 bags à Tsh 900.00)	22,500	
Empty bags (25 bags à Tsh 300.00)	7,000	
Filling in bags (25 bags à Tsh 500.00)	12,000	
Sealing bags and taking out of plot (25 bags à Tsh 200.00)	5,000	
Transport costs (from plot to milling machine/home)	10,000	
Total production costs per hired plot	**251,200**	
Total production costs per own plot (251,200-70,000)	**181,200**	
Gross income (25 bags per plot à Tsh 13, 000 per bag)		325,000
Net real income (from hired plot)		**73,800**
Net real income (from own plot)		**143,800**

[24] Tanzanian shilling 64 = US $ 1 (estimated for 1987). Tanzanian shillings 1000 = US $ 1 (estimate for 2001).

Source: Adapted from KADP, Extension Department September 2001

As shown in Table 2.6, the production costs of 0.3 ha, which included buying inputs and hired labour was estimated to be US $251.00 (2001). Of this amount hired labour was the most expensive item, as shown in Table 2.7 (US $100.00 per plot).

Hired labour is needed for land clearing, puddling, preparation of seed beds, nursing of seed beds, fertilizer application, seed preparation, transplanting, weeding, bird scaring, harvesting, filling rice bags and sealing. A farmer needs to employ labourers because the work follows a tight schedule to enhance water management. Since there is so much work, one or two people in a family cannot cope unaided. Farmers explained that labour costs have been increasing every year. Although the labour per plot back in 1987 looks modest, this is deceptive in real terms, since the Tanzanian shilling has lost much value since.

Table 2.7 Increased value of family labour in rice farming (20 bags/0.3 ha): 1987-2004

	1987-1997	1998-2004
Type of activity	**Average amount of payment in Tsh**	**Average amount of payment in Tsh**
Land clearing	2,000.00 – 5,000.00	7,000.00
Puddling	2,000.00 – 5,000.00	10,000.00
Preparation of seed beds	500.00 –1,500.00	2,100.00
Nursing of beds	200.00 – 800.00	1,000.00
Fertilizer application	600.00 – 2,000.00	3,000.00
Pesticide application	600.00 – 2,000.00	3,000.00
Seedling preparations	1,000.00 – 3,000.00	4,000.00
Transplanting	3,500.00 – 8,000.00 per group	12,000.00 per group
Weeding	3,500.00 – 8,000.00 per group	12,000.00 per group
Bird scaring	3,000.00 – 6,000.00 per month	10,000.00 per month
Harvesting	200.00 – 500.00 per bag	900.00 per bag
Filling in bags	100.00 – 200.00 per bag	500.00 per bag
Sealing bags	50.00 – 100.00 per bag	200.00 per bag
Total	**23,900.00-57,300.00**	**100,100.00**

Source: Field data 2000-2004

Service and support institutions

Service and support institutions were envisaged to work hand-in-hand with other project activities. The support of services included agricultural extension, both under KADC and after KADC was changed to the KATC. The LMIP proposed a 'project approach' extension system, involving establishment of an extension service specific to the project, and paralleling general government extension services for non-project farmers. The project extension services targeted irrigators, particularly men, as rice growers, while women worked in the plots. The extension services had strong linkages with the paddy section, responsible for developing and testing rice technologies best suited to the area. Other linkages existed between the extension service and sections such as irrigation, drainage, and agricultural machinery, controlling water distribution and land preparation operations as well as training. Through these linkages, the Extension Section functioned as the information centre for the project as well as its training hub.

Establishing KATC to train farmers

The existing KADC25 was established through a grant-in-aid from the government of Japan in 1978, in order to facilitate the development of irrigated rice farming by use of improved techniques found most suitable for the Lower Moshi conditions (as explained in Section 2.5).

It provided farmers with training for improved rice farming, and conducted trials to establish crop husbandry systems and irrigation management. It was considered a kind of research station oriented towards improved farming. During the early stages of establishment of scheme (in 1982), the KADC introduced irrigated rice practices to farmers within the scheme. The well-trained and motivated farmers were allocated plots in proportion to the original size of their farms that were registered and became personal property. The conditions given to ownership of such plots was that , they had to attend courses and follow instructions given to them by project staff on how to cultivate paddy using modern techniques. After such trials were successful, there was therefore a desire to extend these achievements to other rice farming areas. This desire was fulfilled in organising training courses conducted at the centre using the nearby pilot farm as a practical training field. The role of KADC was then changed from research and development to training when the KATC was established in 1994. This KATC worked closely with the LMIP26, aiming to disseminate improved technologies to both local farmers and to farmers of other regions in Tanzania and neighbouring countries (Takeda 1999; KATC 2000). The methods and results used in the demonstration area were then transferred to those areas where the representatives came from. The KATC focused more on technology transfer to the farming communities. This development took place after some improvement in irrigation activity was realised within the LMIP. The KATC as a technical cooperation project to the LMIP was planned to enhance the technical capabilities of trainers. It worked to improve the training methods and developed materials to train extension workers, irrigation technicians, agricultural mechanisation personnel and key farmers, while also recommending improved extension methods. To support the LMIP venture the government of Tanzania, again with assistance from the government of Japan, reinforced KADP's management capacity by providing it with agricultural support facilities, including a post harvest centre, farmers' conference buildings and transportation.

2.7 Formation of irrigation management committees and their roles: 1987-1993

The final section in this chapter over views the scheme and what preceded it, focuses on the basic institutional elements required for irrigation management. Institutional aspects are, as noted, often key to the success or failure of an irrigation scheme. Although participatory irrigation management was practiced in the traditional irrigation systems (see Section 2.3), the formation of irrigation management committees was a policy requirement for the modernised scheme, to ensure proper operation and maintenance. The irrigation management policy of the 1980s proposed the establishment of irrigation management committees as operational entities, with

[25] Kilimanjaro Agricultural Development Centre (KADC) was established in 1978 and changed to Kilimanjaro Agricultural Training Centre (KATC) in 1994 and is still operating with thee same name.

[26] Lower Moshi Irrigation Project (LMIP) is referring to the modernised scheme in Lower Moshi as a project.

representation of and participation by farmers within the system. These management institutions are considered important as structures through which participation was (and is) mediated. Together with the user organisations for water resource management they are seen as the forum for decision-making and the source of authority for rules and regulations, punishments and rewards, governing collective action in water.

They are therefore considered important as ways of channelling the contribution of individuals and in regulating resource management. For more effectiveness, extension service was to be provided through farmer organisations. The four project villages, Mabogini, Rau ya Kati, Chekereni and Oria, were well organised with village executive committees, sub-village committees and cell leaders. This meant that in every village there was independent Water Users' Group (WUG) (equivalent to earlier furrow committees) formed, which included only members involved in paddy cultivation. A new organisation consisting of water users had to be formed to take care of irrigators as a group. These were known as Water Users' Assemblies.[27] It was in the 1980s that the Water Users' Assembly structure was established and supported by the KADC, to solve problems in operation and maintenance. The intent was to enhance good relationship between the organisation and villagers, in order to improve irrigation management. Each village had such an Assembly comprising irrigators' elected representatives. The central committees of these Assemblies comprised of chairperson, secretary, treasurer and a number of committee members known as water men and block leaders. These committees were supposed to meet regularly, with members and project extension staff fulfilling specific roles. Such roles included to:

- Provide supervision and coordinate the activities of WUGs
- Agree on the cropping calendar and distribute the agreed plans to members
- Discuss and agree on how much to charge for water and tractor hire services
- Discuss about availability of inputs, including clean paddy seeds
- Make by laws on water distribution, canal cleaning and maintenance, agronomic practices etc, and enforce them so as to minimise conflicts
- Discuss and resolve disputes associated with land reallocation problems among farmers
- Water and maintenance fee collection and discussion of how to use it for the improvement of the irrigation system and scheme at large

The Water Users' Assemblies, which were councils within the village government, as noted above, initially the water committee was within village government (councils), they were not separate. In many traditional irrigation schemes this kind of their situation caused a lot of conflicts between village councils and water committees. The most cause of misunderstandings was rooted from money. The village council controlled most of the money collected from fines and charges and there was rarely money available for general repairs and maintenance of the scheme. The village council was in several cases seen as obstacle rather than facilitator between the irrigation project and actual farmers (irrigators).

The water assemblies were later changed to Water Users' Association (WUA) for several reasons apart from the problem of money. First, it had been made conditional on the irrigation scheme by both Tanzanian government and donor agency that improvement of the irrigation scheme should be done through obtaining a water right from the Ministry of Water and Natural Resources (MWNR). Formation and

[27] Used to be called water assembly before the name was changed to Water Users Association.

improvement of WUAs was also regarded as strategic in obtaining a water right from the MWNR. The water right is a permit given by MWNR to an individual or society allowing them to use or divert part of the water according to the Water Utilisation Act of 1974, as amended in 1981 (Government of Tanzania 1984).

There had to be a body to which the right was granted – water was therefore granted to the scheme through the WUA. A second reason for the change was to improve performance of traditional or informal irrigation schemes by making the Association independent of the village council. It was believed that WUA would make for a fairer, more efficient and effective management of water. It was also assumed that all water users affected by water management decisions and rules would be included in the group and that the WUA could modify rules, and democratically represent the interest of all its members. The government and international lending agency marketed the WUAs as democratic institutions, based on the argument that their leadership would consist of water users elected by other water users.

After the main WUA was formed, sub-committees were established in each village (Mabogini, Rau, Oria and Chekereni). The sub-committees were responsible for the village irrigation management, and villagers chose representatives for the executive committee chaired by a KADP representative responsible for the general management and smooth running of the scheme. The executive committee had three responsibilities: management of irrigation systems, agrarian development, and post harvest activities. During the relevant period (1987-1992) both the Governments of Japan and the United Republic of Tanzania were responsible for almost all costs of the operation and maintenance. Farmers paid little for the services rendered by the management. In March 1993, project type of cooperation ended and the government of Tanzania stopped financing the project, planning completely to pull out of running of the project (KATC 2000). Since support to rice farmers was very expensive for both governments it was decided to form a farmers' cooperative society, which was supposed to take over from JICA and the Tanzanian government. Henceforth, farmers were required to meet most of the operational costs of tractor hire services and other facilities. Most farmers supported this idea due to high costs in operating and maintaining the scheme while some production processes were delayed.

At that time, there was no registered farmer's organisation to take responsibility for running the project. Both the dissatisfaction of farmers with services and donor expense were used as justification for formation of the Rice growers' cooperative society (Chama cha Wakulima wa Mpunga = CHAWAMPU). The association was registered in July 1993, under the 1991 Tanzania Cooperative Societies Act, to carry on the management of the project. The hand-over also required that farmers strengthen scheme developments by organising themselves into a WUG.

Functions of the WUG:

- The society is responsible for collection of water and tractor hire service charges US $38.0028 per season from the farmers, and for preparation of cropping schedules in collaboration with KADP
- Leaders manage the finance, while the fee collectors are (usually) tractor operators. They collect tractor user fees when they have finished preparing a farmer's parcel of land. The receipts are in triplicate. One slip is given to a farmer, another is sent to the accountant of each village branch and the third

[28] During this time, the exchange rate was about US $1.00 was equal to 1000 Tanzanian shillings

slip to the head of the project office. The money collected on each day is deposited in a bank account
- WUG, in collaboration with project office (KADP), purchases spare parts, fuel and lubricants to ensure smooth tractor operations.
- WUG prepares annual budgets for acquisition and sale of inputs such as seeds, fertilisers, insecticides etc to members.
- WUG has by-laws or regulations for water users and penalties are imposed on flouters. The rules are enforced through reporting to the police or primary court, and a charge is framed by magistrate. An individual may subsequently be dismissed from CHAWAMPU as a penalty
- The organisation of the WUG in the Lower Moshi scheme covers an extensive area, and comprises a large number of farmers from the four villages. When the group was initiated there were many problems concerning how to assemble the whole group in order to properly perform the intended tasks. In order to solve the problems, a sub-committee was established in each village, with a close relationship with the village government expected to ensure good connections with farmers.

These subcommittees were different from those of the former WUA. In each village the sub-committee had members chosen by water users, but board members were elected by the sub-committee to represent them at the executive committee chaired by KADP (Figure 2.3). The executive committee consists of 15 board members elected from the four villages (six from Mabogini, four from Rau ya Kati, three from Chekereni and two from Oria). Other members include a secretary from the development committees, four accountants, two leaders of the Mabogini and Rau systems, block leaders and watermen. The committee therefore had the mandate to determine the cultivation charges per plot on the basis of projected fixed and operational costs. The revenue received from hiring services was to be utilised by the society for various activities, after being approved by the members. KADP still had its staff to run and manage project facilities. Their main task was to train CHAWAMPU staff to be responsible for general management of project activities and facilities.

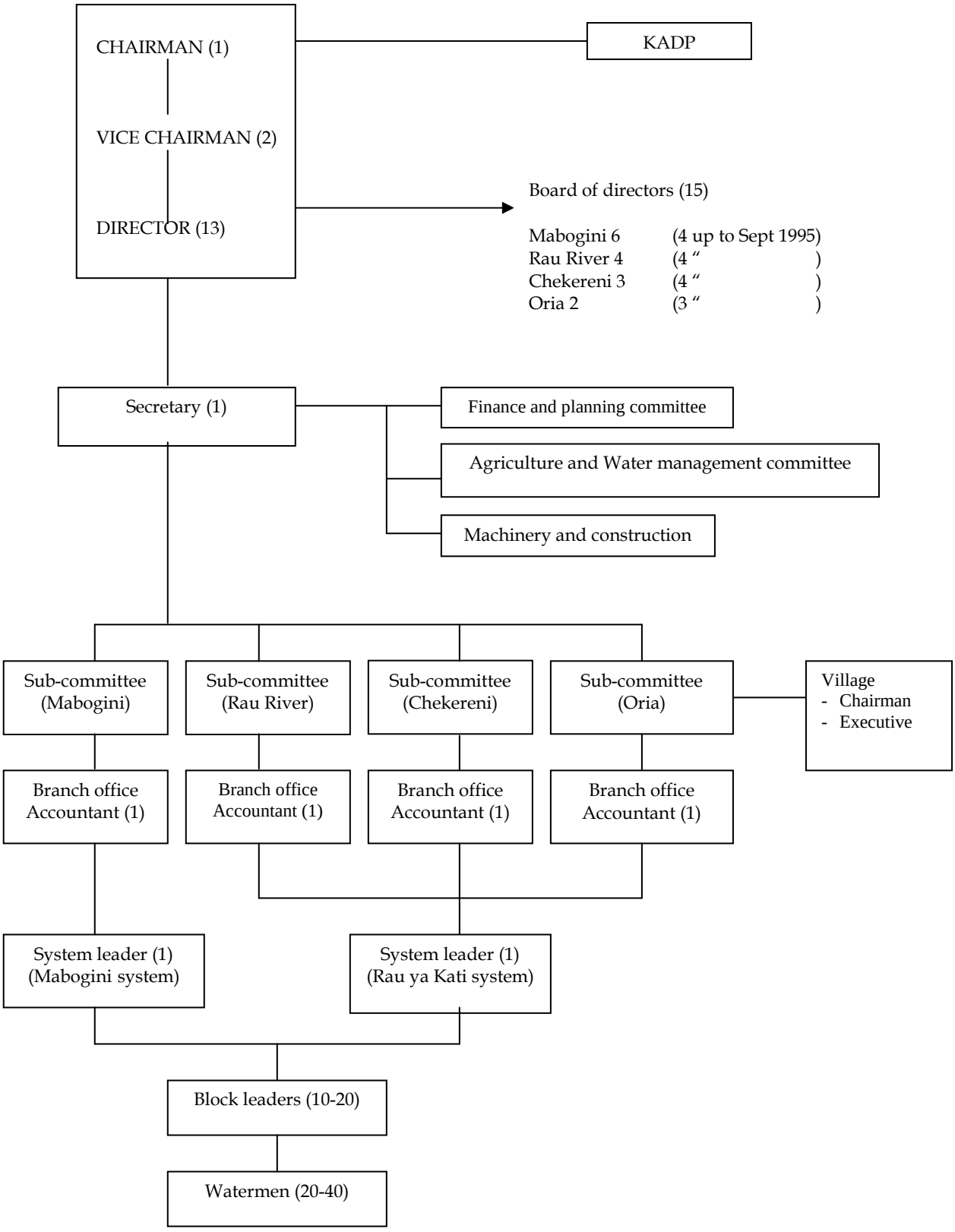

Figure 2.3 Organisation chart of Water Users' Group at Lower Moshi

Source: Tamura and KATC 1996

2.8 Conclusions

In 25 years, the Lower Moshi area was transformed from a crop-diverse area of many farmer-managed intakes (albeit run down) into an irrigation system with a largely unified irrigation canal system, weir constructions and requirements for water rights controlling the intake and flow of water. The older diverse farming systems among villages and multiple plot structures were simplified to a focus on High Yielding Variety (HYV) rice production and maize in uniform plots and blocks, without reference to previous tenure or gender divisions of labour. Mixed plots of land were suddenly blocked for irrigated or non-irrigated production, sharply dividing the haves from have-nots in terms of access to irrigated land and adequate water supply. The area shifted to production under a kind of factory farm model, as noted by Bolding (2005). New expert research and extension systems were supposed to retrain farmers, without real reference to the very sound agricultural knowledge and understanding of possibilities existing with earlier farmers. In terms of the transformation of settlements schemes outlined by Chambers (1969), the Lower Moshi passed through pre-settlement and new settlement phases with an emphasis on welfare and production. However, these processes set dynamics in motion that created greater differentiation in terms of crop specialisation, and access to water and services with devolution. The following chapters chart the evolution of key mechanisms and some of the very differentiated outcomes for different farmers in the maturing Lower Moshi irrigation system.

CHAPTER 3

WATER ALLOCATION INEQUITIES IN A MODERNISED IRRIGATION SYSTEM: CONFLICTS AND CONTRADICTIONS

3.1 Introduction

This chapter offers an overview of an apparent paradox that lies at the heart of the modernisation of the Lower Moshi irrigation scheme; the improvement of infrastructure and agricultural technologies and the reforms of institutions have, instead of smoothing and simplifying water allocation, served as triggers in creating social conflict around water. These conflicts involve both farmers from within as well as those from outside the scheme. The chapter shows that these conflicts emerged largely because the intervening agencies overlooked the socio-cultural context of the local communities and the multiple water uses found within the river system before the irrigation system was modernised. Where some farmers obtained rights to the water of the modernised system to irrigate rice, many who had previously used water from the river were now left without formal rights to water. They nevertheless still continued using water, while many of those within the scheme not only used water for growing paddy but also for other purposes. The ensuing water shortages resulted in clashes between the agency and farmers, and between farmers within and outside scheme, which undermined the ambition to improve water use efficiency and agricultural productivity.

The format used to modernise the irrigation scheme, as described in Chapter 1, reflects the framework employed by international donors and local government agencies in other African countries (Kay 2001; Shah *et al.* 2002). This format has been much criticised in Africa because of its limited success. Though modernisation of irrigation is intended to boost agricultural production to improve local livelihoods, many schemes have ended up as failures. Diemer and Huibers (1996) comment on the disappointing performance of irrigation in developing countries. They show that although billions of dollars have been poured into the irrigation sub-sector outputs rarely attain 50 percent of anticipated targets. Likewise, Guijt and Thompson (1994) argue that irrigation development has often faced technical problems in environments with highly variable rainfall, including much of semi-arid Africa. Seckler (1990) emphasises that the physical, social and economic environment of irrigation should be given attention because according to him, the root of the problem with many irrigation schemes lays in the social not the technical sphere. Examples of schemes that ran into problems of poor performance are many, but some that are especially well documented include the Gezira scheme in Sudan (Barnett 1977) and the Mwea scheme in Kenya (Moris and Chambers 1973; Kamau 2007).

These schemes are different from farmer-managed (local, indigenous) irrigation schemes (Diemer and Vincent 1992; Adams *et al.* 1994) not only in terms of size, but also in their nature and origin, viz. they derive not from the local farming communities or engineers conversant with indigenous conditions but from designs

drawn up within the foreign countries acting as donors to the initiative. In the case of the present study, the donors had imposed technology that reached only a minority of farmers (30 percent) in the area and operated as if in a vacuum. There was a failure to recognise that farmers within and outside the scheme both depended on the local river systems for their livelihoods. After the modernisation of the scheme local farmers were expected to surrender the use of water to farmers lucky enough to be included within the formal confines of the scheme. This, as will be discussed, was a recipe for trouble.

The present chapter offers a technographic survey of the situations and mechanisms at work after establishment of a modern irrigation scheme operating under management of government agencies and by farmers themselves. Technography is to technology what ethnography is to the science of anthropology or sociology, i.e. it is an attempt to provide a systematic description of skill, techniques and human-machine interactions (Richards 2002). It departs from the insight that irrigation and agricultural technology are embedded in heterogeneous networks of both human and non-human elements. So the linkages between these elements, which include the main actors involved, their different interests and perceptions, and the nature of the design process, are major objects of study. The chapter describes the interrelationships involved in attempts to improve technology. Specifically, it sketches the physical environment and the different groups of farmer within, and outside, the scheme, and says something about the outcomes anticipated by the donor agency and the government of Tanzania in agreeing to the scheme. Anticipated and actual outcomes are compared. The realities of water management performance are briefly analyzed.

The chapter is divided into five main sections. The first section briefly conceptualises water scarcity and water equity, major issues addressed in the core of the chapter. The second section provides an overview of the irrigation system community as background to understanding detailed material later in the thesis on practices and relationships among stakeholders (and especially the impact on gender relations). The section identifies the main actors within the irrigation system, and specifies the principal types of agriculture and water supply. The third section describes water conflicts between agency and farmers, both within the scheme and with farmers outside it. The outcome of these conflicts has been to intensify water shortages within the scheme, with serious implications for crops grown and productivity. The fourth section describes the mechanisms of water management and the agricultural production arrangements invented by the agencies in order to cope with water shortage, so as to continue operations. These interventions also triggered responses by farmers, which then intensified the water shortage problem, resulting in another cycle of conflict. The chapter ends with a concluding analysis of water control problems in the scheme.

3.2 Water scarcity and water equity

Water scarcity and water equity are two concepts that are very much interrelated. In most cases government agencies in public irrigation interventions devise a variety of technological, legal and financial policies to control access, in the belief that such efforts will lead to better use of scarce resources. This section explains concepts and how they fit into socio-technical systems.

Water scarcity

Water scarcity can cause enormous problems for local populations and entire societies. If water is not available and sufficient for the production of food, it will be difficult to alleviate hunger and poverty. Furthermore, growth in agriculture will be limited by the scarcity of water (Hamdy *et al.* 2003). This means that increasing of the productivity of water is central to influencing food production, fighting poverty, reducing competition for water and ensuring that there is enough water for nature. However to achieve this end, major improvements are required in water resource use, irrigation technology and management.

There is no widely accepted definition of 'water scarcity', and the term 'water shortage' is often used synonymously with water scarcity. In physical terms, water scarcity is commonly defined as a situation where water availability in a country, community or region is below 1,000 m^3 per person per year (Pereira *et al.* 2002). However, it is important to recognise that this kind of water scarcity can result either from seasonal differences and yearly fluctuations or from human activity, either in terms of overuse of the natural supply or degradation of the water quality (Eggink and Ubels 1984). Human induced water scarcity is common in semi-arid and sub-humid areas, where populations and economic forces may impose large demands on the local water resource, and where insufficient care is taken to protect the quality of this precious resource. Concepts relating to water scarcity of this type include aridity, drought and desertification as well as water shortage. This section deals with water scarcity insofar as it implies water shortage. Water shortage is considered a human-induced, but temporary, water imbalance, including overexploitation and degradation of ground water and surface water, supplies, and is often associated with disturbed land use and altered carrying capacity of ecosystems. The literature argues that while certain regions are more vulnerable due to a shortage of naturally occurring water endowments, scarcity is more often the result of inadequate management of water resources than of 'natural' causes (UNDP 2006). As with other natural resources, scarcity of water has been mostly viewed as an outcome of the increasing demands of a rising human population. It is therefore argued that this kind of water scarcity is not natural, but due to interventions in the realm of land and water management and use (Mehta 2003). Over allocation and improperly controlled extraction of water (Vincent 2004, in Krishnan 2007) are therefore considered to play an important role in the exacerbation of physical scarcity. This section endorses this view of scarcity as incorporating both the ecological and socio-political realities. Building on arguments of other studies (Aguilera-Klink *et al.* 2000) it will be argued that water scarcity is not physical or natural, but rather a socially induced phenomenon, stemming from a set of social processes that reflect wider conflicts over social order and the good society.

Water-induced human conflicts can arise in water stressed areas, since sharing a very limited and essential resource is extremely difficult despite legal agreements (Maganga *et al.* 2004; Mbonile 2005). Tanzania has a pluralistic legal system and hence land and water resources are regulated by different institutions and pieces of legislation, inter alia, statutory law, customary laws of ethnic groups and religious laws. The water crisis faced by paddy farmers described below is clearly related to irrigation policies that promoted a particular allocation and distribution of water, following a newly introduced set of rights, based on state law.

Water equity

Despite attention over a long period, the concept of equity has proven difficult to define. Rasinski (1987) and Syme (1999) show, in the context of social welfare policy, that equity comprises two components, 'proportionality' and 'egalitarianism'. Proportionality implies that resources should be distributed according to efforts or needs (as in the Marxist mantra 'from each according to their abilities to each according to their need'), while in the case of egalitarianism; the term suggests that everyone should be treated equally. Boelens (1998) for example has described equity to be about fairness, about social justice, and about acceptability. He refers to perceptions of a fair relationship between certain items in exchange situations, between rights and obligations, between benefits and burdens, and between advantages and disadvantages. His meaning of equity is directly related to rules and rule-making processes, and to exchange and distribution of material or immaterial resources in specific settings. In this case the rules may help to bring about equity to a certain extent, but people always find ways to break rules and disturb the established equity. In the same vein, Gleick (1998) has argued that equity is a measure of the fairness of the distribution and the process used to arrive at particular social decisions. He differentiates between dimensions of allocation and social need. Cremers *et al.* (2005) characterise equity (in the context of water management) as the degree of social acceptability of the prevailing water management and distribution rules and practices. This amounts to a notion of social justice, as perceived by the different actors involved, reflecting differences of gender, class, ethnicity etc.

Whereas some ethicists continue to debate whether there can be universal principles of equity, others argue that equity is not determined by absolute standards, but is a concept reflecting what is locally considered fair. Boelens and Davila (1998) distinguish five levels of equity in irrigation and water management at local levels. These comprise equitable water distribution and allocation among different water users and uses, equitable distribution of services involved in irrigation development, equitable distribution of the added agricultural production and other benefits under irrigation, and equitable distribution of burdens and obligations related to functions and positions. A fifth level is equitable distribution of the rights to participate in decision making processes, since this related to the fundamental issue of whether or not every farmer has rights to speak, vote, claim an entitlement of irrigated land, and enjoy equality of status in leadership elections, etc.

Levite and Sally (2002) argue that equity in allocation implies that water users should have a fair access to the water needed for their activities, but add that in order to achieve sustainability attention needs also to be paid to efficient and beneficial use. Along the same lines, Gleick (1998) again argues that the concept of equity overlaps with sustainability when determining what is to be sustained, for whom, and who should decide. His argument merges with the argument of Ransiski (1987) and Syme (1999) concerning the two-dimensional character of equity as egalitarianism and proportionalism. In the present study, both these dimensions of equity will be used in the analysis of the impact of irrigation modernisation on water management and of water users both within and outside the case study scheme.

3.3 Overview of the community and the irrigation system

As discussed in Chapter 1, the technographic approach (Richards 2002; Richards 2007) is used in this study to understand an environment where technological

interventions have taken place. Technography seeks to map the actors, processes and client groups in such a way that the analyst can see beyond the technology itself, the problems technological applications are supposed to solve, and to understand what parties and interests are being mobilised in arriving at solutions. The approach aims at understanding the interactions between various components of socio-technical systems. In technographic analysis, various elements that make up a socio-technical system must be identified and explanation is needed as regards interactions among these components. The main components of the socio-technical system or process are boundaries of the system or process, how components are related, how system and process are performed and how the system or process is changing must all be described.

The orientation will be towards water use. The operation of irrigation systems can be determined by understanding who uses the water and who benefits from its use. To orient the reader, it seems appropriate to recapitulate some features of the Lower Moshi irrigation community and the irrigation system shared by its various villages, discussed in more detail in Chapter 2, as background to the more detailed technographic descriptions in forthcoming sections covering specific mechanisms of water allocation and patterns of water conflicts.

The highlands in Kilimanjaro region are a source of numerous springs and streams, which flow down to the lowlands to which Lower Moshi belongs. As discussed in the first two chapters, the area has longer dry seasons than wet seasons. According to farmers within the community, the two main rivers systems have been used by villagers for agriculture since time immemorial. These are the Njoro and the Rau Rivers, originating from Njoro ya Dhobi and Mwananguruwe water springs respectively, which flow to Lower Moshi (Figure 3.1). The Njoro River mainly supplies Mabogini village (the largest settlement) but after Mabogini the Njoro it is joined by a tributary the Rau River. The combined flow then supplies water to three other villages: Rau, Oria and Chekereni. Of the four villages, Chekereni is furthest from the natural river system. It did not have a source of water until in the 1970s, when the villagers (migrants to the region) decided to dig a canal to divert water from the Rau River at a spot close to the village. After modernisation, two intake weirs were built at Mabogini and Rau villages. The two rivers were merged and redirected into a single main canal at Mabogini village via a well-built intake weir at Rau village. A branch of the main canal was constructed towards Chekereni village as a secondary canal; tertiary canals were directed towards plots of farmers who had been allocated plots within the scheme.

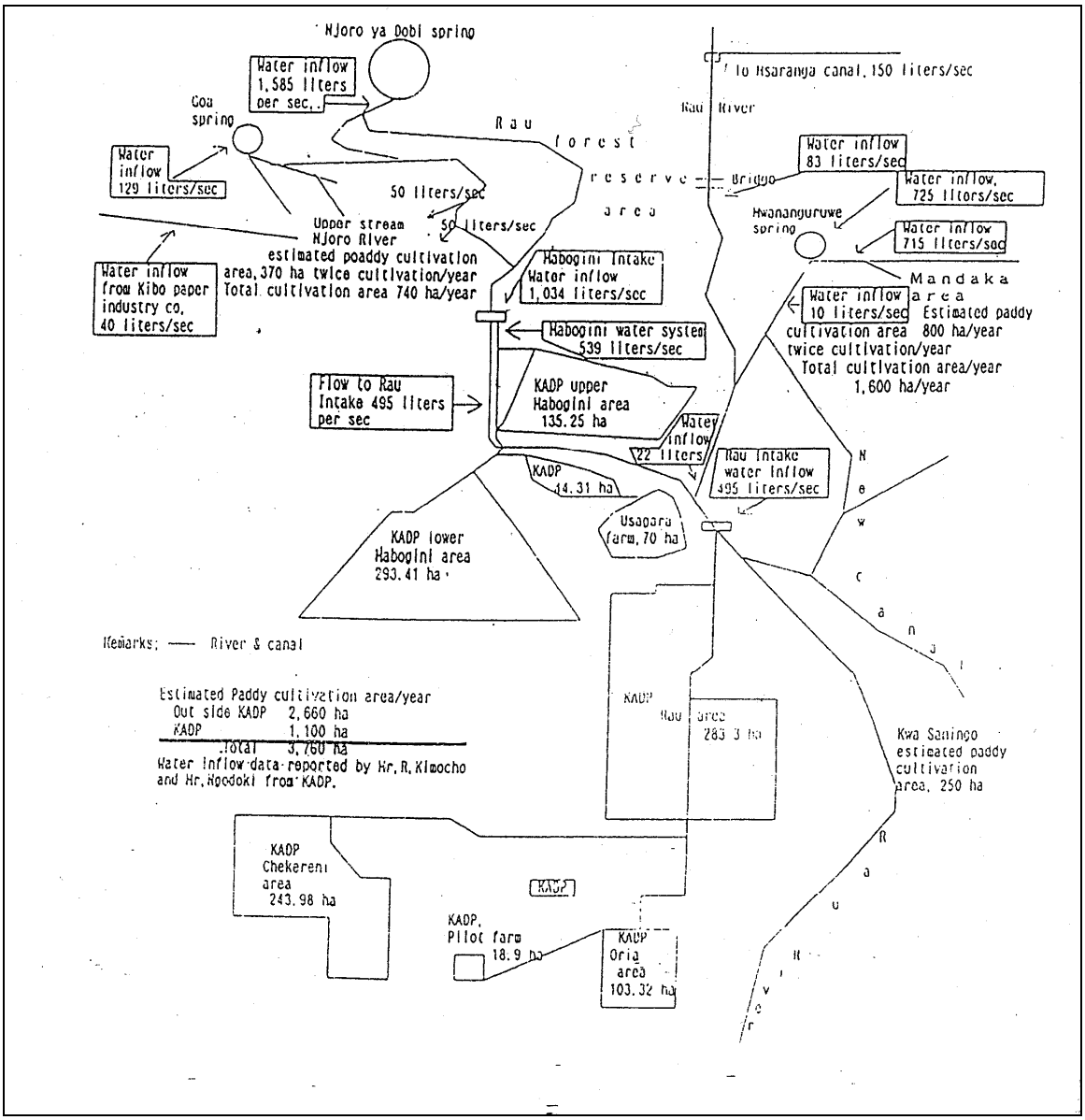

Figure 3.1 Sketch map showing the irrigation system and area cultivated by outside farmers

Source: KATC 1996

The two major river systems were developed to serve the scheme through what is called the Mabogini system (MS) and the Rau River system (RS). Of the four villages, Mabogini, which was swampy and fertile, used to be very productive for most major crops and vegetables. It is the village where local rice was cultivated for almost 50 years before modernisation took place. Many people who used to work in sisal and sugar plantations, and others who migrated from other areas to Rau and Oria villages, decided to settle in Mabogini because they could access river water for cultivation of food crops. Although the Rau River also had good amounts of water from the Mwananguruwe water spring, it was known for its fluctuations, because its flow depends on the amount of rainfall (see Chapter 1). By comparison, most of the water in the Njoro River comes from the Njoro ya Dhobi springs, so the distribution of annual run-off is stable (run-off describes the flow of water from rain, or other sources, over land surfaces, and is a major component of the water cycle). The design run-off, as planned by the engineers at the Mabogini intake weir site (on the Njoro), ranges from 1.06m^3/sec in January to 1.33m^3/sec in July. The run-off of the Rau River, however, fluctuates according to rainfall distribution. The design run-off at the confluence ranges from 0.19m^3/sec in December to 1.74m^3/sec in April (KATC Records 2001 and 2003). These data show the susceptibility of the two rivers to climatic and hydrological disruptions likely to affect agricultural activities.

As discussed in Chapter 1, land and water traditionally belonged to the chiefs, who allocated these assets to different clans residing in the highlands, beginning in the period before farmers moved to the lowlands. Traditional allocation included many villages in addition to the four villages now included within the scheme. After the Lower Moshi irrigation scheme was modernised it acquired official water rights from the Ministry of Water and Natural Resources (MWNR) according to Water Utilisation Act of 1974 (amended in 1981) (URT 1974, 1981, 1994a). From 1992 it became eligible, via water right nr 4,807 for 804 litres/sec through Njoro spring, and via water right nr 4,808, for 1,135 litres/sec through the Rau River, on payment to the ministry of an annual water fee. Initially (1992-1995) the payment was equivalent of US $583.00, but the amount has now almost doubled. A key feature of this legal development was that after the scheme was modernised, all farmers already using the waters of the Njoro and Rau, but living outside the boundaries of the scheme, were denied use of an asset to which they had been accustomed. The agencies in effect imposed rules that restricted farmers from using this water. Restrictions applied both to farmers outside the scheme and the majority of farmers living inside the scheme boundaries but not included in the irrigated rice farming project. As shown on the map (see Figure 3.1), the farmers outside the scheme are mainly in villages located at the head end of Rau River, where much irrigated rice was also cultivated.

Irrigated rice was introduced into all four villages within the scheme, but at different levels of intensity, due to differences in water supply. The area of cultivation is greatest in Mabogini village, where there is more water because of its closeness to the springs at the head of the Njoro. A second reason is that there are more plots and farmers here than in the other three villages, due to the fact that many farmers settled in Mabogini village before modernisation, because of fertile soils and access to water. Many people in Mabogini are employed in Moshi, and inherited land from their grandparents or via clan membership. Rau village also has plenty of water compared to Oria and Chekereni villages. The people who moved to Chekereni came seeking rural employment and cultivable land, especially during and immediately after the Ujamaa Village campaigns (see Chapter 1).

3.4 Water allocation

This section describes water allocation and water conflicts between the agency and farmers within and outside the scheme. This description will help the reader understand how the problem of water supply emerged, and how the agency tried to solve the problem when it was already too late. This was especially when the problem of water distribution was also intensified by changing weather conditions in the area (see Chapter 1). The section first provides a description of how the scheme tried (but failed) to appropriate water from the two river sources, thereby effectively denying many existing users continued access. It shows how scheme design counted on quantities of water it could, in actual practice, not secure because many farmers outside the scheme also continued using water from the same sources. The resulting water scarcity within the scheme demanded adjustments in terms of how water was to be allocated. The adjustments made are described in the second part of the section. Water scarcity, of course, affected crop productivity. The section ends by showing the strong linkages between water availability and yields as shown by trends in agricultural productivity.

Water allocation between the scheme and other users: struggles over rights and water

At the heart of the system's water allocation problem is the difficulty to exclude people from using water from the Njoro and Rau rivers. After the irrigation system was modernised and irrigated rice cultivation introduced on a large scale farmers from Mandaka Mnono, Kaloleni and Pasua villages, all situated outside the scheme and close to the Mwananguruwe water spring, began to adopt similar technologies to those introduced within the scheme. These farmers began using the same variety of rice (IR54), over an area of about 600-800 ha (see Figure 3.1). As a matter of fact, people in these upstream (but outside of the scheme) villages started cultivating paddy even before the completion of the construction works, using hand hoes to plough, puddle and level the newly demarcated plots. Outside farmers at Mandaka Mnono, Kaloleni and Pasua villages started to grow rice in the same manner as project farmers in Lower Moshi; except that irrigation was done sequentially (one plot is irrigated after another). These outside farmers – anticipating exclusion but spotting their up-stream positional advantage – quickly constructed their own main canal from the water source tapped by the scheme (the Mwananguruwe water spring). Although their own canals were not lined, they received plenty of water before farmers on the scheme by means of gravity flow.

Irrigation was of course not new to these farmers. Chagga people are noted for their entrepreneurial spirit, and (as noted in Chapter 1) traditional gravity-feed irrigation technologies were long established in the region. The literature (Gray 1963; Masao 1974; Adams and Anderson 1988; Adams *et al.* 1994; Lein 2004) provides evidence of irrigation system activities by local people, e.g. the Sonjo, Pare and Chagga Kilimanjaro mountain systems. This long experience with irrigation explains why it was not a problem to establish local canals for irrigated rice cultivation. Planners of the scheme may have expected a 'backward' peasantry resistant to innovation; what they found (to their detriment) was very rapid uptake of scheme innovations outside the scheme.

The planting seasons for outsiders were the same as for farmers within the scheme (January-June and July-December). In effect, these local cultivators paid close attention to scheme procedures.

For instance, some outside farmers started to plant rice on the same 0.3 ha plot layouts used on the LMIP. According to the village extension workers, more than 300 ha of paddy was initially grown by these means, and the area has increased since. A major implication of these outside adoptions was a considerable diversion of water that engineers had assumed would be available to the scheme. This 'illegal' water diversion lies at the root of a serious water conflict between farmers within and outside the Lower Moshi irrigation scheme. The nature of the ensuing conflict of farmers is comparable to what has been observed in the Mwea irrigated rice area by Kamau (2007); in Mwea, non-scheme rice farmers 'illegally' innovated '*jua kali*' rice farming adjacent to the irrigated rice area. The problem was more serious when on-scheme farmers scheme discovered outsiders were making profits without having to pay charges.

In Lower Moshi the problem of water scarcity was compounded by a general population increase due to migration generated by the attractiveness of rice farming, both on and outside the scheme. When people from Moshi town and nearby villages realised that farmers were profiting from irrigated rice farming, many went to join them, to trade rice, supply services and rent plots in the scheme and adjacent to the area. This dramatic human population increase had an immediate impact on general water consumption in the area, further exacerbated by water levels required for the upkeep of the cattle, pigs and vegetable gardens people then acquired. The use of water by farmers outside schemes seriously threatened water availability for farmers within the scheme, because by now much less water was available for rice production on the scheme than planners and designers had anticipated. When farmers inside the scheme started to experience serious water shortages in 1993 the agency began to question the government about the validity of the rights of outsiders to use water. Indeed, the water problem within the scheme was viewed by both agency and farmers on the scheme as being caused by the outsiders using 'their' water; the agency considered use of water by outsiders illegal and unauthorised, and sought to challenge these practices by taking these people to the administrative water court. According to the explanation of informants, court verdicts failed to provide a lasting solution because outside farmers claimed they had customary rights, on the basis of the fact that they had used the water from the time they were allocated land by their chiefs in the area.

The agency then contacted the office of the Ministry of Water and Natural Resources and requested officials to come to enforce the water rights approved for the scheme. This demand complicated the issue, because claims by outside farmers appeared to be valid in the ears of many listeners, including (most importantly) some government officials. Indeed, these claims could not be easily dismissed, since the fact of prior water use on which these were based was undeniably true.

On the other hand, the farmers within the scheme became increasingly annoyed, not just because they were not getting sufficient water to grow rice, but because they were paying fees for the water, and not getting what they had paid for. These farmers started organising themselves for vigilante action. They mobilised sympathisers, and marched on farmers outside the scheme. Vigilantism is an established tradition among various age groups of populations in parts of Tanzania (Abrahams 1987, 1989).

Although such groups have different names in various tribes within country, the main focus has been on the ones called '*sungusungu*'[29]. Vigilantes are defenders, often by force, of their view of good life against those they see as their enemies. The farmers of Lower Moshi, following in this tradition, invaded the private properties of the outside farmers, including the unauthorised canals, causing a certain amount of damage, and warning the farmers in question that they should stop using the water. But none of this deterred outside farmers from persisting with rice agriculture and accessing water from the source. The problem has in fact worsened over time, since the area of land irrigated outside the scheme has continued to increase. The agency once suggested to the competing farmers that they should sit and talk about how to share the water. This suggestion was ineffective because of the already existing tensions.

At one point (in 2002), the scheme's farmer organisation, together with the agency, organised a meeting over the water problem with by then President Benjamin W. Mkapa.[30] when he visited Moshi. While the agency hoped the President would support the scheme, he in fact emphasised that both groups of farmers were citizens of Tanzania, and enjoyed certain rights, even if they conflicted. He explained that the two groups claimed rights to water under two different codes, customary rights and the water act laws, both of which are officially recognised. The President concluded by emphasising to the parties that they all had rights to water, because the river is within the land owned by the state and farmers have rights to use water from state lands for their livelihoods. In short, no clear solution in favour of either party could be found.

The Lower Moshi agency, at scheme level, slowly started to realise that nothing could be resolved without the participation and consent of the 'outsiders', whom they had come to see as enemies of the scheme. The agency also started looking for alternatives (i.e. possibilities of utilising other water sources). One proposal was to use another river, provided it was reliable. The suggested river, the Kikuletwa, was provisionally earmarked, but this is important nationally for hydropower. This raised doubts about whether the scheme would be allowed to go ahead. A definitive answer has yet to be reached.

Mechanisms for water allocation within the scheme

The ongoing competition for water between outsiders and farmers on the scheme made it imperative drastically to re-think how water was to be used and allocated within the scheme, since much less of it was available than had been planned. One result of the persistent competition over the use of water from the Mawnanguruwe water spring by outsiders, during the dry season, was that Lower Moshi had become mostly dependent upon a single water source – the Njoro ya Dhobi, which supplies water to the Njoro River for Mabogini system. During the rainy season, when water is plentiful, the Rau River could be used to supply water to the three villages (Rau, Oria and Chekereni), while Njoro continued supplying to Mabogini. This section describes the mechanisms of water management developed by the agency in order to cope with water shortage within the scheme, to allow continued cultivation of

[29] The word s*ungusungu*- means 'large biting black ants'. It is originated from Nyamwezi and Sukuma tribe of Tanzania. This means the defenders have a biting power in order to enhance safety or security in a community.

[30] President Benjamin W. Mkapa , a seasoned journalist, diplomat and politician, was elected president of Tanzania in November 1995 (served for two terms until 2005), and also He is the third president (after President Ally Hassan Mwinyi) of the United Republic of Tanzania since independence in 1961.

irrigated rice. Basically, scheme managers proposed reductions of the command area, and of the total land to be cultivated and irrigated in a season. This meant that some farmers could not continue cultivating irrigated rice. The scheme management also introduced a water sharing schedule among the head and tail ender farmers, and drew up a system of rules, laws and restrictions on irrigated water use within the scheme. In relation to these mechanisms, this section describes the responses and reactions of farmers.

The first thing managers implemented was the decision to decrease the area under cultivation, because there simply was not enough water to allow cultivation over the entire planned area of 1,100 ha. The original idea was that Lower Moshi would have two growing seasons per year, that from January to June and from July to December (see Chapter 2). A total of 1,900 ha of paddy would be cultivated each year (1,100 ha during wet season and 800 ha during dry season) with an expected annual harvest of 8,550 tons. During the rainy season, from January to June, the whole paddy area of 1,100 ha could be planted with rice, while 800 ha would be cultivated with irrigated crops in the dry season (July-December) (KADP and JICA 2001). In addition, the whole area for upland maize cultivation (1,200 ha) would be cultivated in the rainy season, on the assumption that supplementary irrigation would be possible using surplus water. No upland maize was planned during the dry season because water was considered insufficient.

After the scheme started suffering water scarcity, this plan proved too ambitious. Most water from the Rau ya Kati River, fed by the Mwananguruwe water spring, was tapped by outside farmers for their own rice farming. The scheme management next decided to distribute the available water over three instead of two seasons, to decrease peak water use and allow more farmers to have an irrigated rice crop. The strategy was to more or less equitably distribute the available water over the different villages in the scheme, including those dependent on supply from the Rau system. The three seasons were January to June, May to October and September to February. Further adjustments to accommodate water scarcity included a reduction in the area cultivated and irrigated during the dry season (July – December) when shortage of water is most extreme. The total area cultivated per year was reduced from 1,900 ha to 1,500 ha. In each season, on average an irrigated area of 395 ha was cultivated within each of the four villages. In practice, actual cultivated areas were even less than the planned 1,500 ha, ranging from 600 to 1,000 ha per year (KATC 2000). As Table 3.1 shows the closeness of Mabogini and Rau to the water source ensured that most on-scheme rice production (67 percent) happened here (45 percent of plots in Mabogini, and 22 percent in Rau).

Table 3.1 Total land for the command area within the scheme

Villages	No of plots	Ha	% Ha	Water status
Mabogini	1,633 (1,639)	490	45%	Good
Chekereni	877	263	24%	Poor
Oria	343	103	9%	Poor
Rau	813	244	22%	Good
Scheme level	3,666 (3,787)	1,100	100%	

Source: Field data 2001-2003

The practical implication of the seasonal rotation schedule for farmers was that many could only cultivate rice once a year, in a designated season. The rotation schedule affected farmers differently depending on where their plots were located (whether in areas of greater or lesser water availability). Table 3.2 indicates that half of all farmers cultivated only once, while about a third did not irrigate their plots at all, and relied almost entirely on rain fed maize. Since farmers were free to buy several plots, some of them also had plots in different locations, allowing them to cultivate more than once. Some richer farmers (10 percent in Mabogini and 5 percent in Rau) were thus able to cultivate twice a year. In some parts of Rau village and in the other villages of Chekereni and Oria, 35 percent of farmers received so little water that they could not continue to cultivate rice, and started cultivating rain fed maize instead. This division into those cultivated more and less rice and those not involved in cultivating irrigated land at all has important consequences for our later analysis of differences in production and incomes among farmers.

Table 3.2 Cultivable land, cropping seasons and number of farmers cultivating

% Cultivable area	Cropping seasons			% of Farmers cultivating		
	First	Second	Third	Rich twice	Average Once	Less plots Failed
Mabogini 45%	Rice	Rice	Rice	10%	35%	-
Rau 20%				5%	10 %	5%
Oria/Chekereni 35%	Rain-fed maize cultivation				10 %	25 %
Total				15%	55%	30%

Source: Field data 2001-2003

As these figures already suggest, implementing the planned schedule of water distribution proved difficult. Farmers in the head-end villages, including Mabogini, resisted it; they were reluctant to share 'their' water with tail-end villages. These head-end farmers continued to use the amounts of water to which they felt they had a right, and against the formal allocation rules. They argued that the Njoro River system was their property, while the Rau River system belonged to the other villages, and therefore they felt entitled to break structures (and rules) to get 'their' water. The Mabogini farmers not only took more water than their seasonal allotments, they even started cultivating additional areas, claiming even more water than before. There were many complaints, and there were even physical fights between farmers from Mabogini and the other villages within the scheme.

As Table 3.1 illustrates, the result was that farmers from the villages in the middle and tail end (Chekereni, Rau and Oria) experienced great difficulties to access water, especially during dry season. Many farmers, especially from Chekereni, complained of gross water inequalities between farmers situated at the head and tail ends of the scheme. Complaints by tail-enders that farmers at the head end were illegally diverting water came from groups of water users, women's organisations, and individuals. These complaints peaked when crop water demands were highest during the dry season, especially when management overestimated the area to be cultivated relative to the water available.

From the perspective of the agency, the head-end Mabogini farmers were real troublemakers because they took more water than their legal share, by damaging the intake weir and other irrigation structures (Interviews 2002). The actions of the

Mabogini farmers also hampered the effective implementation and enforcement of the designed water rotations.

Already, many farmers had difficulties dealing with the rotation, because the predetermined delivery time reduced flexibility in terms of adjusting water use volume and timing to individual farming needs. Many farmers did not precisely know their irrigation turns, which had a negative effect on their crops, since it caused some to miss timely transplanting windows and resulted in losses. Overall, farmers lost confidence across the scheme in the reliability of the management's water distribution promises, and in the rules that it tried to impose. Tail-end farmers developed various strategies to get water. For example, some members of the Water Users' Groups (WUGs) (especially men) made use of their status and political and social connections to obtain water through bribes. Access to water increasingly started to reflect relations of power among farmers. As interviews revealed, some farmers were also able to get more water to their plots because of personal relations with the watermen. These watermen, the canal operators, sometimes made special allowances to kin and close friends. Some farmers resorted to stealing water. This was mostly done by male farmers at night or very early in the morning, by opening the water gate and diverting water to their plots, especially when the person who had the turn was not there. Such elements of intrigue based on personal linkages, bribery and water stealing further contributed to water distribution inequities within the scheme. The average farmer – especially women – suffered most, and many were forced to switch to less water-intensive crops such as maize and vegetables.

Farmers within the scheme also came into conflict with the agency because of their use of water from canals for non-irrigation purposes. Although the water was not clean enough for drinking or cooking, farmers used it for other purposes. This included watering and washing animals, building houses and watering home gardens. Some women tried to cultivate vegetables on the banks of their irrigated rice plots. Farmers, whose houses were close to the canals also siphoned water, especially during the night, in order to irrigate crops in their home gardens, like vegetables, bananas, potatoes and cassava. Using water like this was formally prohibited by the agency. To enforce its rules, agency staff regularly destroyed vegetables grown on the sides of plots or on the actual canal banks. The management also tried to punish farmers caught illegally withdrawing water for home gardens. This was not very effective, since farmers simply bribed the poorly paid guards, who needed the money. In all, it proved difficult to prevent unauthorised uses of water. Indeed, many houses situated close to the canals were seen to have sizeable and flourishing gardens. Others made use of the water to supplement their income by making burnt bricks, which they then sold.

The implications of struggles over water for crop production

Struggles over water, and experiences of water scarcity within the scheme, are clearly reflected in trends of crop production within the scheme. In the original design, irrigated crop production was supposed to happen within the demarcated area reallocated to farmers for irrigated rice The command area only covered about one third of the total area of land in Lower Moshi irrigation scheme. The rest was to be used for rain fed agriculture, while some of it would remain unproductive.

As noted, as soon as the farmers from outside the scheme realised the possible profits to be gained from new rice varieties, they also started cultivating this crop. Beginning in a small area, the size of land cultivated by outside farmers increased tremendously from 1993 up to the present (see Figure 3.1). In 2001-2003, the area

cultivated by outsiders was estimated to be about 600 ha outside farmers cultivated the same variety of rice (IR54), adopted the same cropping patterns and also cultivated twice a year. The average production outside scheme was 7 ton/ha, i.e. farmers produced 25-30 bags of rice on average per 0.3 ha (Interviews 2003). The amount of rice produced per plot was high because outsiders had good access to water and made good use of fertilizers. As shown in Table 3.3, the success of the outside farmers directly affected rice production within the scheme, which dropped sharply in 1994 and even further declined in 1995 when the outsiders further increased their irrigated agriculture. Since this time, production on the scheme has recovered somewhat but not to pre 1994 levels.

Table 3.3 Trends in paddy output, Lower Moshi: 1987-2004 (tonnes/ha/yr)

Year	Area (ha)	Mean yield (tonnes/ha)	Total yield (tonnes)
1987	923	6.7	6,184
1988	1,323	6.3	8,334
1989	1,452	6.4	9,292
1990	1,525	6.5	9,912
1991	1,173	6.8	7,976
1992	910	5.8	5,278
1993	1,037	6.3	6,533
1994	652	6.4	4,172
1995*	468	5.4	2,527
1996	816	5.8	4,732
1997	810	5.6	4,536
1998	1,042	6.4	6,668
1999	1,090	6.5	7,085
2000	858	5.7	4,890
2001	830	5.1	4,233
2002	819	5.3	4,340
2003	873	5.6	4,888
2004	749	5.4	4,044

*) This is the year when farmers from outside scheme increased the use of water to irrigate more land. As a result there was a severe water shortage within the scheme which caused a decrease in rice production.

Source: Kilimanjaro Agricultural Development Project Records 1985-2004

During the first years of rice cultivation on the scheme (1985-1987) when irrigated rice was first introduced, not all cultivable and irrigable plots were used. Production nevertheless was high. According to respondents, this was the time when it became clear to farmers they could earn a good income from the harvest of a small irrigated plot. Discussions with respondents and baseline data show that the use of irrigated land for rice production was increasing and reached a peak between 1987 and 1993 (Table 3.3). From 1994 to 1997, there was a decline in production, as shown in the table due to decrease in the cultivated area when shortage of water caused by outsiders became a problem. The water shortage was intensified by low rainfall in the area. Usually the first cropping season (February - June) is water-scarce because it

is just after the dry season. According to informants, output is limited as a result, and also because rice matures poorly in cold weather.

The second cropping season (May or June) is best because there is plenty of water just after the rainy season, and the crop matures better when temperatures are higher. It is a time when a large area is cultivated. Productivity of the land depends on cropping seasons, e.g. in the first season the average yield per plot is 15 bags, in the second season it is 20 bags and in the third season 18 bags.

3.5 The organisation of operation and maintenance

Having described and commented on water allocation processes, this section looks at how operation and maintenance were organised. Next to introducing new infrastructure and new agricultural technologies, modernisation of the scheme also implied the introduction of new institutional arrangements to guide allocation of water as well as the operation and maintenance of the system. This section describes these institutional arrangements. The institutional history of the scheme can be divided into two distinct periods. The first (until 1992) was the period of the Water Users' Associations (WUAs) and the second was the period of the Water Users' Group (WUG). In what follows, characteristics of each of these management periods will be described. The section then zooms in on operation and maintenance of the scheme, looking at how these were financed and at the resulting state of the infrastructure.

The Water Users' Association period

After the irrigation scheme was modernised in the late 1980s, the Kilimanjaro Agricultural Development Project (KADP) introduced a management system based on WUAs. In each of the four villages in the scheme, a WUA was set up as part of the already existing administrative structure, the village government. WUAs thus became independent committee of each of the village government, chaired by the village chairman. The four WUAs in all villagers with their leaders were lead by KADP. There were very few interactions between the four WUAs; they mainly or only dealt directly with the KADP, through the village leader. Decisions at the level of the scheme, therefore, were exclusively taken by the KADP.

WUA members were the ones who directly elected by the water users in the respective villages. Farmers recounted that in the WUA period, they would choose those people as WUA members whom they thought trustworthy, and whom they thought could work hard. Most important in electing people was that they could collaborate well with them. The main responsibility of the WUA at that time was arranging the water distribution, and the organisation of maintenance works at the village level. This means that the WUA leader, the elected head of the committee, was responsible for arranging water distribution while assisted by block leaders and watermen (canal operators) who were responsible for implementing the agreed schedule of water distribution. The WUA did not handle money because when the KADP workers collected water fees they gave it to the KADP management. This means that the KADP was in charge of financial decisions, and decided how the collected fees were to be spent.

Although the farmers also had to contribute some fees and labour during the WUA period, most of the funds for running the scheme came from the government.

The WUA period lasted until 1992. Farmers recalled that in that time their relations with the agency, and even with other farmers and with the WUA, were good, and they had positive memories about how water management was arranged.

The majority of respondents thought that the irrigation scheme had been well managed. During this period there was adequate water to meet irrigation needs and the water allocation and distribution went well, without generating complaints from farmers. The WUAs and the agency were working as colleagues since they shared ideas and suggestions. Also in terms of financial management, most farmers remembered the WUA period as a relatively happy time, when they could rely on the fact that their financial contributions would be used as intended. The agency was trusted, since farmers believed it was committed to increase productivity, so farmers could repay their loans on capital improvements and pay for operation and management. Indeed, most farmers indicated that they preferred the way the previous WUA had worked over the current organisation. Even though the old WUA office-bearers were less educated, they were elected from within the villages, which is why they were closer to the farmers and their needs (interviews 2003). There was much less incidence of misappropriation of their money, and the older WUAs were more accountable to farmers.

The Water Users' Group period

In 1993, the old WUA system was changed into a management system with so-called WUGs, which at the same time was the Rice Farmers' Society (CHAWAMPU = Chama cha Wakulima wa Mpunga). The introduction of the WUG was meant to ensure participation and farmers' inputs at scheme level. The WUG was a group consisting of delegates from each village. Members of the WUG were chosen from among the village level sub-WUGs. Members of sub-WUGs were elected by the water users of each village. The village chairman automatically became a member.

Unlike WUAs, WUGs were also involved, together with KADP, in managing the entire system. The WUG consisted of a total of 15 members (four Mabogini, four Chekereni, four Rau and three Oria) elected by the sub-WUGs as their representatives in the board of the main WUG. In addition to these village delegates, the main WUG at scheme level consisted of staff from KADP (see Figure 2.5 in Chapter 2). The chairman was elected from the KADP agency. Within the WUG there were several committees, such as the finance and planning committee, agriculture and water management committee and machinery and construction committee. It also included an accountant for each village, two system leaders (Mabogini and Rau ya Kati systems), and a number of block leaders and watermen (operators).

Where the main WUG shared responsibility for the management of the system with KADP, the sub-WUGs were responsible for collecting the fees, which were consequently handed over to the main WUG. The main system-level WUG decided on how and where collected fees were to be used. The WUG was also responsible for mobilising labour for repairs on the tertiary and secondary canals, but repairs on the main canals were still the responsibility of KADP. Water allocation and distribution at scheme level were done by the KADP and WUG together. The KADP did the overall water allocation planning, and decided (for instance) about the area to be irrigated in each season, and designed the rotation schedules. The WUG and sub-WUGs then became responsible for implementing these plans. Although the WUG comprised farmer representatives from the four villages, water management has been a great problem ever since the WUG system. How much this is related to the change from the WUA system to the WUG system can be debated. Most farmers

interviewed blamed the WUG system for the increasing conflicts over water, but the introduction of the WUG system happened at a time when the competition over water between the scheme and the outsiders was becoming severe.

Many farmers within the scheme were not aware of these outside farmers, and they impact they were having, and just experienced a severe decline in water availability. This also explains why the start of the WUG period marked the beginning of deteriorating relationships between farmers and the management. Irrigators felt the decline in irrigated area to be the result of the malfunctioning of the WUG, which according to many respondents did not work as a real mediator between them and the agency. Rather, farmers felt that WUG members used their position in the WUG to benefit themselves. They explained that the WUG members did not listen to their problems, and did not represent them well. Villagers said they did not trust those who were chosen as board members, and disagreed with the way in which they were elected.

Although the sub-WUG members were still directly elected from among the water users in the villages, the WUG delegates were elected by the sub-WUG members without much influence from other water users. Informally, KADP staff often exerted subtle pressure to indicate their favourite candidates, and these tended to be the better educated, more well to do farmers with whom the staff preferred interacting. The KADP preference was not always the preference of the average farmer, who often would have preferred to be represented by farmers more like themselves. In fact, the biggest change implied by the new WUG system was that many important decisions about water allocation and maintenance were no longer taken at the village level, but at the scheme level. Such decisions were therefore farther removed from most ordinary water users, who felt they had fewer possibilities to demand accountability from their representatives, compared to before. Interviewed farmers identified this lack of accountability as a major reason for the many unattended problems among farmers and the scheme at large, and of the difficulties in mobilising people properly to perform necessary tasks.

Also, and unlike the WUAs, the WUG was handling money. This increased possibilities for corruption and mishandling of funds. When talking to farmers, it was clear that many felt that the fees that had been collected from them were not well spent by the WUG, and this feeling also reflected the overall lack of transparency. Indeed, there are several known instances of WUG officers stealing money from WUG accounts. In the words of one respondent:

> *Since 1993 when CHAWAMPU (WUG) took over from WUA, there have been three major incidences of theft. In 1994, the bursar at that time stole Tsh. 1,485,000 [c. US $1,485]. Between 1999 and 2000 a theft of Tsh. 13 million [c. US $13,000] occurred within the office. In 2001 a sum of 1,500,000 [c. US $1,500] was stolen. Some amounts have been recovered but most of the funds have been lost, and punishment of the suspects has been mild. Because the WUG farmers are interested in money they will not be ready to improve water management and crop production within the scheme. (Interviews 2001)*

Incidents of this kind were the cause of continuous conflicts between the agency (KADP) and the farmers after the project was handed over to WUG/KADP. Farmers frequently referred to their lack of trust in the new organisational arrangements, to explain their reluctance to cooperate in scheme activities, such as providing labour or attending meetings and this lack of cooperation further exacerbated misunderstandings, especially among the smaller farmers, who felt that they had been denied their rights, and that the organisational arrangements favoured only farmers with money. Overall, medium and small farmers felt that they did not

belong to the system and that they would always be on the losing side. Many scheme farmers thought that the introduction of the WUG system was an adverse change.

They said there was no democracy anymore, but a top down management, with farmers having to follow what ever was decided.

Financial sustainability and cost recovery

Water scarcity and organisational weaknesses were directly linked to the financial difficulties the scheme experienced. These mainly consisted of the problem that the fees collected from farmers were far too small to recover the costs of irrigation investment, operation and maintenance. When the scheme started, it was considered a public utility - a government service for the benefit of citizens. As a consequence, operation and maintenance costs were fully paid by the Tanzanian and Japanese governments. Governments used to assume, if not totally, a large share of the funding responsibility through national funds and through international loans. This changed with the 1980s wave of economic reforms, entailing drastic cuts in public expenditures. The implication for Lower Moshi was that farmers had to assume a larger share of the costs. This devolution of financial responsibilities was partial, because the government still continued to pay some expenses. Farmers had no choice but to accept the responsibility of cost sharing. Back in 1992, the operating costs of the scheme included the payment of the annual water right of about Tsh 300,000-400,000 (c. US $300.00-400.00) (interviews 2003), depending on the amount of water diverted from the water source to the fields. The other major cost was that of maintenance.

To recover such costs from farmers, the scheme required a service charge. This service charge covered water fees, tractor hire and maintenance costs, and amounted to US $38.00 per 0.3 ha per season. It was paid before the service was delivered to reduce possibility of non-payment. It has not been a problem to collect fees from farmers, because all farmers capable of cultivating rice paid the amount combined with tractor service charges. In effect if the fee was not paid, the plot simply would not be cultivated. Since farmers had no real alternative to tractor hire they paid. In addition to the service fee, each farmer contributed an additional amount of about US $10.00 (one bag of paddy) per plot per season for maintenance. Assuming that the cultivated area was 600 ha per season, the grand total collected per year would be something like US $38.00 x 0.3 x 600 x 3 seasons + US $10.00 x 0.3 x 600 x 3 seasons = US $25,920. These funds were not enough in relation to what was required for maintenance of canals, intake weirs, roads and drainage system. The agency estimated that the total cost to repair all dysfunctional structures would be about US $400,000. The lack of funds meant that many necessary repairs were shelved each year. In effect, charges were even insufficient to cover the true running costs of the scheme. At one time, farmers were obliged to pay an extra amount to the contractor to ensure that the canals were fully repaired. In order to fulfil this, each farmer was obligated to contribute one bag of rice per season (Interviews 2002).

Both the agency and farmers admitted that the revenue generated by water charges within the scheme was low, and had declined over the years. The irrigation service fees were in fact so low that even if they were collected in full, they would not cover 10 percent of operation and management costs. The continuous decline in the irrigated area is partly to blame; only those farmers who received irrigation water paid fees. Along with the decrease in irrigated area, also the number of farmers who paid fees decreased. As already shown in Table 3.2, about 35 percent of the farmers with plots in the scheme had plots which were effectively non-irrigable. Government

expenditures for the operation and management of the scheme were much higher in 1994-2003, when compared to the previous period (1987-1993).

In addition to cash payments to cover costs, farmers also contributed collective labour (*mtharagambo*). Communal work parties were arranged by the management committee in such a way that every resident (whether farmer or non-farmer, with or without plots) participated. This was introduced when management first properly realised the implications of the fact that most people used water for a range of different needs, and that recovery of irrigation water use fees did not properly cover the range of water usage activities in which scheme residents engaged. Labour requirements, however, introduced a new set of problems and inequities. Most male farmers did not have time to contribute labour because of their involvement in a wide range of off scheme income-generating activities to supplement farming expenses. They usually delegated their wives and children, or hired labourers to do the work. Although risk of fines induced some compliance, many farmers also felt that it was not right for them to be coerced into contributing their labour for the general maintenance at scheme level when they were not even able to continue cultivating rice (due to lack of water). It is unfair, they reasoned, to demand a general contribution to patch and mend a scheme that supplies benefits to a dwindling number of farmers.

The lack of funds to maintain the system was clearly reflected in the poor status of its infrastructure. There has been damage to the banks of the canals caused aging, while some were also broken when cattle tried to drink water. Some of the canals were full of silt. The lack of proper maintenance of the structures damaged by farmers added to the many unattended defects within the irrigation system, and exerted a strong negative effect on efficient and equitable water management. Tables 3.4 and 3.5 reveal a large percentage of defects on canals and other structures resulting from poor maintenance at the time of study. The percentage rose with distance from the main canal. The main canal (10.1 km) had 1.5 km (14.8 percent) where repairs were needed while the secondary canal (24.6 km) needed repairs over about 6.0 km (24.3 percent) and so forth. These defects were mostly caused by farmers, especially along tertiary canals where farmers destroyed the structures purposely to access water. In other canals, the defects more often reflected prolonged lack of maintenance due to lack of funds. The 48.8 km of drainage canals were also in a poor condition, with up to 40 percent in need of maintenance. The flood dykes also needed repairs (19.1 percent) to avoid possible problems within the scheme, especially during heavy rainfall.

Some structures (water gates, division boxes, water intakes) were not fully functioning, because they were damaged in the process of farmers getting more water illegally. At one time, the upstream water intakes were damaged by angry farmers from Mabogini village when they were trying to get water by force and to prevent the sharing of water with tail-end farmers. This damage has been repaired, and the intakes are now in good condition; about 95 percent of them (in fact) are functioning properly. It has not been easy for farmers to destroy water intakes again, because armed guards (called *Mgambo*) were hired to watch them day and night. Of the division boxes, 81.8 percent were fully functional and 18.1 percent are partly functional.

Table 3.4 Defects of sample canals

Type of canal	Size of canal	Portion of defect	Percentage of defect
Main canal	10.1 km	1.5 km	14.8%
Secondary canal	24.6 km	6.0 km	24.3 %
Tertiary canals	65.6 km	20.0 km	30.5 %
Drainage canals	48.8 km	19.5 km	40.0%
Flood dyke	15.7 km	3.0 km	19.1%

Source: Field data 2001-2004

Table 3.5 Defects in sample structures

Type of structure	Good condition		Fair condition		Bad condition	
	Number	%	Number	%	Number	%
Water gates	150.0	50.0	90.0	30.0	60.0	20.0
Intake weirs	2.0	95.0	2.0	5.0		…..
Division boxes (Turnouts)	9.0	81.8	2.0	18.1	…..	…..

Source: Field data 2001-2004

Only 50 percent of water gates were fully functioning, and 30 percent were partly functional, while the balance (20 percent) was not functioning at all. The condition of water gates tended thus to assist water poachers, negatively affecting the effectiveness of water distribution. Many water gates were destroyed by farmers during attempts to get water out of turn. Most of the water gates have been replaced by hand made wooden structures. There are also places where there were no water gates at all, and some local material was used. Structures replaced ten years ago were mostly damaged, and most of them remained unrepaired, especially the water gates at farm level, because of the high cost of more frequent replacement. One farmer commented:

> *The management is tired of repairing the water gates since most of them are destroyed by farmers themselves in the process of obtaining water illegally. This is the reason why some of them are repaired by use of pieces of wood or sometimes farmers put stones and some mud to block waters. (Interviews 2003)*

3.6 Conclusions

By analysing an irrigation scheme in Tanzania as a socio-technical hybrid, using a technographic approach, the present chapter has revealed some sources of inefficiency and conflict within the scheme. In its establishment and modernisation, the scheme was dominated by 'development import' and 'top-down' perspectives. The project management did not understand, match and respond to the complexities of smallholder irrigation found in a multi-user irrigation context. The plan and construction of the infrastructure was done without considering people living at the head end of the river who could also use water. In particular, the rights of existing farmers and water users were neglected. Within the scheme itself, a modernised

management structure became more remote from the needs and perspectives of farmers, and corruption and inefficiency increased. These are the mechanisms captured by the technographic approach (Pawson and Tilley 1997; Richards 2002, 2007) as explained in Section 1.5. The outcome of the implementation of modernised irrigation technology for improved water management was affected by a number of unregulated actions. These included conflict of interest in regard to water between the agency and outside farmers, and among farmers within the irrigation scheme, and resulted in water shortage. In response to these shortages, the agency implemented some management and control mechanisms in a top-down manner. This included equal sharing among tail and head-enders, restricted use of water, and reduction in area of irrigated land cultivated.

These reforms created conflicts between the head and tail end farmers, as well as between different groups of farmers within scheme; especially at the tail end, which resulted in even poorer water allocation. Henceforth, only those willing to use illegal physical intervention or bribery were sure to get water. This threatened the scheme with ungovernability, due to inequity. Only the rich and strong were able to enjoy the benefits of technology. Forceful ways of getting water included destroying infrastructure (e.g. intake weirs) so as to prohibit tail-enders from getting water. Tail-enders responded by abandoning the rules of water use, and saw themselves as pitted against the agency. There was little spirit of cooperation to maintain the scheme. In short, the failure to understand the complex cultural landscape on which the scheme was imposed, and growing internal inequities, worsened the serious water shortage within scheme, which in turn resulted in poor cost recovery, and thus poor maintenance, further intensifying the poor relationship among farmers and between farmers and the agency. In short, lack of attention to the interaction of technical and social factors has resulted in a vicious circle of increasingly poor irrigation management performance.

The results of a technology transfer approach with such challenges, have so far failed to achieve intended results and an already poorly performing irrigation scheme continues to deteriorate. Irrigation management has not been cost effective, because the amount of money collected from farmers declined after the area of land was decreased due to water shortage, and the revenue base is now insufficient to take care of routine operation and maintenance. Rapid deterioration of infrastructure, reported by farmers, was confirmed during inspection of the infrastructure. A sampling of canals, roads and other irrigation system structures revealed that the maintenance was not neglected. Both farmers and members of staff confirm that these defects affect the performance of the system. Despite the fact that modernisation has given farmers opportunities to manage the irrigation system jointly with the management this has not proved any solution.

The water users' organisation is reported to have misused funds contributed by farmers for water and service charges and repair of infrastructures, and this has resulted in failure to meet other essential operating costs. Generally, there has not been a good relationship between the farmers, the agency and water users' organisation officials, a prerequisite for good performance, equitable water distribution and timely maintenance of well-functioning irrigation systems. Farmers are sceptical about the staff of the water users' organisation, considering them people motivated by individualism and lack of commitment to farmer's needs.

The picture remains bleak. Poor water management and water shortage remain. The management needs to look for another water source or change the cropping system to less water intensive crops than rice. Otherwise the vicious circle contributing to poor water management within the scheme will remain. Lack of real

reform is hindered by multiple conflicts. But resolving these conflicts will require a broad understanding of the interaction of technical and social factors in underpinning competing claims. Effective management of water requires engagement with the knowledge, experience and opinions of local communities, who are key stakeholders in resource utilisation. The effects of water scarcity and inequity caused by the conflict with farmers outside the scheme have very much affected irrigated rice production within the scheme. For this reason, the subsequent chapters in this thesis will probe more deeply into factors that arise in realising challenges and opportunities for irrigated agriculture in Lower Moshi. The impact of introduction of irrigated agricultural technology on livelihood strategies, gender relations and water management will be discussed.

CHAPTER 4

IMPACT OF IRRIGATION MODERNISATION ON LIVELIHOODS AND SOCIAL DIFFERENTIATION

4.1 Introduction

This chapter aims to show how irrigation development increased the socioeconomic differentiation among farm households in the Lower Moshi scheme. It engages with wider debates in the literature about how irrigation interventions impact on poverty and social differentiation. One widespread assumption in development thinking is that irrigation is reducing poverty (Lipton *et al*. 2003; Smith 2004), and it is also believed that irrigation helps solving other problems such as water shortages and food production (Hall 1999). Indeed, and especially after the Sahelian drought in the 1970s, investment in irrigation has been a favoured strategy to bring about increases in crop productivity, enhance food security, and expand opportunities for higher and more stable incomes and employment. In development policy circles, irrigation was seen as 'a privileged solution' (Moris 1987) or viewed as 'islands of salvation' (Chambers 1988). Yet the success of the many irrigation development efforts initiated by governments and donors has been disappointing. In spite of huge investments, productivity remains far below expectations and national food imports continue to increase (Barnett 1977; Kortenhorst *et al.* 1989; Moris and Thom 1990; Underhill 1990; Adams 1992). The previous chapter showed that this was also true for the Lower Moshi scheme; anticipated production targets were not met, and recurrent conflicts over water resulted in low cropping intensities, low levels of cost recovery, and poorly maintained infrastructure.

In addition to the criticism of not attaining anticipated increases in production, studies have also been critical of the tendency for irrigation development efforts to be accompanied by an increased differentiation between rich and poor. Irrigation projects tend to favour some farmers and households at the expense of others (Patnaik 1990). Irrigation often involves a switch to mono cropping, and because this requires expensive inputs it created difficulties for households without access to capital or credit. Increased dependency on money and markets for buying inputs and selling produce also tends to increase the vulnerability of large groups of farm households to livelihood insecurities (Patnaik 1990). The Kenyan experience of the Mwea irrigation settlement project, for instance, resulted in farmers not being able to generate sufficient income to sustain their families, due to the high cost of, in particular, fertilizers and other agro-chemicals (Hanger and Moris 1973; Alukonya 1993). Whether and to what extent people were able to benefit from new irrigation opportunities depended very much on their ability correctly to apply water, purchases and required sets of inputs, and to follow prescribed cultivation techniques.

To analyze whether and how different categories of farm households benefited from new irrigation opportunities in Lower Moshi, this chapter uses a livelihoods approach. Understanding how irrigation fits into farmer livelihoods is one of the

important lacunae in irrigation studies. Chambers (1994) believes that benefits from irrigation should be assessed in terms of its livelihood intensity; the number of households enabled by irrigation to gain adequate and secures livelihoods. This approach starts from the realisation that irrigation is one set of livelihood practices designed by local people or government to enable crop production by removing the uncertainties inherent in natural rainfall (Carter 1989). Following Guijt and Thompson (1994), the chapter attempts to come to terms with the complexity of local livelihood strategies in diverse and risk-prone environments by using an environmental and socio-economic analysis of irrigated agriculture.

The livelihood approach entails a redefinition of irrigation as a means to an end and not an end in itself. The chapter shows how irrigation development interventions created an unequal distribution of land resources among farmers, thereby also influencing access to other livelihood assets, The resulting social differentiation was intensified by the acute water shortage caused by water conflicts with farmers outside the irrigation scheme (see Chapter 3), and by the increased dependency on the use of inputs that the newly introduced rice varieties required. Hence, some farmers with good access to assets and incomes clearly benefited from the introduction of irrigation and the adoption of new technologies, while others suffered. The first section of the chapter defines the concept of sustainable livelihood. The second section describes the impact of both irrigation and agricultural technology, as well as the impact of water conflict on the access to assets (resources). It shows how the unequal distribution of irrigated land among farmers within the scheme created a differentiation among farmers. It also shows how unequal access to water and other resources, including market access, further shaped possibilities to benefit from the technology. The third section uses an analysis of the differential access to important livelihood assets needed for rice farming to explain why different categories of farmers benefited differentially from new technological opportunities. The fourth section looks at the relative importance of irrigated rice farming as a livelihood strategy among other strategies. It shows how the differential access to resources among categories of farmers influenced their dependency on irrigated rice farming and involvement in diversified income activities of various economic kinds. The fifth section discusses and concludes the key findings of the chapter.

4.2 The sustainable livelihoods conceptual framework

In this chapter, I adopt the sustainable livelihood approach framework (DFID 2001, Carney 1998) and use it to analyze and assess the impacts of irrigation technology. It helps to understand the opportunities and constraints that farmers are facing, which may influence dynamics in assets and livelihood strategies. In general, studies of technology impact face both conceptual and empirical challenges, partly due to complexities of the relationships between agricultural technology and rural livelihoods. As the goals of agricultural technology development change from increasing food production to the broader aims of improving livelihoods or reducing poverty both technology developments and studies of its impact become more complex. Yet examining the impact pathways of agricultural technology is essential to guide future research in ways that will bring about better contributions to the aim of poverty alleviation. A livelihood approach helps tracing these pathways. The sustainable livelihood framework used in this study paints a more accurate picture of

stakeholder assets and activity and the intervention context blocking or enabling pursuit of more secure livelihood over time.

A livelihood is defined by Chambers and Conway (1992) as a 'the means of gaining a living, including livelihood capabilities, tangible assets and intangible assets'. One of the very important characteristics of this definition is that it looks at the connection between assets and activities, which result from options people have and their strategies for survival. Niehof and Price (2001) have expressed their concern about the fact that the various livelihood definitions fail to distinguish between the dimensions of process, activities, outcomes and assets and resources.

They comment that the flows and stocks of food and cash within households that Chambers refers to are in fact generated through a bundle of interest activities on the basis of resources and assets. Households usually undertake various activities to generate a livelihood in a dynamic system. Such a livelihood system is comprised of resources and assets as inputs, their use and management, which together give an outcome or a type of livelihood. Rural household assets range from the more tangible types such as labour, livestock and land, to the intangible types such as household relations and social capital. Ellis (2000) and Moser (1998) have provided a good framework for asset classification. Even though the Ellis and Moser asset groupings might seem different in terms of nomenclature, the two frameworks are very similar in content.

Generally, household assets can be grouped into five broad asset types (Carney 1998; DFID 1999, 2001). The asset pentagon is comprised of natural assets, physical assets, human assets, social assets and financial assets. The natural assets in the study area are items such as land, water resources. Financial assets are savings, income, wages, credit (informal or formal) as well as flows like transfers or remittances. Both types of assets are important in irrigated agriculture. Large scale irrigation schemes are designed to maximise use of land and water Physical assets are tools and items of production equipment such as seeds, fertilizers, irrigation technology, transport, milling machines, storage buildings and farm buildings. In addition there are human assets, which are factors determining people's capabilities, which include skills, knowledge, power, and labour. Social assets are networks, relationships of trust, ability to work together, access to opportunities, informal safety nets and membership in organisations. These five kinds of assets put together form an asset pentagon, which can be used to assess people's overall asset base. Here, attention is given to the assets that people can draw upon for their livelihoods. The distribution of livelihood assets in any population is often uneven. Gender, age and other social and economic differences may significantly affect access to livelihood assets within the household or other groups (Rocheleau 1999). For example, while land or type of crops may be regarded as household assets, women's rights to it may not be the same as men's. Livelihood strategies are the result of the assets and their access. In most cases the environment that a household lives in, the assets it owns and the assets needed to access resources determine livelihood strategies. So this means that livelihood strategies are the set of life sustaining productive activities undertaken by rural households. These sets of activities can be broadly classified into three main categories: agricultural intensification (increasing farm yields) and extensification (increasing farm size), income diversification (through engaging in a range of off farm economic activities), and migration (temporary or permanent, partial or whole household) (Devereux *et al.* 2003).

Even though it is possible to classify household livelihood strategies into these main groups, it is important also to indicate that rural household livelihood strategies are complex, and as a result household members may be engaged in more

than one strategy at any one time. This phenomenon sustains the idea of multiple livelihoods and income diversification. Livelihood diversification is defined as 'the process by which rural households construct an increasingly diverse portfolio of activities and assets in order to survive and improve their standard of living' (Ellis 2000). It is usually referred to as diversification away from agriculture, and often includes a migration strategy (Scoones 1998). The reasons for diversification have been argued from several points of views, such as necessity versus choice, seasonal nature of agriculture, risk strategies, labour markets, credit market failure, and investment in future (Ellis 2000).

They influence access to assets and livelihood strategies. They shape people's access to assets and livelihood activities, as well as the vulnerability context in which they live. It is here that linkages can be made between livelihood activities taking place at the micro level and/or macro level institutional and policy contexts. In term of development policy, sustainable livelihoods approaches typify a shift from needs-based, resource-centred solutions to a focus on people and their capacity to initiate and sustain positive change (Carney 1998; Alterelli and Carloni 2000). As a concept, sustainable livelihood is held to provide a more rounded picture of the complexities of living and surviving in poor communities than understandings based on measures of income, consumption and employment. In rural contexts, it is also held to shift attention from a focus on agrarian change to consideration of livelihood diversity, an issue of increasing significance in scholarly research (Davies 1996; Goodman and Watts 1997; Long 1997) and rural development policy (Ashley and Maxwell 2001).

Livelihood outcomes encompass many of the types of impact of interest for the study of the significance of agricultural research and technology for poverty alleviation. Potential outcomes include conventional indicators such as income, food security and sustainable use of natural resources. Outcomes can also include a strengthened asset base, reduced vulnerability, and improvements in other aspects of wellbeing such as health, self-esteem, sense of control and maintenance of cultural assets, and thus have a feedback effect on the vulnerability status and asset base. For example households that have higher incomes or better alternative resources are better able to cope with the impact of income shocks like HIV/AIDS (Rugalema 1999). As shown in the framework, livelihood outcomes can either be sustainable, vulnerable or unsustainable. According to Devereux *et al*. (2003), both sustainable and vulnerable livelihoods are adequate in food stocks and income, but while a sustainable livelihood is resilient to shocks and trends, a vulnerable livelihood is not. On the other hand, a household with an unsustainable livelihood lacking adequate food supplies has little or no income and hence is highly susceptible to shocks and trends.

4.3 A categorisation of farm households based on access to land and water

Differential access to land and water lies at the basis of the social and economic differentiation among farmers. This section explains the land- and water allocation among farmers in Lower Moshi. The section ends with a categorisation of farmers based on the distribution of irrigated plots in the scheme. Among plot holders, the number of plots owned and their location in the scheme provides a good indication of wealth. This categorisation will be used throughout the rest of the chapter to explain the livelihoods of those within the identified categories.

Plot distribution within the scheme

The reallocation of irrigated land within the site selected for the project by the donor agency was done on land that already used for farming by inhabitants of the villages. Farmers who cultivated these sites had acquired the land under a range of customary and national land laws, as discussed in Chapter 2. When designing the new irrigation scheme the command area selected only covered part of the landholdings of the communities. In fact, a deliberate choice was made to concentrate the use of the available water in a limited area so that enough would be available to produce rice twice a year. This choice resulted in a reduction of (potentially) irrigable land available to the communities from 6,320 ha (before the scheme) to 2,300 ha, the figures for the eventual command area of the scheme. The command area was levelled during modernisation and divided into 0.3 ha plots reallocated to original owners. The reallocation happened according to original titles, and the final allocation therefore reflected pre-existing differences in land ownership. According to respondents, most farmers who cultivated in Mabogini and Rau villages owned land through customary claims from their clans. Within the area, land was traditionally associated with wealth and security. It was the main source of income, and brought in regular returns to those who cultivated it. In contrast, in Oria and Chekereni, the influence of clan land was not as pronounced, because most of this land was occupied during the Villagization Settlements in the Ujamaa period (as discussed in Chapter 2), when land was allocated through village governments. This is why most farmers here owned more or less equal amounts of land. There are also a few farmers who moved to the villages before the establishment of the local government; these have variable holdings depending on bush clearing. Ownership of plots at the time of study still clearly reflects these differences between head-end villages Mabogini and Rau, and tail-end villages Chekereni and Oria (Table 4.1).

Table 4.1 Resident and non resident plot holders among villages within the scheme (N = 1,863)

Villages	All farmers			Resident farmers		
	Males	Females	Total	Males	Females	Total
Mabogini	601	185	786	176	100	276
Rau River	278	54	332	248	49	297
Chekereni	411	137	548	240	92	332
Oria	186	11	197	33	2	35
Total	**1,476**	**387**	**1,863**	**697**	**243**	**940**
Percentage	**79%**	**21%**	**100%**	**74%**	**26%**	**100%**

Source: Field data and scheme documents 2001-2004

Before the inception of the project both customary and national laws were guided by ideologies of patrilineal inheritance (inheritance through the male line) and patriarchy (rule by men), discriminating against ownership of land by married women. All married women therefore depended on their husbands (or sometimes fathers and brothers) for access to land. Only female heads of households (about 30 percent in the scheme) owned land in their own name, acquired through inheritance, purchase or allocated through village government. In the rest of the chapter, when 'female farmers' are mentioned, it is this group of female plot holders that is referred to. Of course, there were many more female farmers than the female plot holders; in

fact most of the work in farming (especially in maize cultivation) was done by women (see also the following chapters).

Over the years, the original plot allocation has changed through the sale, rental and inheritance of plots. Economically well off farmers have been able to buy plots from those with less economic power, while people from outside scheme have also come to Lower Moshi to buy plots. Poor harvests and missed seasons caused by lack of water or inability to obtain tractor services meant many farmers could no longer pay farming expenses and these often decided to sell or rent out their plots to other farmers, resulting in the distribution captured in Table 4.1.

The land market in the scheme has been unregulated and open to those with financial resources such as businessmen and retired officers who look for cultivable irrigated plots. For those without funds it is virtually impossible to acquire plots. This was due to the fact that there are no clear regulations governing sale and purchase of land, and prices are very high by community standards. Only those with good cash income are the ones who managed to take advantage of buying more land. Land prices have increased year on year, with the price per 0.3 ha rising from US $10.00 in the 1980s to US $30.00 to $40.00 in the 1990s and ranging between US $150.00 and $300.00 in 2004. Renting plots is expensive relative to purchase; a 0.3 ha plot costs about US $70.00 per season and even more, depending on location of a plot. The rent had been high because the one who rent out knows the profit of the renter and at the same time the farmer who owns the plot treat as a source of income. The number of farmers who were to rent land plots had been decreasing during the time of study because of low profit margin. Renting out used to be more popular (before 2000) because it was easy to make a profit, but as the time went by profits from rented plots declined. As from the year 2001, farmers decided to cultivate rain fed maize in the plots that were not receiving irrigated water. Some farmers owning such plots decided to sell green maize before harvest to ensure income for their families. They also earned good harvests of dry maize at an average of 12 bags per plot. The success of maize cultivation in irrigated plots has reduced the number of farmers interested in renting out their plots.

The market in plots for sale and rent also allowed some women who had money to acquire plots, but opportunities to acquire irrigated land are mostly accessible to wealthier male farmers because of their greater financial resources. Although new land policy (URT 1999a; URT 1999b) made it possible for women to claim rights to acquire land, this has come too late because all land within the scheme was already fully occupied and owned. Yet, there have been a few women who benefited from changing land inheritance practices, and the situation may get better; many families at the time of the study were changing their inheritance to the effect that women also could inherit. Some married women had inherited land from their fathers, but most preferred not to use such plots in their married households. The women explained that they left the inherited land with their parents or brothers because they were afraid their husbands would take the plots and own it on their behalf. To the extent this is a common attitude, this demonstrates that men and women share patrilineal ideology, and is thus not itself 'gendered'. Patriarchy (the idea that the man should rule) is another matter.

Location in the scheme and access to water

The use of land among farmers within the scheme depended very much on water access. As discussed in the previous chapter, the land plots within the four villages differ in the way they receive water depending on locations. Farmers with plots in Mabogini and Rau got more water than those with plots in Oria and Chekereni. Plots

that access a good amount of water produce more than plots that do not get enough water. The scheme designers had anticipated that most, if not all, water available in the two rivers feeding the scheme would be available for the scheme. They had not taken into account that many farmers, from villages within the scheme as well as from other villages, were already using this water. Many of those farmers, who had not been allocated plots within the scheme, from the villages of Mandaka Mnono, Kaloleni and Pasua (as discussed in Chapter 3), little by little started to cultivate the same variety of rice as was promoted within the scheme at the head end of the Rau river. They claimed to have customary rights to the water, and their use of water caused the down streamers inside the scheme to experience water shortages. Not all farmers suffered the consequences of these water shortages to the same extent. Commercial farmers with many plots have their lands at the head end of scheme, in the villages of Mabogini and Rau, where it is easy to access enough water to produce rice twice a year. The subsistence groups of farmers mostly have plots in areas where there is a shortage of water. Indeed, the highest number of farmers with few plots and those who receive less water is in the tail end of the irrigation system in Chekereni and Oria villages

Table 4.2a gives a picture of the distribution of plots at the time of the study, based on the sample of 300 farm households. As explained in Chapter 1, this sample is representative of the overall population of the scheme. The table shows that almost 30 percent of the villagers had plots in the scheme. Indeed, the number of farmers without irrigated plots within the scheme (70.4 percent) was bigger than the number of farmers included in the project. Of the 29.6 percent of those with plots, some people had more than others; just over 40 percent (12.6 percent of all farmers in the sample) owned more than seven plots, while just fewer than 60 percent (17 percent of all farmers in the sample) owned one to six irrigated plots. The majority of those with high numbers of plots were men, because land was distributed to heads of households, a group mainly made up of men. As explained, the majority of married women did not own their own land, but accessed land through their husbands. The percentage of female-headed household within the scheme was high (about 30 percent), but most of them did not have any irrigated plots.

Table 4.2a Plot holding categories among sample farmers (N = 300)

Heads of household	≥7 plots		1-6 Plots		Without plots		Total	
	No	%	No	%	No	%	No	%
Men	32	10.6	41	13.7	128	42.7	201	67.0
Women	6	2.0	10	3.3	83	27.7	99	33.0
Total	**38**	**12.6%**	**51**	**17%**	**211**	**70.4%**	**300**	**100%**

No = Number

Source: Field data 2001-2004

As shown in the table, only 5.3 percent of the women out of 19 percent of all owned plots. Among farmers who were able to own more than seven plots, only 2 percent were from female-headed households while the rest (3.3 percent) owned one to six plots. This increase of plots among them means that there were some women who were able to buy more plots for themselves. It is thus important to note that economic differentiation affects women as well as men. In interviews, the majority of ordinary women cultivators indicated that they felt left out, and left with no other choice than to depend on rain fed land plots as their major livelihood assets. In all,

plots are rather unevenly distributed among farmers, with a few very rich farmers owning many plots, like in Mabogini, where there are a small number (about 2 percent) of very rich farmers own more than 30 to 40 plots. There are also some very well doing farmers in Rau, owning between 22 and 26 plots.

Table 4.2b describes a total distribution of wealth ranks of different household categories according to their involvement in rice farming as rich farmers (15.7 percent) average (33 percent) and poor farmers (51 percent).

It clearly shows that most of the rich people in the scheme were those who had more than seven plots, belonging to the group of commercial farmers. Farmers with one to six plots, (especially in low productive locations) most belonged to the average category, while most of the poor farmers belong to the non-plot holders. As indicated, there is a clear spatial dimension to wealth and the number of plots owned; most rich farmers with many plots are in the head-end of the system, in Mabogini and Rau which (as explained in the previous chapter) also has best access to water.

Table 4.2b Wealth Ranking of farmers in different production categories (N = 300)

Household category	Rich		Average		Poor	
	No	%	No	%	No	%
Commercial farmers (38)						
Female -headed households	4	10.5	2	5.2	-	-
Male-headed households	22	57.8	10	26.0	-	-
Sub-total	**26**	**68.3**	**12**	**31.2**		
Subsistence farmers (51)						
Female-headed households	1	1.9	8	15.6	5	9.8
Male-headed households	4	7.9	31	60.7	2	3.9
Sub- total	**5**	**9.8**	**39**	**76.3**	**7**	**13.7**
Non-plot holders (211)						
Female-headed households	4	1.8	17	8.0	68	32.0
Male-headed households	12	5.6	32	15.1	78	36.9
Sub-total	**16**	**7.4**	**49**	**23.1**	**146**	**68.9**
Total of household categories: 300						
Total and % of each category	**47**	**15.7**	**100**	**33.3**	**153**	**51**

Source: Field data 2001-2004

4.4 Rice farming

Photo 4.1 Rice seedlings prepared for rice farming in Lower Moshi

Source: Field data 2003

This section looks at how plot holders adopted the new improved technological package promoted by the scheme management. The intention of the scheme was that all plot holders would grow rice, and that many would grow two crops per year. The shift to improved rice variety (see Photo 4.1), entailed a number of other changes, and only some of the plot holders in the scheme were able actually to meet anticipated targets and turn rice production into a profitable enterprise. I show that to make rice cultivation into a profitable business, access to capital is crucial (to buy inputs, hire labour and tractor services). Most average farmers did not have regular access to capital, and depended often on expensive loans to start cultivating. Some financial reserves also came in handy when hiring tractor services; offering some small extra financial incentive to tractor operators made the difference in obtaining timely access to the tractor service. A financial reserve, in addition, allowed farmers to sell rice when prices were high, instead of being forced to sell it in husk directly from the field, risking the malpractices of businessmen. Within the scheme, only the rich farmers with many plots and good access to water (in Mabogini, Rau, and a few from Chekereni and Oria) succeeded in turning rice farming into a successful enterprise. For the others, the introduction of rice implied a distinct increase in their vulnerability, as it increased their dependence on markets for survival. In what follows, differences among farmers in terms of their ability profitably to produce rice are explained on the basis of their differential access to livelihood assets.

Tractor services

The scheme management introduced the mechanisation of rice cultivation as one important component of the overall plan to increase productivity. Imported tractors and implements (see Chapter 2) were deemed necessary to meet the cropping patterns originally planned, and to ensure efficient utilisation of available water. This was based on estimates of labour availability and the economic conditions of the people of Lower Moshi, showing that ploughing and puddling were the operations for which labour might become a constraint. It was made compulsory that all farmers engaged in rice production hire such tractors. In order to acquire services, farmers had to pay water and tractor fees before the farming season began. The fee has increased annually. For example, in 2001 the fee was US $34.00 per 0.3 ha and in 2004

it was US $38.00 to $39.00. All farmers who decided to become involved in rice farming have proven capable of paying these expenses.

As indicated in Chapter 2, the scheme started operating using many tractors, but at the time of the study most had broken down. Farmers blamed administrative sloppiness and mismanagement for the failure to repair tractors and equipment. According to the management, the major problem has been the lack of funds to buy expensive spare parts. Farmers agreed that unavailability of spares for maintenance of aging tractors lay at the root of problems in acquiring tractor services. Even though the cultivated area was sharply reduced because of water shortages, it remained difficult to plan tractors services for the entire area. In order to increase the utilisation of the machines, it was agreed by the management that farmers' requests to grow upland crops like maize, beans, vegetables and sunflower in the plots that were un-irrigated during rainy season would also be accepted. Even so, the small number of operating tractors remained a major problem within the scheme.

The small number of serviceable tractors was inadequate to provide services to all farmers, especially during peak periods. Indeed, the scarcity of tractor services was one of the main sources of conflict between farmers and the management of the scheme. Many farmers in the average category were of the distinct impression that management favoured richer farmers when allocating tractor services and they therefore frequently complained of unfairness. Most of these smaller farmers had stories to tell about hassles in trying to obtain timely tractor services. Complaints about the Kilimanjaro Agricultural Development Project (KADP) and the Rice Farmers' Society (CHAWAMPU) were frequent, with farmers being sent up and down the bureaucratic line of KADP drivers, CHAWAMPU tractors and KADP fuel in the course of attempting to hire a tractor. One farmer said:

> *When we went to see CHAWAMPU so that we could get tractors to cultivate our plots, they said it was KADP who have drivers. And when we decided to go to KADP they said they did not have fuel, because it was CHAWAMPU who had it. As a result of this we were left stranded, not knowing where we should turn to and what we should do. Most of us farmers who have been through this are tired of this and have missed some cultivation seasons because of lack of getting a hold of tractors during our turns. We wish we could be allowed to hire tractors from outside the scheme. (Interviews 2003)*

Many farmers echoed these sentiments, having experienced delays in farming activities, with some having indeed missed entire cultivation seasons because of tractor delays. The wealthier farmers were more successful in obtaining tractor services, largely because of 'what they are' (they could afford to offer inducements) and because of their better connections. Many of them are called *'wazee'* (elders) because of their wealth. After the work is done, those who facilitated the hire of the tractors services – are likely to receive money as a token (*kitu kidogo*), to ensure that next times things also run smoothly. Problems in acquiring timely tractor services caused late ploughing and therefore negatively affected the rice harvests of the average farmers.

Labour

On one hand the introduction of irrigated rice increased labour requirements, while on the other hand it also contributed to reducing labour availability by stimulating migration and engagement in other income generating activities. The introduction of high yielding rice varieties, in combination with an increase in cropping intensity, and an increase in the number of agricultural activities performed, added to labour

requirements. Agricultural activities in irrigated rice include ploughing, puddling, transplanting, weeding, fertilizer application, bird scaring and harvesting. Although ploughing and puddling were mechanised, overall labour requirements for farming increased. Most farmers used to have surplus labour prior to the introduction of irrigated rice, since they focused on crops such as maize and cassava, which did not require much labour. In rice, activities such as transplanting, weeding and harvesting are done by women, while some of the activities traditionally done by men were mechanised (ploughing, puddling and fertilizer application), thus unbalancing the prevailing gender division of labour and gendered distribution of responsibilities (see Chapter 5). Harvesting is done by women, who often work collectively, sometimes with help from men or hired labourers.

Somewhat paradoxically, the introduction of irrigated rice also contributed to a decline in labour availability among families by stimulating emigration. Although it is a tradition of Wa-Chagga men to migrate for trade or wage labour as a livelihood activity, the introduction of irrigated rice led to an increase in the migration of young men, many of whom were seeking to escape from the tedious farming work, preferring to become involved in wage and trade labour in nearby towns instead. According to some informants, young men wanted quick money from petty trading yet in fact many young men also left because they could not afford to acquire irrigated plots to become involved in rice farming. Whatever the exact reasons for the emigration of young men (the topic deserves a further study), the effect was that many households did not have enough labour to cultivate irrigated rice.

More than before, therefore, labour needed to be hired, and labour opportunities in fact attracted many people from outside the scheme who came looking for paid farm labour. Interestingly, while people from the villages in Lower Moshi migrated to villages outside the scheme in search of work, there was also immigration of labourers to the scheme. Wages in Lower Moshi were lower than those elsewhere, for instance in Kahe, which was why Lower Moshi people emigrated. For example, when in Lower Moshi the on-farm labour payment was US $1.00 per day per person for people working in groups, in other areas the payment was double. But wage rates have risen as the rice economy has developed. During the period 1987-1997 the average labour cost per 0.3 ha plot rose from US $23.00 to $53.00, and by 2004 had reached US $100.00 (100,100.00 Tanzanian shillings) (see Table 2.7 in Chapter 2). Many women (young and middle aged) have taken advantage of increased farm employment opportunities to hire out their labour where before they would work without wages on the family farm. Such women sometimes organised themselves in groups, and hired themselves out on this basis, dividing the income after they were paid. Richards (1986) reports for rice farming in Sierra Leone groups work more efficiently than individuals and attract better rates per capita.

There were only very few families entirely reliant on family labour, and these were mostly those farmers with plots smaller than 0.3 ha. Most families only used the labour of children during school holidays, and also hired labourers or organised labour exchange groups. The majority of rich farmers, as well as more than 50 percent of average farmers, used hired labourers because of the number of time-constrained agricultural activities they had to complete, and due to lack of family labour. Male farmers who were financially capable of paying labourers generally did so and engaged in the rice work only as overseers. Many of the less well doing farmers with a few plots depended on exchange (collective, rotational) labour, in addition to some family labour. Exchange labour was voluntarily organised by farmers who agreed to help one another by organising in groups and working on each others' plots one after the other. These labour groups often consisted of women,

because they were the ones who looked after the irrigated plots when men were engaged in other income generating activities. They organised exchange labour because they could not afford to pay labourers. Access to labour also depended on the season. During the rainy season, women had to divide their labour between their rice plots and irrigated maize plots (to be discussed in Chapter 5). It was the time when most hired labour was needed and women then had both to perform agricultural activities and also supervise hired labourers. Most irrigated rice activities are performed by women, and missing work and supervision is one of the reason's their workload has increased.

Recommended inputs

Although inputs were expensive for average farmers, most prepared themselves, for instance by borrowing money for fertilizers. To save money on improved seeds, some farmers re-used harvested seeds. This is feasible with self-pollinating rice, provided the seed intended for replanting is harvested carefully. Survey data showed no differences in the use of inputs among the rich and average farmers except in use of seeds. Most average farmers re-used seeds, but some richer farmers bought new seed each year. According to their experience, most farmers were capable of selecting and storing the right type and amount of rice for the next season. Some farmers said that they knew the good seeds because they had prior rice farming experience.

Some farmers commented that 'a true farmer can never consume seeds, because if she/he does that will end his occupation of being a farmer'. The farmers were keen on this issue, and made sure they did not consume all the rice, always putting aside an amount for next season. The practice of re-using seeds is a cause of concern for the management, since it fears a reduction in quality and yields. Other studies (Richards 1986) show that the quality of saved seeds in African rice farming is actually at times higher than certificate seed available from projects, so the concern is probably misplaced.

All farmers who cultivated irrigated rice were required to use fertilizers in order to improve productivity. Since all farmers were aware of this, those who wanted to cultivate rice always budgeted for this expense. Those who could afford fertilizer were (in effect) the ones who could continue cultivating rice. Most such farmers were richer than average, and did not have difficulties in getting money to buy the inputs. As for some average farmers (most of them from subsistence category), although they have been managing, it remains a problem. Most of the farmers in this category depended on small private loans from relatives and friends. There were also shops which allowed them to obtain seeds and fertilizers on credit . This is why most of the farmers in this category wanted to sell their harvest as soon possible in order to pay back debts and become eligible for further credit next season. Being compelled to sell directly after the harvest (when there is an abundant supply) risks low prices and depressed incomes. Many average farmers complained about this and some said that if at all there was an alternative to fertilizers they would go for that. Pesticides are used when necessary. Since weeding is done by hand, farmers have either to incur labour costs or go for exchange labour.

Financial assets

Most average farmers lacked the necessary finances to cover high rice farming expenses. In the early 1990s, a SACCOS (Saving and Credit Cooperative) was started

by the CHAWAMPU for the benefit of rice farmers. The aim was to improve farmers' financial capabilities, to allow them to engage in irrigated rice without problems. It became the main financial institution associated with the project, supposedly owned and managed by members of CHAWAMPU. Many farmers joined the institution initially by paying an entry fee (then Tsh 2,000, = US $2.00, although it increased later to Tsh 10,000 and invested shares per harvest (was Tsh 10,000 or US $10.00 per farmer). The challenge the institution faced was that members wanted loans for inputs like fertilizers, water and tractor services, as well as for hiring plots. According to respondents, credit was especially desired by those farmers whose returns were low due to poor markets. Yet there were soon many defaulters, which reduced the viability of SACCOS. In addition, theft before the money was taken to the bank was also a problem. As a result, many farmers withdrew their membership and new ones hesitated to join. Due to these problems SACCOS folded on the scheme; alas, most farmers no longer trust their CHAWAMPU for anything. Farmers started to look for other ways to obtain credit for rice farming. Some average farmers started to buy and keep animals they could sell in times of need, while others became involved in non-farm income generating activities, like selling items from small kiosks, paid jobs, and sale of local brew. Some poorer farmers also organised themselves into private Rotating Savings and Credit Associations (ROSCAs). These financial groups are known as *Upatu* in Swahili. Various small women's groups are listed in Table 4.3.

These groups, *Zinduka, Mkombozi*, *Kusaidiana, Kibati, Sia Yako, Upendo* and *Kiwakuku*i, had other functions (as shown in Table 4.3) but also functioned as credit facilities. Members of such groups contributed shares after every harvest and then were allowed to borrow from the group in turn and to repay with a small interest. Only those who paid a contribution of Tanzanian shillings, 1,000 per month (c. US $1.00) and able to repay were allowed to join such groups.

Table 4.3 Women's groups

Name of groups	Age groups	Purpose of group
Upendo	18 years – older women	Production of seeds for bean cultivation/labour exchange
Kiwakuki	18 years - older women	Caring for those suffering from HIV/AIDS and to help them with agricultural or household activities
Zinduka	18 years - older women	Credit union for agricultural activities and income
Mkombozi	18 years – older women	Credit union for agricultural activities and income
Kusaidiana	18 years – older women	Supports needy families, assistance for funerals, exchange labour and weddings
Kibati	Average of 15–30 years	Paid labour (collective work)
Sia yako	Average of 15-60 years	Income generating activities group + wedding and funeral ceremonies

Source: Field data 2001- 2004

Women are especially keen on such groups, and say they provide a big help to female household heads, who live without help of a husband, but sometimes still have smaller children. Married women, who did not cooperate with their husbands, or those who want to help their husbands with some of the family expenses, have

also benefited from these organisations. The richer farmers financed their rice cultivation either through their involvement in highly paid income-earning activities, like trading from big shops, or salaries paid by companies. Some of these farmers are sufficiently credit-worthy to obtain loans from commercial banks.

Rice marketing

Where and when to sell rice proved to be important in determining the income from rice cultivation. Farmers of different socio-economic status were found to have different ways to sell their rice. The marketing of rice was done after every crop harvest through three types of method: as husk rice on the farm, off farm, as polished rice at post harvest centre, and as polished rice elsewhere. Arrangements for paddy marketing were guided by market forces. Usually, agreements were made between farmers and buyers before the harvest. Male farmers were in charge of marketing, reflecting their control of the produce (see Chapter 2 and 5). Most of the paddy was marketed at farm level (see Photo 4.2, 4.3), because most farmers could not afford to buy bags and fill the paddy and then transport it to the milling machines or elsewhere to be sold. Expenses rose further because before rice is milled it requires labourers to dry and re-bag it.

Also, when the paddy was being milled there was a risk of milling machine workers stealing quantities of rice, which is why the milling process required close monitoring (see Photo 4.4). This is why most interviewed farmers indicated reluctance to sell polished rice, and preferred to sell rice in husk on the farm. This also gave them the quickest access to money to repay debts or buy new inputs and other household requirements. Yet the prices they obtained in this way were usually low, due to the fact that they were not organised collectively to demand a better price.

Businessmen and traders coming to the plots often took advantage of the farmers' immediate need of money. Such businessmen often set any price they fancy, and come with their own empty bags, invariably much bigger in size than the normal bags (see Photos 4.2 and 4.3). When these bags are filled with rice, farmers said that they some times weigh about 120-140 kg, far above the normal agreed weight of 100 kg (Interviews 2002, 2003).

Photo 4.2 Businessmen buying rice from a farmer

Source: Field data 2003

Photo 4.3 Businessmen filling rice in their bags

Source: Field data 2003

Photo 4.4 Farmers have brought rice to be milled at Post harvest centre

Source: Field data 2003

These heavy bags were bought for 15,000 Tanzanian shillings (US $15.00) per bag, while the normal 100 kg bag costs about US $13.00. With the bigger bags traders and that these prices traders are paying farmers between $0.107 and $0.125 per kg, but when sold in smaller bags farmers receive US $0.13/kg. There were only a few well to do farmers who cultivated rice purely as a business. They were the ones transporting their paddy to milling machines and selling polished rice at the best prices. Some of them had trucks to transport rice to other regions and neighbouring Kenya. These farmers understood business, and had no problems in selling rice.

Social capital and networks

The introduction of irrigated rice changed the social capital in pre-existing local networks. The concept of social capital has been popularised differently among authors (Bourdieu (1985), Coleman (1988). The notion of social capital in this study is generally taken to mean the social resources upon which people draw, such as friendship networks and family connections. In times of need, people once turned to traditional kinship-based networks of assistance, but these have disappeared. Respondents said that after the introduction of irrigated rice many families struggled to make ends meet because rain fed crops were not reliable and life had become more expensive. According to one viewpoint the family is only concerned to take care of its immediate members. Other respondents said that because people are busy with agricultural activities supplemented by other kinds of income generating activities, they do not have time to help one another.

The emigration especially of young men decreased the number of people living in households, but without fully compensating returns. Respondents said that those who had emigrated worked only for their own benefits, most failed to send remittances to their parents, as once had been the case. The reason for this was that every individual was busy with their own plans for their development, while

incomes (in government jobs, for example) were often disappointingly low. In order to cope with the situation the women have organised various community-based groups to replace earlier forms of (family-based) mutuality. These new mutual help groups exist to help with funerals, sickness, agriculture, credit needs and a range of (expensive) social activities such as marriage celebrations. Examples of such groups on the scheme are listed in Table 4.3 Despite such groups; there are still some women who could not afford to join because they lacked entry fees and monthly contributions.

Women who cannot join such groups sometimes experience difficulties in getting help when needed. For example in one female-headed household, a woman with six children was very ill, but had no money to buy medicine or food to eat. She said that she had a sister who lived across street, but never received any help from her. She was depending on hired labour as an income activity, but was too ill to go to work.

Production and incomes from rice and maize

Differential access to tractor services, capital, labour markets and inputs clearly showed up in differences in yields between different categories of farmers, and between men and women. These differences then translate into differences in incomes among the different categories of farmers. The comparison of average number of plots and yields among commercial and subsistence farmers and between rice farmers and non-plot holders in growing rain fed maize is apparent. The number of crops per year, the number of plots owned, access to water as well as the production costs as compared to the selling price, results in major differences between farmers in terms of income earned from crop production. The calculated net income benefits of farmers in different categories of farm households are shown in Tables 4.4 and 4.5. Such values for the calculations were derived from discussions with farmers.

Photo 4.5 Rice produce of commercial farmers waiting to be milled at post harvest centre at Lower Moshi

Source: Field data 2003

Commercial farmers

Farmers in the commercial category had more plots, and these plots were located in areas with better access to water. As apparent in Table 4.4, commercial farmers cultivated (during three years) on average 16.7 to 23.7 plots per male farmer, and 10.1 to 11 plots per female farmers, with high yields. The total production from male farmers in this category averaged at 20 bags per plot. Both the responses from farmers and the data collected on crop production revealed that these farmers were rarely affected by bad weather because of the location of their plots and their ability to get water for irrigation. Their production record for three years (2001 to 2003) shows an increase in both output and cash income (see Photo 4.5). Although there are differences among male and female farmers, the data suggest that all of them are doing well. As shown in Table 4.4, male farmers increased the size of their land in each of the three years, and many of them cultivated twice a year due to ownership of plots in different locations and ability to manoeuvre to cultivate illegally in a season not scheduled for their plots. This is why their total production was high (334 to 474 bags per year). The production returns in terms of cash income ranged from Tsh 2,075,810 to 2,955,310 per year. In other words the income of these male headed households was from US $5.60 to $8.0 per day. As for farmers from female headed households in this category their rice production and cash incomes were about half of what the male farmers obtained. Their output ranged from 202 to 220kg per year, because they did not have as many plots as male farmers. Their cash income per year within the three years ranged from US $1,255,430 to $1,371,700, which means that they earned about US $3.4 to $3.7 per day. Most of these farmers earned more that of the other farmers, but they said they used to earn more per plot during 1988 until 1992 when water was in plenty.

Subsistence farmers

The output of the subsistence farmers was low because many of them had less plots were affected by poor access to water, and had plots located in areas without much access to water. Their plots were also found in only one area scheduled for cultivation per season. Some of the average farmers in fact failed to continue cultivating rice because it became too expensive for them. Farmers said that it was very difficult to harvest the amount of rice they were used to about ten years ago when they could still get more bags per plot; their production had gone down every year since. Farmers from both male and female headed households in this category cultivated their plots only once in a year, i.e. in only one of the scheduled seasons. As discussed earlier on, the subsistence farmers comprise about 17 percent of all farmers living on the scheme, and some of them produced very low yields. The averages in Table 4.4 show that during the period between 2001 and 2003, farmers in male-and female-headed households were able to produce an average of about 17 to 18 bags per plot, which was less than what the commercial farmers produced.

The average production and cash income from sales of irrigated rice for the subsistence farmers was low during the 3-year period analysed, though improving somewhat in the third year examined. Total production of the male farmers ranged from 72 to 104 bags per year, while female farmers produced from 49.6 to 99 bags per year. Both male and female farmers experienced difficulties in selling their harvests at good prices. As discussed, farmers have little control over the price offered by businessmen buyers. The average income for male farmers ranged from Tsh 300,400 to 413,050 per year, while female farmers earned from Tsh 176,640 to 413,050. The

low cash income discouraged many farmers from continuing to cultivate rice. Many farmers said they cultivated rice because they were used to it. Some added that the income from rice was needed to obtain money for school fees because it is not easy to get the sums required from other sources. Some farmers indicated they did not depend on income from rice to take care of the household.

When the amount was calculated, male farmers' cash income per day, was US $ 0.8 per day, in 2001 when there was a problem of shortage of water, but in the following two consecutive years (2002-2003) the income went up a bit to an average of US $ 1.00 per day. The income for female farmers was even lower in 2001, it was US $0.40, but in the year 2002 and 2003, it also went up to US $1.00 per day. Such low incomes makes it clear as to why women in both male and female-headed households cannot really depend solely on income from harvests to meet their needs. This is also the reason why the income from irrigated rice is mostly used for family development expenditures (as discussed in Chapter 5).

Table 4.4 Rice production, area cultivated and income among categories of farmers in male and female households, Tsh (N = 89)

Indicators	Rice production among categories of farmers (2001-2003)											
	Commercial farmers						Subsistence farmers					
	2001*		2002		2003		2001*		2002		2003	
	MHH	FHH	MHH	FHH	MHH	FHH	MHH	FHH	MHH	FHH	MHH	FHH
Average total production per plot per season, bags per plot	20	20	20	20	20	20	18	17	18	18	17	18
(1)	334	202	416	210	474	220	72	49.6	99	84.6	104	99
Price per bag	15000	15000	15000	15000	15000	15000	13000	13000	13000	13000	13000	13000
Gross income per plot per crop	300000	300000	300000	300000	300000	300000	234000	221000	234000	234000	221000	234000
Production cost/plot (2)	175700	175700	175700	175700	175700	175700	158900	157000	158900	158900	157000	158900
Net income/plot	124300	124300	124300	124300	124300	124300	75100	64000	75100	75100	64000	75100
Total number of plots	16.7	10.1	20.8	10.5	23.7	11.0	4.0	2.76	5.5	4.7	5.8	5.5
Total income/HH/ per year (3)	2075810	1255430	2593760	1309350	2955390	1371700	300400	176640	413050	352970	371200	413050
Income per day Tsh	5687	3439	7106	3587	8096	3758	823	483	1131	967	1016	1131
Income/HH/day US$	5.6	3.4	7.1	3.5	8.0	3.7	0.8	0.4	1.1	1.0	1.0	1.1

(1) Derived from farmers' responses and calculations using KADP calculations per farmer (Table 2.6), but with amendments according to number of bags harvested.
(2) Production costs per plot (0.3ha) that they own, were 175,700 Tsh for commercial farmers 2001- 2003, and 158,900 or 157, 000 Tsh for subsistence farmers 2001-2003
(3) Based on 365 days per year
* In 2001 there was water shortage within scheme as a result of poor rains, as a result there was a delayed season that affected production (KADP 2001)
Costs and cash income are in US $ (US $1.00 = approx. 1000 Tanzanian shillings in 2001-2003)
* A variation of sizes of bags are used by different farmers when harvesting and selling rice. Average weight of bags varies from 85-100kg. This created problems in calculations
MHH = male- headed household; FHH = Female- headed households

Source: Field data 2001-2003

Table 4.5 Rain fed maize production, area cultivated and income among non-plot holders in male and female-households, in Tsh (N = 211)

Indicators	Maize production among non-plot holder category (2001-2003)					
	2001		2002		2003	
	MHH	FHH	MHH	FHH	MHH	FHH
Average yield in kilogram/ ha (1)	800	800	760	825	817	900
Average cultivated area /ha/year (1)	0.2	0.2	0.5	0.4	0.6	0.4
Production in bags/ha/year	8	8	7.6	8.3	8.2	9.0
Price per bag of maize	10,000	10,000	14,000	14,000	16,000	16,000
Income per hectare	80,000	80,000	106,400	116,200	131,200	144,000
Production costs per hectare (1)	25,000	25,000	50,000	50,000	58333	62,500
Net income/hectare	55,000	55,,000	56,400	66,200	72,867	81,500
Net income/HH/year (2)	11,000	11,000	28,200	26,480	43,720	32,600
*Net income/HH/day (3)	30.1	30.1	77.3	72.5	120.0	89.3
No of farmers interviewed	41	10	128	83	128	83

(1) Derived from farmers' responses on production costs per plot (0.4ha), adjusted per hectare
(2) Based on average cultivated area
(3) Based on 365 days per year
* In Tanzanian shillings (US $1.00 = approx 1000 Tanzanian shillings (2001-2003)
1 bag , estimated by farmers as 100 kg (not weighed)

MHH = Male- headed households; FHH = Female- headed households

Source: Field data 2001-2003

Non-plot holders

The non-plot holders, as noted are the majority (70.4 percent) of the population within the scheme. They continued to engage in rain-fed farming, mainly cultivating maize (see Table 4.5), but depend on non-farm and on-farm income activities. As again noted above, farmers had rain-fed plots sometimes as big as an acre (0.4 ha), but due to poor rains and low soil fertility output is generally very low and generally inadequate to meet family subsistence needs (see Photo 4.6). The output from male farmers ranged from 7.6 to 8.2 per hectare per year while women produced from 8 to 9 bags per hactare per year. According to informants, it was the women in both male and female-headed households who were mostly responsible for maize cultivation, which is mainly used to feed families. The harvest is inadequate for feeding the family through the year especially when the amounts are converted to the actual amount of land cultivated as shown in Table 4.5. The actual cash income among men is 30 cents of Tanzanian shillings to 120 shillings as an income per day in male headed households while in female headed households is almost the same ranging from 30 cents to about 90 cents of Tanzanian shillings. The farmers are getting few bags of maize which never last for three months. Farmers in this category and those who depend on such harvests are many and this is the reason why many of them depend on diversification to non-farm small scale income activities, which however do not pay enough to meet the needs of their families per day.

Photo 4.6 Rain fed maize

Source: Field data 2003

Photo 4.7 Irrigated maize, well flourishing

Source: Field data 2003

4.5 The importance of irrigated rice farming in livelihoods

Although planned otherwise, and as the previous sections suggested, most farm households (29.6 percent) did not solely depend on irrigated farming for their income and livelihoods. In fact, especially among average households, it was difficult or impossible to survive on irrigated rice farming alone. Many, and especially those most affected by water shortages, had decided to modify their land use and cropping patterns, to incorporate other crops, while others also engaged in other income generating activities to sustain livelihoods. This section illustrates the relative importance of irrigated rice farming in household livelihoods for different categories of farmers, and shows the other activities in which farm household members engage to make ends meet. Data show that many farmers engaged in irrigated rice farming were also engaged in other income activities. On the one hand, farmers with better access to resource opportunities got good returns from rice farming, which they then invested in other income activities.

These different livelihood activities were beneficial in strategically complementing each other. On the other hand, farmers with fewer opportunities were involved in other income activities in addition to rice farming mainly for risk reduction, compensating for diminishing returns. Diversification patterns reflected individual allocations of assets across various activities so as to reduce risk exposure to a range of hazards and constraints. Diversification patterns included agricultural and non-agricultural income activities. Generally, as shown in Table 4.6, most farmers within community depend on some combination of non-farm income activity, farm wage labour and rain fed maize cultivation.

Table 4.6 Livelihood activities of farmers by household category (N = 300)

Livelihood activities	Commercial		Subsistence		Non-plot holders		Total	
	No	%	No	%	No	%	No	%
Irrigated rice farming	38	12.6	51	17.0	-	-	89	29.6
Irrigated maize farming	8	2.6	26	8.6	-	-	34	11.3
Vegetable farming	5	1.6	21	7.0	-	-	26	8.6
Livestock farming (low income)	-	-	41	13.6	64	21.3	105	35.0
Livestock farming (high income)	27	9.0	2	0.6	21	7.0	50	16.6
Non-farm activities (Low income)	-	-	45	15.0	170	56.6	215	71.6
Non-farm activities (high income)	38	-	5	1.6	20	6.6	63	21.0
Rain fed maize farming	-	-	45	15.0	124	41.3	169	56.3
On-farm labour	-	-	38	12.6	138	46.0	176	58.6

Non-farming low income activities = small-scale income activities such as petty trading, extensive livestock keeping, casual wage employment and hired labour.
Non-farming high income activities = secure off-farm employment, business/trade
* Due to overlap of activities among farmers, the total percentage of farmers involved in each activity is made on the right

Source: Field data 2001-2004

The overall diversification pattern among farmers show that most of them depend on low return non farm income activities (71.6 percent) and farm labour (58.6 percent) as well as rain fed maize farming (56.3 percent). Although there are a lot of restrictions in livestock keeping with the scheme, 35 percent of farmers are engaged in low income livestock while 16.6 percent are engaged in high income livestock keeping.

Commercial farmers

As already suggested when discussing rice farming, both male and female commercial farmers have reasonable to good access to livelihood assets. Their main rationale for diversifying their agricultural and non-agricultural income activities is based on expected economic returns. Irrigated rice production was one important income activity, supplemented with other high-return income activities. All farmers in this category engaged in high return non-farm income activities, while almost three quarters of them kept a substantial number of improved breed livestock (more than five cows). Some engaged in irrigated maize and a few in vegetable farming. Most farmers in this category said that they were happy to be involved in irrigated rice because it helped them to support other income activities. There were nevertheless differences between male and female farmers. Male farmers were more engaged in income activities with high returns than female farmers.

The respondents explained that women do not have as many income activities because of their lower access to economic and social resources, when compared to males. The female farmers from female-headed households said that their social resource base is poor because many young males emigrate from their households. They did not have people they trust to help them to run their income activities, while they are engaged in other activities. Some women were afraid to engage in income activities far from their homes because of the fear of being harmed or robbed. As single parents they also find it difficult to handle household chores and become fully engaged in income activities. For female commercial farmers, irrigated rice farming was more important in their overall livelihood than for most men. In addition to irrigated rice farming, they kept dairy cows and sometimes poultry. Some women within the scheme were also employed by the government, and some were engaged in business and trade. The most common businesses for women were shops, hair salons and restaurants. Some of these women are retired government officers and get a pension from their work places. Women farmers in this category sometimes also cultivated irrigated maize, mostly for food purposes, but also sell the surplus.

In all, the economic and social status of male commercial farmers was better than that of female commercial farmers. This was because male farmers could count on the help and support of their wives, and often also had the assistance of other household members in running their income activities. This allowed them to travel long distances to engage in business and other high-return income activities. Some male farmers had, for instance, established income-generating activities in other regions, which were operated by workers that they hired from within the area. In general, the income activities that the male farmers were engaged in were greater in number and also more profitable. The activities included, next to irrigated rice farming, livestock keeping (dairy cows, poultry and goats), and businesses like schools, restaurants, and different types of shops. Some of them also were government employees, or retired officers who received pensions. Some male farmers also used their plots for vegetable farming (leafy vegetables, onions, watermelon), sunflower and irrigated maize (see Appendix 4), when they were not scheduled for rice cultivation.

Subsistence farmers

Although the subsistence farmers engaged in irrigated rice farming (17 percent), they only could grow one season out of the three season schedule, and their yields were low. As shown in Table 4.6, these farmers diversified into many income activities, to

be able to afford the high farming costs of irrigated rice and to complement the income from selling of rice. As shown, the plots of subsistence farmers did not produce much, while they also got lower prices for their harvests, which is why they had to seek extra incomes to survive. In this category, the income from irrigated rice is always for specific use within family and mainly for development activities (see Chapter 5). Some subsistence farmers engaged in irrigated maize using their rice plots (8.6 percent), others engaged in rain fed maize (15 percent), and some engaged in vegetable farming (7 percent). Most subsistence farmers also kept low-income livestock like one or two dairy cows and goats. These animals generated some food and income, but also served as savings. Very few farmers engaged in high-income livestock keeping (0.6 percent) and other non-farm income activities (1.6 percent). This category of farmers also engaged in wage labour, especially the women.

The number and quality of income activities among male and female farmers were different, for the same reasons as given by the commercial farmers. This means that the male subsistence farmers were involved in more income activities, because they had access to more people to help them than farmers from female-headed households. Indeed, in many of the male-headed households of this category, both husband and wife were working very hard to make a living. Male farmers often migrated to other towns or regions and engaged in wage employment or trade, leaving their wives to work in such activities as rice farming, sometimes irrigated maize farming, rain fed maize, sale of burnt bricks, and cultivation of other crops (leafy vegetables, tomatoes, onions, watermelon and sunflower), (see appendix 4) when irrigated land was not used. In addition, women were engaged in selling rice and selling foodstuffs and local brew while others had small local canteens where they sold cooked food. The female farmers complemented their income from irrigated rice farming with irrigated maize farming when they got a chance, but mostly cultivated rain fed maize in plots planted outside the main cultivating season. The female farmers also engaged in such activities as small-scale dairy farming (keeping two to three dairy cows), the sale of cooked food and tea in small restaurants within the village, the buying and selling of milled rice, and the employment of some women to sew garments. When they needed money badly they might re-engage in farm wage labour.

Non-plot holders

Farmers without plots in the scheme did not have access to irrigated plots. As shown in Table 4.2b, non-plot holders can be found in the rich, average and poor categories. Although rain fed agriculture remains unreliable, it will be seen from Table 4.6 that most farmers (41.3 percent) try to engage in rain-fed maize cultivation. The productivity of rain-fed maize was very low; the harvest hardly lasted for three months and was therefore not enough to sustain livelihoods. A number of farmers (21.3 percent) in this category owned a few cows of traditional breeds, either as an investment or to keep it for milk and meat production. There also were a few who engaged in non-farm income activities with higher returns (6.6 percent) and a few farmers (7 percent) in this category who were rich enough kept improved breeds of livestock.

Discussions with respondents and data collected made it clear that most families depended on some kind of mixture of on-farm and off-farm income activities for their livelihoods. They diversified into so many income activities because the returns to farming were low (or at best average) compared to the needs of their families. This

engagement in numerous income activities very much depended on economic status, gender and other people living in the household. The rich male and female-headed households among the non-plot holders were the ones who had some business within the village. For example most of the imported beer bars, shops and some restaurants were owned by them. Some of these farmers bought and traded paddy rice, while others worked as middlemen and women for business people who came from far away to buy rice. The female average and poor non-irrigated farmers diversified income activities to make a living and sometimes experienced more difficulties in making ends meet because they were alone. Sometimes it was difficult to diversify livelihoods due to lack money. As for male-headed households, the male and female within household in most cases share the responsibilities.

The poor non-plot holders were mostly the ones that were hired for on-farm labour (46 percent), although subsistence farmers also occasionally hired themselves out for wage labour. Most wage labourers were women. Farmers pointed out that although on-farm labour was available, it was difficult to do it everyday because it took the whole day to work in the field bending in the mud, which is tiring. Working as a daily wage labourer in fact is quite heavy physically, and many women said they were suffering from backaches, fungus and sometimes bilharzias because of this work. When they are engaged in daily wage labour and suffer from such diseases, the poor earnings reduce even further because they then have to spend their incomes on health care and medicines. Women labourers are paid from about US $1.00 to $1.50 per day. Higher wages (more than US $2.00 a day) are usually only given for male tasks, which are few. Although the opportunities for work have increased since the modernisation of the irrigation scheme, there are many immigrants who compete for such opportunities. From the estimates of rates per day within three crop seasons (each of three months) farmers said that at most they could work 40-60 days per season and may be less. This suggests that women on average earn about US $225.00 per year from this activity while men earn about US $180.00 per year, which is small compared to what the irrigated rice farmer earns. Labouring cannot sustain many households and this is a reason why many have to diversify livelihood activities.

4.6 Conclusions

This chapter has shown that the good intentions of irrigation development intervention towards improvement of farmers' livelihoods, has resulted to an increase of socio-economic differentiation among farming households within Lower Moshi. The social economic differentiation seems to be strongly associated with lack of resources as well as inability to secure non-farm alternatives to diminishing farm opportunities. Some farmers do not have access to key assets to enable them to continue with rice cultivation. The current results of the project have been influenced by, first, the strategy of implementing an intervention through a small percentage of farmers and excluding the majority. Selection of a piece of land area and diverting water to only one area for development caused a majority of farmers to lose access both to land and water, their major assets for agriculture. Second, irrigated land reallocation among the few farmers was unequal, triggering a process of differentiation that has continued since, as this chapter has argued. Successful farmers have now purchased more land, intensifying the socio-economic differentiation. Third, the farmers with more land also tend to have more water than

those with less land. Such differences correlate with ongoing differences in production capabilities and output among farmers, influenced their ability to access further resources for agricultural activities and other livelihood activities. The picture that has emerged from the chapter is of three groups of farmers, the commercial, subsistence and non-plot holder farmers.

This differentiation in access to assets has influenced differential livelihood strategies and diversities among plot-holders and non-plot holders. Such constraints of lack of assets have shown important implications for increasing productivity, production and involvement in livelihood strategies within scheme. It has been revealed that a small percentage of farmers (29.6 percent) have been involved in irrigated rice farming (agricultural intensification) and diversifying in high-income non-farm activities. Among them, a minority of farmers have become richer at the expense of the poorer farmers. The richer farmers benefit disproportionately from the investment in the scheme, and get richer, while those with fewer resources are eventually driven out of irrigated agriculture, and cajoled into selling their plots either to the richer farmers within the scheme or to new farmers with money in their pockets, and looking for irrigated land. The average farmer continues to cultivate irrigated rice, but with limited success and poor profit margins, while depending on other income activities to buttress livelihoods. The findings of this study on how low access to water affected negatively farmers' production are supported by other studies done in irrigation schemes in Tanzania (Kadigi *et al.* 2007). The impact of reduced access of poorer households to natural resources (water and land resources in particular), have forced them to rely more on other sources of income, and mainly on sale of labour. The decomposition of total income showed that of all the household income-generating activities, irrigated agriculture represents an inequality-decreasing source of income.

The majority of non-plot holding and some subsistence farmers (71.6 percent) have been engaged in non-farm low income activities, on-farm labour (58.6 percent) and rain fed maize cultivation (56.3 percent), which are highly affected by seasonality and result to low income per year. Due to difficulties of access to grazing land and grass to feed livestock, few non-plot holders and subsistence farmers were able to keep low income livestock (35 percent) as an investment. The out come has shown that the few farmers who were involved in rice farming and high-income non-farm activities have sustainable livelihoods. The majority of farmers' involvement in various low income livelihood activities have shown a pronounced vulnerability and unsustainability in income, food security, and improvements in other aspects of wellbeing, which was revealed through discussions, interviews and observations. These results are in line with Schrijvers (1984) in the case of Mahaweli irrigation scheme, the most vulnerable households to food insecurity were those who had no land or no access to sufficient land to produce food. And such households were mostly those of female-headed households. They had to depend on labour wages, which was not enough to buy food for their families and fulfil other needs. In case of Lower Moshi, informants claim that for some farmers life is worse than before they first accessed to irrigated water, in that in those days they at least grew enough food to last through the year. Many poor farmers fast for a number of months during a year, because they depend on rain fed maize or petty income generation. The farmers call such fasts 'fastening belts' (*kufunga mkanda*), when they only take porridge once a day. The findings in this chapter strongly corresponds with argument made by Guijt and Thomson (1994) as well as Lankford (2003), about the importance of knowing the complexities of local livelihoods strategies before investing on interventions that aim

at improving livelihoods. Such conclusions calls for consideration and importance of using livelihood approach in irrigation development interventions

CHAPTER 5

INTRA-HOUSEHOLD GENDER RELATIONS IN IRRIGATED AGRICULTURE

5.1 Introduction

This chapter analyses how the changes introduced by the modernisation of the irrigation scheme played out at the level of households. In the 1970s and 1980s, a number of studies were produced that raised concerns about the effects of new irrigation developments on intra-household gender relations. Indeed, irrigation projects provided some of the most striking examples of how neglect of prevailing gender relations in planning and implementing projects negatively affected project outcomes, as well as having adverse impacts on women. These studies showed that irrigation development entailed fundamental changes in labour and tenure relations. Changes typically favoured men, and resulted in women's loss of control over resources, and over the products of their own labour. The studies also showed how this widening gender gap, in terms of control over resources and incomes, depressed yields of irrigated crops; women lost interest in providing labour in irrigation when they were not sure of benefiting from their investments, and without the 'free' family labour of women, irrigated crop production became much less lucrative. Women's loss of independent access to and control of land entailed within projects also jeopardised household food security by reducing women's capacities to earn incomes or otherwise provide food for their families (Hanger and Moris 1973; Jones 1986; Zwarteveen 1994, 2006; Carney 1998).

A well recognised problem with the design and planning of irrigation schemes was that engineers, planners and donors of projects often had wrong ideas about the internal organisation of rural households. They assumed households could be considered as a unit, with members having common objectives and pooling their resources (Becker 1974; Alderman *et al*. 1995). It was also assumed that irrigators were predominantly men, seen as heads of households who decided on behalf of other household members. This is why most resources for agricultural production were targeted to men; it was thought that women would benefit through their husbands. Such a unitary conception of households poorly captured the realties of most rural households in sub-Saharan Africa, which were characterised by a combination of shared and individually owned resources, collective and separate incomes streams and gendered division of responsibilities among household members.

This chapter investigates the intra-household organisation of activities and the division of incomes in Lower Moshi. Unlike in some of the studies referred to above, there was no previous tradition of women owning their own plots or fields in Lower Moshi. Traditionally, women obtained plots through their husbands, and there existed some kind of gendered division in crops, with men being responsible for cash crops and women being responsible for food crops. The chapter looks at how this set-up changed with the changes introduced by the system, and tries to analyze the

implications for intra-household gender relations. The first section of this chapter presents theories of households in order to understand intra-household dynamics from a gender perspective. The second section gives a brief account of the organisation of agriculture and livelihoods within the irrigation community before modernisation. The third briefly revisits an earlier categorisation (into commercial, subsistence and non-irrigated) and description of households in the study area, bringing out salient points for the present analysis. The fourth section then focuses on intra-household organisation and labour allocation for agricultural production and livelihoods, for the three different categories of households.
The fifth section describes the distribution and use of benefits within these categories. The sixth section offers some concluding remarks.

5.2 Understanding intra-households dynamics from gender perspectives

The conception of household adopted here rejects the notion of a harmonious unit benevolently guided by a male head and sees it as a sphere of struggle over resources. Kabeer (1991) presents the household as a family-based collectivity concerned with the generation and daily reproduction of its membership. It is a collection of individuals involved in a range (of sometimes competing) of production activities, for use and exchange, and via a variety of means (for example, wage labour, market activity, own production and neighbourhood networking). In consumption and production, households have complex trans-boundary linkages involving, for example, exchange of food and labour. Households are neither homogeneous nor closed, and differ in composition according to gender balance and age of members. They are often embedded in larger structures such as kinship networks and community organisations, and their boundaries are permeable (Guyer and Peters 1988; O'Laughlin 1999). According to Rudie (1995), households are co-residential units, usually kinship-based in some way, which take care of resource management and the primary needs of members. As for other researchers (Koda 1995; Niehof 2004; Nombo 2007; Karuhanga 2008), households being co-residential do not necessarily mean all related members live and eat together, or sleep under one roof. Households are also regarded as contexts within which provision of primary needs and livelihood generation take place (Niehof and Price 2001). They may include members who are absent, e.g. people who have migrated (temporarily) for wage labour (Netting and Wilk 1984). In African countries a household may be distributed over several residential units (houses) belonging to an extended family (Guyer and Peters 1988).

Within households, domestic activities and production processes are mostly intertwined: household members provide labour to both, assets are used for both, and production outcomes are circulated in the household and the farm. Although much attention in policy analysis has focused on the male farmer, as presumed business principal, farm manager and decision-maker, it is known that farming involves different household members. Women in fact often are the major agricultural producers, and their involvement in farming involves specific forms of familial relations, most significantly through marriage, as wives, but also as daughters or mothers of male farmers (Whatmore 1991). Indeed, in general terms, most agricultural activities in rural areas are organised through the 'intimate' household relations of marriage, parenthood and family (Kabeer 1991). In the African

context, households are not only characterised by a division of labour by gender and age, but also by a division of economic spheres. Men and women and often children separately control productive resources, take partly independent decisions, manage personal incomes, assume different responsibilities and favour different investments (Guyer 1986, 1988).

Scholars of rural gender relations in different parts of Africa have long drawn attention to the centrality of women hoe cultivators in African farming systems (Boserup 1970; Bryceson 1995; Guyer 1995). They have also shown how men and women operate in separate spheres, often growing separate crops, with an overall dominance of women in agricultural production activities, but especially food production. Gender and age, rather than class, have been found to determine social standing and labour allocation in hoe societies. Control over the labour of others was often been hypothesised to be the key to male power and authority in African society. Yet while the issue of labour control is central to understanding the position of women in African agriculture, it would be misleading to infer that women's labour is slavishly exerted in the service of men. On the contrary, existing evidence suggests that women tend to think of their labour effort in terms of being part of a natural order to ensure adequate food production and basic survival of their dependants and themselves (Bryceson 1995).

To understand intra-household behaviour, households can well be treated from a perspective of moral and political economy, with distribution of assets and tasks among women and men taking place according to principles of both legal and customary legitimacy (extended entitlements), reflecting power relations (Sen 1990). Household production involves different male and female members of a family, who may have shared, separate and conflicting interests, and who may wish to use resources in different ways. How labour and resources are allocated, and how incomes are spent, are often the result of negotiation and possibly even conflict between household members. It is underpinned by culturally defined social arrangements regarding who does what, who gets to consume what and who takes what decisions (Seiz 1995). Following Sen (1990), Zwarteveen (1996), in a study of farming society in Burkina Faso, suggests that households can be characterised as domains of cooperative conflict. Cooperation between the different household members occurs around collective goals of household survival, e.g. earning enough income or growing enough food to ensure survival of all household members year round. Intra-household conflict occurred when production failed to meet consumption requirements, or when there was disagreement about the intra-household sharing of surpluses. The main source of contestation between the different members of a household lay in the differences they had about how to allocate surpluses and use savings.

Whose interests prevail in intra-household conflict, is the outcome of the bargaining power of the different members. A bargaining model of a household forces one to pay attention to the variables over which household members exercise leverage in determining the resource allocation and expenditure patterns (Jones 1983). In this respect, Hart (1992) defines households as a political arena constituted by particularly dense bundles of rules, rights and obligations governing relations between men and women, as well as between elders and juniors. The rules defining property rights, labour obligations, resource distribution and so forth are particularly subject to contestation and must be constantly reinforced and reiterated.

The influence that different household members can wield in negotiations and struggle over the mobilisation and deployment of 'family' labour and resource are reciprocally linked with the organisation of labour and conditions of access to

resources in non-domestic spheres. The use of bargaining approaches for the understanding of farm households has proven particularly helpful in understanding use of un-pooled resources by African households (Jones 1986). For example some incomes of men and women from individual small-scale income activities may not be pooled. The approach also helps unfold how gender asymmetries are constructed and contested (Agarwal 1997). Kabeer (1995) believes that households are primary sites for the construction of power relations. I would argue that power relations must be seen in their proper contexts or domains, in keeping with the context-mechanism-outcome approach discussed in Chapter 1.
Within households, women and men both restrict each other's room for manoeuvre, but can also give each other a space in controlling and allocating resources for their families and kin.

5.3 Agriculture and livelihoods before modernisation

This section briefly examines the intra-household organisation of agricultural production before the modernisation of the scheme. It describes how the ownership and assignment of plots among women and men was related to the allocation of labour in farming and how the distribution of benefits and incomes was done. The section aims to provide some historical background against which the situation at the time of study can be assessed.

Before scheme modernisation, agriculture was mainly subsistence oriented, and consisted of a combination of rain-fed and irrigated crops. Crops grown differed from village to village according to local access to irrigation water and type of soil; villages at the head and mid section of the river had different agricultural practices from those at the tail, where water was in short supply. Villages with relatively good access to water used irrigation to grow crops such as local varieties of irrigated rice , maize, potatoes, cassava and vegetables, in addition to rain fed maize. Where access to water was limited, farmers did not cultivate rice, but sometimes grew rain-fed cotton as a cash crop. In addition, all farm households kept some livestock and also cultivated vegetables for sale.

Intra-household ownership and allocation of plots

Before the modernisation of the irrigation scheme, almost all households owned small irrigable plots, normally less than 0.4 ha. In addition, households had rain fed plots where they grew maize and cotton as cash crops. Ownership of land tended to be concentrated in the hands of men, as heads of households. Men also decided which plots were to be used for which purposes and by whom. Most households depended on cultivating several plots of varying soil quality and with differential access to irrigation. Having more than one plot was a tradition transferred from the highlands. Having several plots made it possible to cultivate different types of crops, thereby spreading the risk of crop failure. As discussed in Chapter 2, historically, when the Chagga (who moved to the lowlands) were in the highlands they used to have irrigated (*vihamba*) and rain-fed (*kishamba*) plots (Masao 1974; Fernandez *et al.* 1984), belonging to and controlled by men. The *vihamba* were close to the houses, and considered male plots because coffee - a cash crop - was cultivated here. The *kishamba* plots, considered female plots, were far from the houses, and the place where rain-fed maize and finger millet were cultivated for food purposes.

Although some plots in lowlands were the responsibility of women, women did not normally own plots in their own names, but were assigned plots through their husbands. During data collection, I came across one household where a married woman had bought two plots before the irrigation scheme was modernised. She said: 'Although I bought the plots using my own money all plots were registered under my husband's name, which means I had rights to the plots through my husband because I am married to him'. The heads of households allocated irrigated plots for food crops like irrigated maize, local rice, cassava, potatoes and vegetables. Even though the crops grown were food crops, men controlled them.

The gendered division in crops that existed in the highlands persisted in Lower Moshi. In general, men were responsible for cash crops, and women for food crops. The cotton plots were under men, who were responsible for the harvest and benefits, but the labour was contributed by men, women, and their children, as well as by exchange labour groups. Men and boys were also the ones responsible for the cultivation of different types of vegetables (tomatoes, cabbage, spinach and onions) meant for sale. According to informants, there were no women, at that time, engaged in the vegetable business, because it was thought to be men's work, and women accepted it. The cultivation of food crops, either in irrigated or rain fed plots, was more the responsibility of women and children. This was a direct result of women's responsibility to feed their household. In fact, women sometimes looked for additional plots (to rent, or in communal lands) in addition to those assigned to them by their husbands (usually rain fed land) in order to be able properly to fulfil this responsibility. Such additional plots were never treated as women's individual property, but seen as belonging to the household, headed by the man.

Labour allocation among crops and plots

The division of labour within households was governed by cultural notions, which determined tasks for adult males and females as well as for children. In general, plots were assigned to household members depending on the crops grown. As indicated, working in food crop plots was primarily the responsibility of women, because they were expected to feed the families. Working in cash crops was treated as the man's responsibility, because men were expected to earn cash incomes to provide for their families. Although the women and men were divided that way, still the women had to contribute labour to men's plots, because in addition to a gender division in crops there also was a gendered division of labour. For example weeding and harvesting were considered tasks to be done by women and their children, while clearing the bush was considered a man's task. The whole family performed land tilling and sowing. When tractors started to be used by some families, ploughing then became a man's task.

Who contributed how much labour to which tasks and crops and when was also determined by the overall availability of labour and cash within households. Most farm households entirely depended on family labour, because it was available. Families did not have many problems with the organisation of production, because most children used to live with their parents. Because they depended on their parents, they helped them with agricultural activities. At that time, hiring labourers to do the work was not common, since most households lacked the finances to pay for this. Very few farmers engaged in non-agricultural income-generating activities, although some were employed as workers by the government or the estates. A few wealthier farmers hired labourers (both men and women) for weeding, but generally paid them in kind (some amount of maize flour).

Women's labour in farming was central to all different crops and plots, even more so when men were not around. The respondents explained that although men and women both used to work in the plots women spent more days than men. The reason for this was that men were also engaged in non-agricultural activities, such as building and repair of houses. A woman's ability to work hard and be productive was what a man would look in seeking a wife. Husbands expected wives to be hard working and productive, while women themselves, in seeking to impress a potential husband, would make efforts to show that she was hard working.

Land preparation of rain-fed cotton and maize started at about the same time: cotton planting took place in February and March while maize sowing began at the onset of the rainy season, which started also in February. In this case families usually started working on maize plots and then moved to cotton fields. Sometimes when the husband organised exchange labour, women did not have to go to the cotton plots. The harvesting time of cotton was also about the same time as that of maize, in June and July. Men usually tried to organise exchange labour parties to harvest the cotton so that women could concentrate on the harvest of maize in both rain-fed and irrigated plots. In other households, there was no gender division of labour when working on cotton plots. Both men and women worked together because there was no much non-farm income activities. They performed all tasks together, except for pesticide application, which was done only by men. The women were exempted from this task because they always handled and prepared food for families, so it was treated as way to minimise contamination to foodstuffs. Although the clearing and tilling land was considered man's work, the whole family participated. They also sowed, weeded and harvested together. For cotton picking, they often organised labour exchange groups. Men and boys were responsible for the harvesting of vegetables for sale, and after the harvest they would take the crop to town for sale, or sometimes men with pick up trucks or bicycles would buy the vegetables in the village later to resell in town markets. Women sometimes helped with vegetable cultivation, especially during sowing and weeding, especially when men were tied down by other duties.

In terms of how labour was allocated among plots and crops, polygamous households did not differ very much from monogamous households, except that the number of plots was usually higher. In polygamous households, each of the wives had separate plots because each had separate kitchens to take care of their own families. The men in such households had more plots for cotton, but had an advantage in getting labour from several wives. The female-headed households did not then involve themselves in cotton farming because they said it was risky, and they did not have enough money to grow it, because it needed fertilizers, pesticides and more labour, all of which were to expensive for such households.

The intra-household distribution of benefits and incomes

The harvests of maize from small-irrigated plots might amount to between one and two bags twice a year per plot. Output was so small because the maize plots were simultaneously planted with other crops such as cassava and beans. Although of the rain-fed plots were larger than the irrigated plots (1.2 ha) the output was very low due to the unreliability of rains. Sometimes people might harvest only one to two bags of maize per ha, not enough to provide food for the family for the whole year.

The heads of households controlled all the income from these plots. The harvested maize was put in bags or local containers (drums) and stored in the houses, while the

harvested cotton was taken to the ginnery for sale, and vegetables were sold in markets. Whatever the amount of money earned, it belonged to the head of the household, who was expected to spend it on family needs. Women had their own income from the sale of milk from cows; this was considered as 'female money', that was to be used for kitchen needs. Men controlled maize and other food crops stored in the house. Men were the ones who decided if some it was to be sold for cash; they also decided how much was to be stored for food and how much to be kept aside for seed.

In other words, all crop benefits were pooled under men's control, but the cash incomes were kept separate. According to respondents, men in polygamous households would store maize separately for each wife after harvest, but each of these stocks was controlled by the husband who was the one who retained rights to sell some of the maize anytime a need arose in the household; income from such sales was kept and controlled by men. One woman within a polygamous marriage explained:

> *Sometimes this type of sharing benefits used to create quarrels between me and the young wife at that time, because her maize harvest always used to be low and she used to run out of food earlier than myself. It annoyed me when our husband always decided to take my bag of maize and give it to her because everyone was supposed to work hard. My yells to him did not help because our husband said [that as] he was the head of household he had the right to do anything with the maize. At one time I also did not harvest much and I ran out of food, then he reminded me of my words and I had nothing to say, but plead for help. (Interviews 2001)*

This explains that the pooling of maize was to make sure all the wives had something to eat and, if possible, share with the family. In fact, when asked about possible intra-household conflicts or disagreements over allocation of labour or sharing of incomes reference was often made to polygamous households. The monogamous families only had conflict when they had to work in their food plots and go to cotton fields at the same time. But many men found a solution through involvement in exchange labour groups for cotton activities, thus freeing the women to work on food crops. In all, the pooling of agricultural produce and its control by the male head seemed to be an accepted norm. Men explained it by saying: 'Women are married to us, and what is ours is theirs too; provided we take good care of them, give them what they need, they usually have no complaints.' Women informants agreed with this, they said it was their culture, and that when they are married they belonged to the family, so they listened to what their husbands said. The women in female headed households had their own type of experiences, since they were heads of households; sometimes it was difficult for them to keep harvested crops when they had cash needs.

5.4 Families, household structure and agriculture production after modernisation

To introduce and explain how the modernisation of the scheme affected farm households, this section first provides a general introduction to household life in Lower Moshi, and gives a detailed description and example of each of three identified household categories.

Households in Lower Moshi

As discussed in Chapter 1, the inhabitants of Lower Moshi consisted of people of different origins. According to the study data (as presented in Chapter 3) most people came from the Kilimanjaro highlands, and belonged to the *Chagga* (57 percent) and the *Pare* (25 percent) groups. There were a smaller percentage (18 percent) of people from a variety of groups moving into the area for a range of purposes. The main local languages were *Ki-Chagga* and *Ki-Pare,* but *Kiswahili,* the national language, was widely spoken, and this helped stimulate the integration and intermingling of different ethnic groups after settlement, resulting in a new polity and society. Indeed, the various ethnic groups frequently intermarried.
However, since the *Chagga* were most numerous groups in the area, it is their customary values, attitudes and ideas about life and society that tend to prevail. Most marriages within Lower Moshi were done according to either the *Christian* and or the *Moslem* religious tradition, though some consisted of just living together. The majority were between *Christian* partners (66 percent), while *Moslem* marriages were 34 percent. The predominance of Christianity is a reason why polygyny has declined. Polygamous marriage was most common among Moslems because the religion allows marrying up to four wives. All types of (recognised) marriage involved the payment of a bride wealth by the family of the bridegroom to the family of the bride in terms of cash or a number of cows or goats.

Members of households lived together in a compound and were either involved in family enterprises or in their own, individual, economic activities. Sometimes there was only one house in a compound for the family, but a household could also consist of a number of smaller houses, in which some household members were sleeping and eating together. Indeed, it was common to find smaller houses next to one big house, with the smaller houses used by relatives and young men who wanted to live more independently. Such houses were also common in polygamous marriages, where a husband could have more than one wife and several children by each of them. The wives usually had separate houses, but in the same compound, where each lived with her children. In this case the husband slept in the sub-households in turn, living and eating in one sub-household for a week or so, then moving to another household the following week, and so on. Although the norm was that all members of a household worked together towards the shared goal of household survival, in practice members were free to engage to some extent in various income-generating activities, the incomes from which they did not always share with the household. The bottom-line was that adult women were responsible for feeding their children and husbands.

As explained in the previous chapter, after modernisation, the irrigated plots were reallocated to the previous owners, most of whom were men. In this sense, the Lower Moshi project stuck with the prevailing tradition that married women could not own plots of their own, but obtained access to land through their husbands. Even if it happened that a woman acquired a plot, this plot was counted as belonging to the household collective controlled by the husbands if she married. Just as before the scheme, most households depended on two types of plots - those that produced cash crops and those for food crops. The ones producing cash crops from irrigated areas were termed male plots, while those producing food crops (mostly rain fed plots) were termed female plots, labels that referred to the person responsible and not to control or ownership of the land. In addition, household members could have individual plots, which were rain-fed or wetland plots acquired (rented, mostly) by women to supplement harvests from the plots assigned to them by their husbands.

These plots were still considered household plots, and again men controlled the yields. During the research, some people also confessed to having *secret* plots, i.e. plots they tried to conceal from other household members in order individually to control the income from it. Women did this to have some extra food not under the control of their husbands, whereas men did it to have some extra income they could use without being held accountable by their wives.

Categorisation and description of rural households

As described in Chapters 3 and 4, when irrigated rice was introduced, the irrigable area was reduced and plots were reallocated only to those few farmers who were included in the project. The majority of farmers did not receive any irrigable plots, and thus came to depend exclusively on rain-fed farming. Chapter 3 described how the initial allocation of plots, together with a differential access to water, led to a process of social differentiation among farm households. Some farm households with many plots and good access to water were able to turn irrigated rice farming into a profitable enterprise, and used it as a springboard for further wealth accumulation.

Table 5.1 Farmers' characteristics by household category (N = 300)

Household production category and gender of head of household	Average age	No of farmers	Marriage status			Average household size
		None	Poly	Mono	S/D/W	
Commercial farmers ≥ 7 rice plots	62					
Female- headed households		6 (2%)			S/D/W	5.1
Male- headed households		32 (10%)	2	30		5.9
Subsistence farmers 1- 6 rice plots	54					
Female-headed households		10 (3.3%)			S/D/W	4.6
Male-headed households		41 (13.6%)	3	38		5.2
Non-plot holders	47					
Female-headed households		83 (27.6%)			S/D/W	4.2
Male-headed households		128 (42.6%)				5.1
Total		**300 (100%)**				

S = Single; D = Divorced; W = Widow
Poly = Polygamous; Mono = Monogamous

Source: Field data 2001-2003

Table 5.2 Wealth ranking of farmers in different production categories (N = 300)

Household category		Rich		Average		Poor	
	No	No	%	No	%	No	%
Commercial farmers	**38**						
Female -headed households		4	10.5	2	5.2	-	-
Male-headed households		22	57.8	10	26.0	-	-
Sub-total		26	68.3	12	31.2		
Subsistence farmers	**51**						
Female-headed households		1	1.9	8	15.6	5	9.8
Male-headed households		4	7.9	31	60.7	2	3.9
Sub- total		5	9.8	39	76.3	7	13.7
Non-plot holders	**211**						
Female-headed households		4	1.8	17	8.0	68	32.0
Male-headed households		12	5.6	32	15.1	78	36.9
Sub-total		16	7.4	49	23.1	146	68.9
Total of household	**300**						
Total and % of each category		**47**	**15.7%**	**100**	**33.3%**	**153**	**51%**

Source: Field data 2001-2004

These were earlier categorised as the commercial farmers. Many others continued to be subsistence farmers because irrigated rice was for the purpose of development activities and sometime not enough. The largest group of households was entirely dependent on rain-fed crops or on non-agricultural income activities. I will continue to use this categorisation into commercial, subsistence and non-plot holders to further explore in this chapter how farming and livelihoods were gendered for different groups of households. Most commercial farmers belong to the wealth category 'rich' and a few to average, whereas most subsistence farmers belong to the wealth category of a few of 'rich', and many of 'average'. There are some who are 'poor ' especially those who had one plot and experienced water shortage (Tables 5.1 and 5.2). Among non-plot holders, there are a few 'rich', those involved in well paying income activities, some are 'average', but majority are 'poor'. As shown in Table 5.1, in each category, there are male-headed households, which are characterised as polygamous, monogamous and female

Box 5.1 Mr Kessy: An example of a commercial household:

James Kessy is a 65 years old commercial farmer who used to work as an agricultural officer in the Ministry of Agriculture. Before he retired in 1992, he had two plots in Lower Moshi inherited from his late father. After he retired he moved from Moshi town and built himself a house in Lower Moshi where he bought a further six irrigated plots and in addition rents about four plots a year, kept dairy cows and started a new life as a farmer. His wife, a secondary school teacher, was still teaching in one of the private secondary schools in Lower Moshi, but she also bought three plots in which she cultivated irrigated rice and maize. She also kept poultry for eggs, which were usually sold in town and supplied to local shops in Lower Moshi. They have a household of 12 persons. They have four children. Two sons have completed university level education and are working in Dar-es-Salaam. A daughter is married in Moshi town, while the last born daughter is in one of the universities in Arusha. They live with a housemaid and five male relatives and workers who help in looking after the agricultural plots and livestock production. Mr Kessy owns two trucks that transport maize and rice to be sold in Kenya. During his absence the wife and other relatives take care of all the agricultural activities (Field data 2001-2002).

headed households consisting of single, divorced and widow women. In what follows, I provide a brief description of each of the categories.

Commercial farming households

As shown in Tables 5.1 and 5.2, farm households in this category (12.6 percent) had a good socioeconomic status, (68.3 percent rich and 31.2 percent on average) and there are no poor farmers. They are comprised of farmers who had access to more than seven plots where they cultivated rice. Among the farmers, there are those who sometimes cultivate irrigated maize in some of their plots, at least twice a year. From each plot, a farm household was capable of harvesting more than 20 bags/ha[31] depending on the season and amount of water. This means that the households were capable of meeting their daily food requirements and even produced a surplus. In such households, adult members (men and women) were usually educated. Many of them were involved in additional non-agricultural income-earning activities, e.g. wage employment or business earning money to invest in farming. Many of the male members of these households were retired officers, businessmen or employees who had purchased land in the area. Some of them rented in land from those farmers who could not afford the expenses of irrigated rice farming. Apart from rice farming, members of these households were also involved in cultivating cucumber and onions (Appendix 2) and kept improved breed livestock for meat and milk, as well as being involved in other types of businesses (Chapter 4). The income from these various activities was used to boost irrigated rice and maize production.

Subsistence farming households

Farmers in this category (16.9 percent) who are 3.3 percent female heads and 13.6 percent male heads of households depended on a small number of irrigated plots (1-6 plots) and some rain-fed plots for their livelihoods. Among the farmers, there were 9.8 percent rich, while 76.3 percent were average and 13.7 percent were considered poor. There were poor farmers in this category because most of them failed to cultivate rice due to lack of water and most of them had one plot. Household members were also engaged in non-agricultural activities, but mainly to supplement incomes from farming in only minor ways. In this category of households, engagement in other income activities was a coping strategy. These farmers are classed as subsistent because they do not accumulate surpluses, but outputs from irrigated plots added to other livelihood activities serve, as a coping strategy, to meet basic needs. Although men were the owners of the irrigated plots women are usually the ones to cultivate them. When women were working in such fields they did not feel they were working on men's plots, but considered it as working for themselves but as part of the family. Both male and female household members of these households were always on the look-out to access more plots, or for other income activities in order to improve household income for themselves and family welfare, but they struggle to achieve this aim due to lack of capital or other substantial sources of income. Women in this category did not only work in the irrigated plots, but also invested labour in rain-fed plots. During the dry season, although the irrigated plots get little water, women worked in such plots to grow what they could

[31] This is recognised to be a very high yield, but field confirmation of actual yield was beyond the scope of this study. More research is recommended on the range of the yields of different farmers. confirmation of actual yield.

and at the same time engaged in other income generating activities. Both men and women in this category sometimes rented secret plots to secure money for individual or family use.

Box 5.2 Mr Mosha: An example of subsistence farming household

Mr Mosha has two plots of irrigated land (0.6 ha) where he cultivates rice, and sometimes also maize when plots in his particular block are fallow during the off season. His plots are located where there is not much water. He has a wife and four children (a boy who is older than ten years and three girls of eight, six and four years). They live together with a male relative who helps them grazing their livestock and also in making burnt bricks outside their house. Mr Moshi and his parents moved to the village from the highlands in the early 1970s since they wanted more cultivable land. They were allocated plots to build a house and a plot to cultivate. Before they died, his parents had bought six plots that were distributed among the male children. So Mr Mosha has two plots he inherited from his parents. He then bought another two plots (0.8 ha) where his wife cultivates rain-fed maize for food. Mr Mosha used to live in a two room small house, but he started building a bigger house of three bedrooms. From the irrigated plots he harvests a total of 12 to 15 bags of rice per season, but since he does not cultivate every season, due shortage of water, he finds it difficult to meet his needs. This is why he started to dig a portion of his plot to make bricks for sale. Some he used to build his new house. He claims to harvest about 25 bags of maize per season in his fallowed irrigated plots, while his wife harvests about two to five bags from the two rain-fed acres. The reason for the very low yield on the wife's plot he claimed is due to very poor soil, but they cannot afford fertilizer. Mr Mosha has been complaining about a difficult life due to lack of water within Lower Moshi, which has forced farmers like him to switch to cultivating maize and vegetables.

Non-plot holder households

In this category (70.3 percent), of which 27.6 percent are female heads and 42.6 male heads of households, farmers were not at all involved in irrigated rice production, even though resident within the Lower Moshi scheme boundary, but many of them did have rain-fed plots and some plots in wetlands. Among these 7.4 percent are considered rich, 23.1 percent average and 68.9 percent poor. Since the rain-fed plots were not reliable such households diversified their livelihoods mostly through non-farm or off-farm income generating activities. Rain-fed plots in this category of farmers ranged from 0.5 to-4.0 acres (0.2 to 1.6 ha), but the production sometimes fell to 20 kg maize per acre. There were some non-plot holders who did not cultivate rain-fed maize, but depended

Box 5.3 Elikunda: An example of a non-plot holder household

Elikunda is a widow who is about 56 years of age and has a family of six people. They moved from Uru in the highlands to the Lower land in 1974. She has a house that her husband left to her. It is made of burnt bricks and roofed by corrugated iron sheets. She has five children of whom three are sons and two daughters. All of them attained primary level education. Two sons are married and live within Lower Moshi, while the third migrated to Mererani in Arusha to engage in mining. He left in 1999 and has never come back. One of her daughters is also married in Moshi town, while the youngest is staying with her together with her two children. There is a male relative who lives with them. This relative has opened a small men's hair cutting salon so as to help his aunt. Mama Eliakunda used to have two irrigated plots, but after her husband died it was difficult for her to cope with expenses of irrigated rice farming. She decided to sell them and instead opened a small local canteen room where she prepares meals for sale. Her daughter helps her, although she sometimes goes for on-farm labour so that she gets money for herself. The young lady also buys wholesale milled rice and sells it to retail customers especially during market days. The money they get is not enough to fund any developmental plan. The main objective is to manage to acquire food, clothes and medicines against malaria.

solely on non-farm income activities. There were many women who depended on work as labourers, though perhaps also cultivating some vegetables. Some women travelled to Moshi town to buy food items like vegetables, fruits and beans to sell in the villages. Some women and young men also sold cooked foods or bought and sold second-hand clothes, especially on the market day. Once in a while some men also rented secret plots and cultivated these to earn an individual income.

5.5 Organisation and allocation of labour for crop cultivation

The organisation and allocation of labour is crucial in the cultivation of irrigated rice and rain-fed crops in collective plots, and the modernisation of the scheme imposed new organisational requirements. As referred to in the previous chapter, irrigated rice is labour-intensive, which is why many households were not able to depend on family labour alone. The out-migration of young men from the village to towns for wage employment or trade has worsened this problem. Farming was not the only activity that required labour; most household members were engaged in a variety of income generating activities, while women also had to do all kinds of caring, cleaning and cooking tasks. Especially in the busy rainy season, when many children had malaria[32] (see Table 5 in Appendix 2), this sometimes caused insuperable difficulties. Most farm households owning plots, therefore, depend on hiring in or exchanging labour for their farm enterprises. Hired labour mainly comes from women lacking plots, groups of young women often hired for agricultural work and young men who have immigrated to work as hired labour. In addition female exchange labour groups are common among women with plots, but without the money to hire labour. They organise to work their plots in turns. Overseeing the work of the labourers was also done by women especially in households where husbands are engaged with other income activities. Though a number of young men have migrated into Lower Moshi to engage in hired labour, this is mainly for post harvest activities such as bagging and drying rice. In the case of hired farm labour women are mostly assigned to work on irrigated crops and some on food crops.

Photo 5.1 A man clearing a tertiary canal to allow more water for rice plots

Source: Field data 2003

[32] Malaria is a common illness transmitted by mosquitoes among children and adults especially during rainy season and especially in rice farming areas.

Photo 5.2 A man puddling the irrigated plot after ploughing

Source: Field data 2003

How the labour requirements of the different farming and non-farming activities were met, and how household members' labour was allocated among different activities, varied by household category, but was also partly determined by the schedule imposed by the management of Lower Moshi scheme. The way farm activities are shared and divided among household members was partly governed by cultural notions concerning male and female roles. After the inception of cultivation of irrigated rice, the general gender division of labour was that most of the land ploughing and puddling in irrigated plots was done by machines (see Photo 5.2), operated by men. Fertilisers and pesticide application was also done by men, while women did most of the agricultural activities in both irrigated and rain fed plots. Discussions with farmers concerning this division of labour (Table 5.3), revealed that the agricultural activities such as transplanting of seedlings, weeding, harvesting and threshing are women's farm activities. Since such activities are done throughout the seasons it is the reason why most of the time more women are found in plots working compared to men (see Photos 5.3, 5.4, 5.5).

Table 5.3 Gender division of labour and extent of involvement in farm activities (N = 24)

Activities	Number of Frequencies by gender			
	Males	Females	Both	Other
Land preparation	11	8	-	1
Ploughing	10	9	-	1
Irrigation activities	7	10	2	1
Seed bed preps/transplanting	3	15	1	1
Weeding	1	17	1	1
Harvesting	1	14	2	1
Threshing	1	17	-	2
Transporting and storage	10	8	1	1

Both = males and females
Other = use of labourers, children or relatives

Source: Field data 2001-2004

Photo 5.3 Women transplanting

Source: Field data 2003

Photo 5.4 Harvesting

Source: Field data 2003

Photo 5.5 Weeding

Source: Field data 2003

As part of the study, an indication of the extent of involvement of different people in different plots and other income activities was obtained from a small sample of people on how many days in a week they were involved in each activity. This was done through interviewing the farmers as well as observing them for a number of days in different seasons. The numbers in the tables below (Table 5.4a, b and c) indicate how many days a week different people work in a plot, or are engaged in an income activity. Hence, the numbers do not necessarily mean that they were involved in actually doing the work, because in some households most of the work was done by hired labourers. In this case, irrespective of how men and women were involved in the activities on the plots, either through directly work in the field or as overseer, it was counted as an allocation of labour time to farming by the respective interviewee. The data thus obtained provide a rough indication of gendered involvement in farming and non-farming activities is based on people's own

estimates. It clearly shows the centrality of women's labour in farming; in total (see below Table 5.4a).

Table 5.4a Days per week worked in plots and other income activities, per plot holder category (N = 18)*

Type of HH	Female's plots			Male's plots			Engage in income activity		
	Male	Female	Rel.	Male	Female	Rel.	Male	Female	Rel.
Commercial I	-	2	2	1	2	3	5	5	6
II	-	2	4	-	-	-	-	4	5
III	-	3	1	1	3	1	4	4	2
Subsistence I	2s	3	1	1	3	1	3	5	1
II	-	4	2	-	-	-	-	5	2
III	2s	2	2	-	3	2	3	5	2
Non-plot-h. I	-	3	3	-	4	3	4	6	3
II	-	4	3	-	-	-	5	5	2
III	-	-		-	5	4	6	5	5
Total	**4**	**23**	**18**	**3**	**20**	**14**	**30**	**42**	**26**

I- Male (monogamous) household, II- Female household, III- Male (polygamous) household
s – Number of days in secret male plots
Rel. - Relative

Source: Field data 2001-2004

The 18 women indicated being busy in farming for 43 days, while the total of days the 18 men indicated spending on plots was only seven, of which four were dedicated to secret plots. Relatives[33] spent in addition some 32 days working in agriculture.

Women's activities were in fact much more diversified, and many of them were working both in farming as in small-scale other income generating activities. Men, on the other hand, preferred to engage in off-farm income generating activities, many of which meant that they were actually absent from the farm household for lengthy periods of time. Many women in addition to farming also engaged in off-farm income generating activities, but these were often closer to home and consisted of small business and trade. In fact, it would be no exaggeration to say that farming in Lower Moshi is largely women's business, with men often being engaged in off-farm and non-farm activities.

This is also confirmed with what I observed when visiting the fields. I hardly ever encountered men working in the fields. Women worked by themselves on rain-fed plots assigned to them by their husbands, but women, helped by labourers or exchange labour, also did the bulk of the work on irrigated plots. Both women and men accepted this division of work, and men commented that they trusted their women to do a good job, since they know that women will never let their families die of hunger. Table 5.4b and c show that what makes the difference between the rich and the other (average and poor) households is that rich households spent more time on non-farming activities than on farm activities; they have been able to replace their own labour by hired labour, and get a higher price for their own labour elsewhere. The scheme in effect subsidises a complex form of reinvestment by those well

[33] Relatives = in this study has been used as a meaning of any other person other than husband and wife. It includes labourers, children and extended family members.

positioned enough to have secured the more productive plots. Here we uncover one of the embedded mechanisms of social differentiation activated by the introduction of irrigated rice in the scheme.

Table 5.4b Days per week worked in plots and other income activities, per wealth category in the wet season (N = 18)

Type of HH	Female's plots			Male's plots			Engage in income activity		
	Male	Female	Rel.	Male	Female	Rel.	Male	Female	Rel.
Rich I	-	2	2	1	3	3	5	5	3
II	-	3	3	-	-	-		4	2
III	-	3	1	1	4	1	4	1	2
Average I	2s	3	1	1	4	2	4	1	1
II	-	5	2	-	-	-	-	1	-
III	2s	4	3	-	4	2	2	1	1
Poor I	-	5	3	1	5	3	1	1	-
II	-	5	3	-	-	-	-	1	1
III	-	4	3	-	5	4	3	1	1

I - Male (monogamous) household, II- Female household, III- Male (polygamous) household
s – male secret plots
Rel - Relative

Source: Field data 2001-2004

The outcome of this particular context-mechanism-outcome interaction, unanticipated by the scheme's designers, is to accelerate the economic advance of a relatively privileged group of farmers. The Tables 5.4b and c also reveal the differences of farmers in involvement in agricultural and non-farm activities between the dry and the wet season. In the wet season there are more agricultural activities than non-farm activities (small scale) due to rain while in the dry season there are more varieties of off-farm income activities. The chapter now turns to the topic of the intra-household organisation of farming and non-farming activities, in terms of how members' labour is allocated across these activities in the different categories of households.

Table 5.4c Day per week worked in plots and other income activities per wealth category – in the dry season (N = 18)

Type of HH	Female's plots			Male's plots			Engage in income activity		
	Male	Female	Rel.	Male	Female	Rel.	Male	Female	Rel.
Rich I	-	1	3	1	2	3	5	5	6
II	-	3	1	-	-	-	-	4	5
III	-	-	-	1	3	1	4	4	3
Average I	2s	-	-	1	3	1	4	5	3
II	-	3	1	-	-	-	-	5	2
III	2s	-	-	1	3	2	3	5	3
Poor I	-	-	-	-	3	3	4	6	3
II	-	2	1	-	-	-	-	5	2
III	-	-	-	-	5	4	6	5	5

Types of HH (household): I – Male (monogamous), II – Female, III - Male (polygamous)
s –male secret plots
Rel. - relative

Source: Field data 2001-2004

Commercial farming households

Commercial farming households (rich and average) encountered few problems in meeting labour requirements for crop production in plots. Although there was a division of responsibilities among men and women in taking care of food and cash plots, both genders were capable of attending to all their activities with few problems because there was enough cash income. The actual work mostly consisted of overseeing hired labourers, since most field operations were carried out by wage labourers. The specific division of farming responsibilities varied depending on the household, and was largely a function of the different members' engagement in non-farm activities. In those cases where both of them worked within the scheme, husband and wife mostly worked together in arranging the organisation of agricultural production. Sometimes they divided the organisation according to their responsibilities in plots.

In other cases, activities were more divided, with women being responsible for organising agricultural production and men working or doing business far from the farm. And in yet another group of households the men were the ones organising the agricultural production because their wives were involved in other activities. In fact, in the commercial households, off-farm income generating activities and income streams of men and women were often more or less separate. Since most of the actual farm work was done through wage labourers and machinery. Even if the activities of rain-fed and irrigated agriculture coincided, especially during wet season, it was still relatively easy for commercial farming households to attend to all the activities. This is due to the fact that they have ability to delegate work to relatives and labourers. There was a small difference between monogamous and polygamous households.

In monogamous households women were busier than the polygamous households, where the two or more women shared the responsibilities for the plots. It was also more work for the female-headed households, but they managed relatively well by hiring overseers and using hired labourers. During the wet season (Table 5.4b), it shows that the rich commercial farming households spent an average two to three days in female plots and a total of three to four days per week in men's

plots, depending on the number and size of plots and the amount of hired labour. For the commercial farmers of average wealth it was a little different, with women spending an average of three to five days in female plots and four days in male plots. In total, women contributed more labour to plots than men, which can be explained by men's higher involvement in other income activities (four to five days per week). Women in rich households were also involved in non-farm income activities (a maximum of four to five days per week), but the difference was that women, who are not employed, usually stayed closer to their homes and fields, whereas men moved further. Women often hired boys and girls to do the work, while they themselves collected the money or made sure things were going on all right.

In wet season, the female-headed households had the same pattern of allocating labour, but mostly used relatives and hired labourers and assigned them to oversee the work in plots. After assigning such labour to their daughters, sons, relatives or hired labourers, the women generally attended to other income activities where also they were helped by relatives. Most women, therefore, were involved in more than one activity each day. Men in both rich and average households among commercial farmers were not involved in these plots, and sometimes just came by to check on their women and labourers, or to see how the crop was growing, or if there was any problem. This is why it was reported that men either used an average of few hours to one day per week to check on the male plots. Most of them had nothing to do with female plots, where maize or maize was cultivated.

During the dry season (Table 5.4c), when agricultural work is reduced, both men and women were engaged more in off-farm income activities. A few women from rich commercial farming households spent an average of a day per week in female irrigated plots, but spent two to three days in males' plots and four to five in off-farm income activities. Commercial farming households in the average wealth category did not have female plots so they spent some three days in males' plots and five days in off-farm income activities. Men of such households had the same average number of hours up to a day spent in male plots but were also engaged in off- farm income activities at an average of three to five days per week. Women of female-headed households of both categories spent an average of two to three days in their plots and also used an average of four to five days in off-farm income activities.

Subsistence farming households

In this category, where there are a few rich, many average and a few poor households as described in Section 5.4, households have different ways of meeting labour requirements. Most of them find it more difficult to meet labour requirements and agree on the intra-household allocation of labour to different farming activities. In contrast to commercial farming households, most women were not provided with irrigated plots for home consumption. The rain-fed plots were the ones that were used for home consumption. This influenced the arrangements for the organisation of agricultural production, with men in this category being more interested in irrigated plots than rain-fed plots because of the cash income generated.

The rain-fed plots therefore totally left to be cared by women, in line with their responsibility were to feed their families. Due to the insecurity of rain-fed harvests, women in this category tried supplementing their incomes by engaging in various small income activities, and some also tried increasing the area cultivated by renting in rain-fed and acquired wetland plots to grow maize and beans as supplements. Some women walked up to one to two kilometres to find such wetland plots at a

nearby village called Mkonga. Sometimes they concealed the fact that they had these additional plots from their husbands, so that the husband would not claim part of the harvest.

Who provided how much labour to which plots in these households also depended on the involvement of the different members in other livelihood strategies (Tables 5.4a, b and c). Most subsistence-farming households had average or small cash incomes, and struggled to allocate enough labour to the various farming operations in the different plots. When their cash incomes allowed it, they hired labourers, but those with the lowest income were compelled to use their own labour. Women often organised exchange labour groups with other women, which allowed major farming operations to be completed in a timely way.

Sometimes it became difficult for women to maintain work standards, especially when their husbands were not present and they had to divide their time between the irrigated and the rain fed plots. Table 5.4b for the wet season and Table 5.4c for the dry season; show the differences between three types of households (male headed-monogamous and polygamous and female-headed households) in terms of men and women's average involvement in number of days on both family and individual plots. As shown in Table 5.4b, during wet season women and kin in rich farmers' households mostly allocated labour to male plots for three to four days a week and to their 'own' plots for two to three days a week, with minimal help from men who were mostly engaged in other activities, (four to five days). The women also spent an average of one to five days in other income activities. Hired labourers performed most of the labour. In average farmers' households of the same category (subsistence), women spent more time than those of the rich farmers' households (three to four days) in female rain fed maize plots while men spent some few hours or never attended. In male plots, women spent some four days while men spent (less than) a day (mostly for checking the labourers or the work) including farming their secret plots. During the rainy season, women were not very much engaged in off farm income activities due the weather and their involvement in agricultural activities. The time spent on the income activities was one day, although some of them hired boys or girls to work for them, which included selling of cooked foods or snacks.

Since it is difficult to depend on family labour every day, wives and daughters sometimes formed named groups (e.g. *Vibati, Upendo*, as described in Chapter 4) to work their plots in turns, and in some case they also hired themselves out for income. Such groups eased time constraints and the tedium of solo work, and were invaluable for those who could not afford to hire labourers. Women from monogamous and polygamous male-headed households, and from female-headed households, involved themselves in groups. Just as in commercial farming households, women were the ones who assumed most responsibility for organising those agricultural activities in order to make sure that they were carried out as planned. During the dry season (Table 5.4c), the rich women in this category (polygamous and monogamous), spent some two to three days in male irrigated plots and more time (four to five days) in other income activities (kiosks, sell of cooked food and wage employment).

Most men were only involved in farming once a week, and were most (four to five days) involved in other income activities like trades, small shops, employment or migrate for other business. The female headed-households spent some three days in irrigated plots and have been helped by hired men or labourers. They also spent four days in other income activities. Average and poor households spent some three days in male plots and spent most of their times in off farm and on farm income activities

(five to six days). Women's income-generating activities included on farm labour, and selling local brew, vegetables and cooked food. The actual observations showed that husbands rarely showed up in plots, apart from during cultivation, fertilizer application and at harvesting time. Some respondents indicated that men left all the tasks in the irrigated plots to women and children except during harvests. Men certainly showed up in irrigated plots during the harvest, to ensure they knew exactly how many bags had been harvested. In fact, whenever visiting the fields, only women could be observed working.

As shown in Table 5.4 a, b and c, the actual labour contributions of men and women to rain-fed and irrigated plots varied greatly among households. Labour contributions to rain-fed plots varied between one and four person-days per week by women and men respectively, regardless of whether they had other responsibilities or not. Men in these households were either employees or engaged in other income-generating activities including brick making. There were a few subsistence-farming households where women were employed, and then it became the responsibility of a man to make sure labour was allocated to the plots. Although the organisation of farming operations was usually discussed and agreed upon between men and women, in practice women carried the brunt of the responsibilities for both the irrigated and rain fed plots. The role of men was usually limited to contributing cash to hire labourers. Some women who earned good incomes from their income activities helped their husbands to pay for labourers.

Non-plot holder households

In this category there were a few rich families who did not at all get involved in agriculture, but entirely relied on off-farm incomes for their livelihoods. These incomes either came from wage employment, trade or other small-scale income activities. Some of the average households and a few of the poor were involved in rain fed agriculture. Most households had two or more rain fed plots, all meant for food consumption. Since most of the rain-fed plots produced little (0.5-8.0 bags per 0.4 ha), many women in this category were also involved in hiring out their labour to farmers with irrigated crops. The money they got from selling their labour was used to meet daily food needs. Most of the men in this category were engaged in a range of income generating activities to cater for the non-consumption needs of the family. Some of them engaged in renting and cultivating irrigated rice plots secretly in order to acquire income they did not want their wives to know about. Some did not want to tell their wives so as to avoid responsibility, and others used the money for drinking alcohol or supporting other women outside their marriage. The women explained that men think the rain-fed plots are the women's sole responsibility, to cultivate food for their families, while they get involved in trade and other non-agricultural income generating activities. Most men were uninvolved because they said the plots produced so little it was better if they engaged in other activities. These other activities provided the money some contributed to enable their wives to manage the work.

The majority of farmers in this category rely on off farm or on farm income activities, which vary among different seasons (dry and wet in Table 5.4b and c). Women said farming was primarily their obligation, because all those plots were meant for food production. In this case women mostly did the organisation of agricultural production, while men were busy with non-agricultural income activities. Yet the degree of involvement of men in organising agricultural production varied from one household to another. Most of the average farmers'

households were the ones involved in rain fed agriculture while the poor did not cultivate at all due to lack of productive land. Some men were involved directly in agriculture, while others were only indirectly involved by providing some money to the women, to help them with buying inputs, hiring labourers or hiring a tractor to plough the land. In most of the lower income households women were the ones arranging for exchange labour to do the work, or else they organised family labour for the family male plots.

During wet season (Table 5.4b) women from monogamous households spent some three days per week on female plots and four days on male plots and less time (one day) in other income activities. In polygamous households, wives and relatives were assigned to work on 'men's' plots (i.e. family land), each wife had female plots for their individual families. They were also responsible for their own plots where in most cases they depended on exchange labour and sometimes hired labour. Most women worked very hard before the rainy season to save 20,000 Tanzanian shillings (US $20.00) to pay for ploughing of their plots, so as to reduce physical work burdens. Sometimes when groups of women earned some money they put this money together to hire a tractor to plough all their plots. They also sometimes hired cheap labour from men and women who were paid in kind (in clothes, food and other items). Men were only involved in farming about once a week. Most of them spent more time (two to four days) in other income activities.

During dry season, all households were totally dependent on off farm (including wage employment) and on farm income activities. Many poor women, especially those who could not afford running small-scale income activities depended on on-farm wage labour. Some of the women engaged in buying food stuffs like vegetables, dry maize, plantains and beans from Moshi town or nearby villages to re-sell in the market. Other women were engaged in selling cooked food, selling local brews *(mbege*) or buying and re-selling of milled rice from the rice milling posts where businessmen sell rice. Most men in this category get involved in various income activities including wage employment, keeping livestock, trade and migration for wage labour.

5.6 Distribution and use of benefits

Distribution of benefits and their use within households generally was considered the responsibility of the head of the household. In female-headed households, the woman was the one controlling the distribution and use of benefits, with minor involvement of relatives, while in male-headed households (monogamous and polygamous) men were seen as being in charge, but other household members were often also involved to a limited extent. In all household categories, there was a pattern of men dominating in decision-making, regardless of the contribution of women to various plots, or their engagement in income activities. Yet as explained by farmers, there were differences among households. The incomes women earned individually, through their own employment or businesses, were usually controlled by them, even though (especially in average and poor households) husbands sometimes lowered their contributions to the household income when they knew that a woman could contribute from her own earnings. Table 5.5 shows the involvement of women in decision-making over the use of benefits, distinguishing between those who were always, sometimes and never consulted. The dominance of men in decision-making over the use of income and benefits was explained by the

respondents as being part of the culture of the dominant group (Wa Chagga) in the area. In the majority of households, consisting of Chagga men married to Chagga women, men always controlled the distribution and use of benefits without consulting their women, while women had to listen and obey. In households where Chagga men were married to Pare women, it was different in all categories.

Table 5.5 Involvement of women in decision making over use of benefits in male-headed households (N = 201)

Involvement in decisions	Commercial		Subsistence		Non-plot holders	
	No	%	No	%	No	%
Always						
In agricultural activities	5	16.0	6	12	16	12.5
In non-agricultural activities	2	6.0	2	4	13	10.0
Sometimes						
In agricultural activities	3	9.3	5	10	7	5.5
In non-agricultural activities	3	9.3	5	10	18	14.0
Never involved						
In agricultural activities	8	25.0	14	27	31	24.0
In non-agricultural activities	11	34.4	19	37	43	34.0
Total	32	100	51	100	128	100

* All 99 Female-headed households of the sample were excluded from the study
*Benefits are both produce and cash income

Source: Field data 2001-2004

The Pare women were more involved in decision-making. Some respondents believed that women from the *Pare* tribe used witchcraft to make their men listen to them, and they were seen as the ones who had the last say on the distribution and use of benefits. One male informant said:

> *Chagga men like to control and make the decisions about the distribution and use of the incomes within households. It has been like that through generations and even when we were in the highlands our women understood that the incomes were to be controlled and distributed for use by the male heads of households while women were simply informed. But some Pare women married to Chagga men are the ones who control the distribution of incomes, which is abnormal for a Chagga man. (Interviews 2002)*

As shown in Tables 5.6 a and b, 5.7, in all households the use of the benefits and income for their families was related to the responsibilities of men or women. The cash crops were considered men's responsibility, and the incomes derived from these were also under men's control. In principle, men used cash crop income to take care of long-term development activity needs more often than women. This includes investments in other income activities, purchase of livestock, paying for children's school fees, and building houses (Table 5.7). They only supplemented the income for food consumption when there was pressing need.

In all the household categories most of the benefits from female plots and women's income generating activities were used for home consumption, Table 5.6a and b clearly shows that the income from both irrigated plots and other income activities controlled by men were invested in long-term activities or development activities, while the women's incomes were used for food. Women were found to be more likely to spend their incomes on home consumption than men. Such expenditures included purchasing of additional staple foods, buying children's and

own clothes, as well as body care, buying medicines, school stationary and other kitchen needs. Marketing and storage of crops within households varied according to the type of crops and the person responsible. In male-headed households, husbands usually marketed cash crops like rice and irrigated maize, while women themselves marketed food crops like beans and rain-fed maize. According to the farmers, the responsibility of crops marketing reflects the cultures and traditions that existed in the highlands (Chapter 2). Although this type of division of responsibility is common, it was reported that, men still decided to sell beans or rain-fed maize, sometimes without the consent of their wives. On the other hand, wives were considered (and considered themselves) responsible to plan for expenditure from other crops in order to feed their families. Male heads of households were the ones who allocated different portions of the harvest to consumption, seeds, and sale. A large amount was often sold to cater for school fees, livestock purchase and food for the household (Table 5.7). In what follows, decision making around the use of incomes and benefits and actual expenditure patterns is explained in more detail, for the different categories of households.

Commercial farming households

As shown in Table 5.5, many women from commercial farming households said that their husbands never consulted them about the distribution and use of benefits and incomes from agricultural activities (25 percent) and non-agricultural activities (34.4 percent). They said that they were only informed, and (by custom) they were expected to agree without saying a word. Men did not see any need to consult their wives, saying that if they had all they needed there was no point of telling them about their plans.

Table 5.6a Cash income expenditure among females in male-headed farming households (N = 201*)

Expenditure of cash income	Category of farming households					
	Commercial		Subsistence		Non-plot holders	
	No	%	No	%	No	%
1. Investment in home consumption						
Income from agricultural activities	15	46.9	16	39.0	40	31.2
Income from non –agricultural activities	5	15.6	17	41.5	71	55.5
2. Investment in development activities						
Income from agricultural activities	5	15.6	3	7.3	2	1.6
Income from non –agricultural activities	7	21.9	5	12.2	15	11.7
Total females (wives)	32	100	41	100	128	100

Development activities = investment in income activities, use for building houses, pay school fees
Home consumption = use of income for food and meet family needs
* All 99 female-headed households were excluded in this comparison

Source: Field data 2001-2004

The women in this group did not complain about this, because they often had enough income from their own activities to cover household consumption needs. There were nevertheless a number of households (16 percent) in which men always involved their wives in decision-making about the use of incomes from agricultural activities and some did so on incomes from non-agricultural activities (6 percent).

Observations and interviews suggested that these were mostly the households where women were also earning a good amount of money from different types of income activities. Some few women (9.3 percent) in agricultural and non-agricultural activities were consulted sometimes, depending on the man's attitude and when households get stranded or income is small. In commercial farming households, as shown in Tables 5.6a and 5.6b the cash expenditures was according to the division of responsibilities within households. Many women (46.9 percent) contributed from agricultural activities (the harvest of their rain-fed and rice plots) towards home consumption, whereas only 9.4 percent of men in such households (Table 5.6b) contributed to food from their irrigated plots. The distribution and use of benefits from other income activities followed the pattern for agricultural incomes.

Table 5.6b Cash income expenditure among male heads in male-headed farming households (N = 201*)

Expenditure of cash income	Category of farming households					
	Commercial		Subsistence		Non-plot holders	
	No	%	No	%	No	%
1. Investment in home consumption						
Income from agricultural activities	3	9.4	5	12.0	12	9.4
Income from non –agricultural activities	4	12.5	6	15.0	27	21.0
2. Investment in development activities						
Income from agricultural activities	14	43.8	18	44.0	12	9.4
Income from non –agricultural activities	11	34.3	12	29.0	77	60.2
Total male heads (husbands)	32	100	41	100	128	100

Development activities = investment in income activities, use for building houses, pay school fees
Home consumption = use of income for food and meet family needs
* All 99 female-headed households were excluded in this comparison

Source: Field data 2001-2004

As shown in Table 5.7, although both men and women contributed to the households, more women spent a greater proportion of their incomes on home consumption. Sometimes men contributed less to the household than they might precisely because they knew their wives had an income. For example 15.6 percent of women from monogamous and polygamous male headed households contributed income from non agricultural income activities to food, as compared to 12.5 percent of men. But on the other hand the table shows that few women used their incomes for long term investment in development activities. It is men who are always responsible for investing their income in developmental (long term) activities to improve the family's standing. For example, 43.8 percent of men used their income from agricultural production for such investments, as compared to only 15.6 percent of women. In regard to non-agricultural incomes, 34.3 percent of men and 21.9 percent of women used these earnings for longer term investments, a smaller difference. These different patterns of income use reflect cultural and economic aspects of power relations between men and women. The allocation and use of the surpluses also depends on the total amount harvested from irrigated and rain-fed plots, in relation to needs of the household.

Table 5.7 Gender division of income expenditure on items, among men and women in male-headed farming households

Items	Commercial HH		Subsistence farmers HH		Non-farmer HH	
	Males	Females	Males	Females	Males	Females
Pay school fees	****	-	****	*	****	*
Buy livestock (goats, cattle)	****	*	****	-	**	*
Additional staple food/meat	*	****	**	***	**	****
Buy, rent more irrigable plots	****	*	*	-	-	-
Build and furnish house	****	*	****	-	**	*
Local beer drinking	**	*	***	**	**	**
Buy fuel wood	-	-	*	**	*	**
Children's medicine/clothes Soap & school stationary	**	****	**	****	**	****
Buy own clothing and body care	***	****	***	****	***	***
Salt, sugar, vegetables, fish, oil	*	****	**	***	*	***
Buy farm inputs	****	**	****	-	*	-

None, * few, ** some, *** many, **** majority

Source: Field data 2001-2004

Subsistence farming households

In subsistence farming households, many women were never involved in decision-making over either agricultural produce (27 percent) or non-agricultural incomes (37 percent). Female respondents said that couples often quarrelled after the harvest about how to use the income and men could become very arrogant in preventing women from asking them about how the benefits were to be used. Women explained that, culturally, men are the ones to decide, except for the food crops from the individual plots of women, or milk from cows (as discussed in Chapter 2).

Men usually did not ask the women how they used their own incomes from food production or cows, because they could tell through meals how well kitchen needs were being met. The men said that it used to be shameful to find a man taking food crops or milk from a women, or wanting to know how their income was used. They used to trust their women, who wanted to do their best to please their husbands.

There were some households (10 percent) where the women responded that they were sometimes involved in decision-making on the use of income from agricultural activities and non –agricultural activities. They said that their husbands involved them; especially when they needed help in making-decisions among alternatives, and this was true both for agricultural and non-agricultural incomes. Some women indicated always being involved in decision-making over agricultural income (12 percent) but far fewer said they were involved over non-agricultural incomes (4 percent). Observations and conversations suggest that these women tended to be among the better educated, and often had more income of their own. In this category, a larger percentage of women (39 percent) indicated contributing from their agricultural incomes towards meeting household food needs, whereas only 12 percent of men said they contributed from their agricultural income towards this goal. In the polygamous households even fewer men contributed, because here men had to divide the income between sub-households. This is the reason why the women from polygamous households had to work so hard to take care of their own dependents.

The distribution and use of benefits from other income activities were like those from agricultural incomes. Although most women got very little income from other income generating activities most used what they had for home consumption. It was common to find men contributing less to the household, because they knew their wives have income. In this category, 41.5 percent of the women contributed, as compared to 15 percent of their men, towards meeting consumption requirements. But on the other hand the table shows that fewer women contributed their income from agricultural and non-agricultural production (7 percent and 12 percent) to long term investment needs, as compared to men. It is men who were always responsible for investing their income in developmental (long term) needs. For example, almost half the men (44 percent) used incomes for these purposes from agriculture and 29 percent from non-agricultural production.

Sometimes when production of rain-fed plots was especially low, and not enough to cater for the family all year round, women requested their husbands to complement their incomes from the irrigated crop harvest available. If the irrigated crop was rice, it meant that some bags had to be sold in order to buy maize for food. It became easier when a farmer cultivated maize in irrigated plots, because some of the bags could to be stored for home consumption. When the proceeds from rain-fed plots were not enough to feed the family, sales of irrigated crops, especially maize, were reduced. Farmers stored only a little maize (on average one to three bags) in the house due to poor harvests and inadequate storage facilities. Rice was not always retained for storage; instead it was sold immediately to buy other foodstuffs, to pay debts, and to buy goats and cattle as an investment, as well as to pay for school fees or other development activities. In other households men did not care about buying foodstuffs because they knew their wives would look for alternatives to feed their families.

Non-plot holder households

In the non-irrigated farming households, the few men involved in rain-fed plots seldom involved their wives in decision-making about the use of agricultural incomes (24 percent) and non-agricultural incomes (34 percent). Men in this category explained that women also have their own plots and income activities, to be used for household survival, while they had to take care of the bigger plans. Farmers said that most women in this category had no say in how men's incomes were to be spent, because of low education, low economic power and social cultural reasons. There were nevertheless also a few households where the woman was always involved in the decision making over agricultural produce (12.5 percent) and non-agricultural incomes (10 percent). Some said they sometimes involved their wives in deciding how to use agricultural incomes (5.5 percent) or non-agricultural incomes (14.0 percent). Some farmers said that any differences reflected on the way their wives were brought up; many had been trained always to respect their husband's decisions.

Few men contributed from their incomes from rain fed agriculture towards home consumption (9.4 percent) as compared to women (21 percent). This means that the plots for which women were responsible were the ones reliably used for home consumption. This also applied to the incomes of women from non-agricultural activities, often also used to support home consumption (55.5 percent) as compared to men, who less often used such income in this way (21.0 percent). Within such households, men only contributed when the woman could not cope. But again men (where they could) took care of long term investments.

For example 9.4 percent of men contributed from agricultural activities to long term investments, as compared to only 1.6 percent of the women, in this category of households. Also, men used more from their non-agricultural incomes, to invest in long term consumption (60.2 percent), compared to 11.7 percent from women. In order to fulfil family needs, sometimes women hid some of their incomes from their husbands, so that they would still be able to request some support from them, or to avoid that the man would claim part of it. Some women sold part of their harvest secretly, while others kept small amounts in friends' houses (usually in female-headed households) to be used in times of need. Some of them tried to save to invest in small livestock, and a few women even managed to buy cows. Cows were mostly kept for milk to be sold or consumed at home, while other types of small livestock were sold when money was needed to buy food during periods of food shortages. Some women involved themselves in private circulating loan associations of women groups known as Rotating Saving and Credit Association (ROSCA or 'UPATU' in Swahili so that they could invest in other income activities or be able to fulfil other family needs. Women in male-headed households derived important bargaining power from their control over rain-fed agriculture and some livestock. This gave them the ability to contribute to their households and support their families, including the husbands. As for the heads in female-headed households, their proceeds were smaller compared to those in male-headed households. The proceeds harvested were all controlled and used by heads of such households according to their individual plans for their families. Such households suffered from the problem of how to make use of limited proceeds while they had so many obligations, requiring both food and cash income.

5.7 Conclusion

Unlike some studies on African irrigation done in the 1970s and 1980s (Hanger and Moris 1973; Jones 1983, 1986; Carney 1988), this study of Lower Moshi does not find that the modernisation of irrigation caused major disruptions in intra-household gender relations, or tenure relations. If women were disadvantaged in these areas it is because they were customarily disadvantaged, and the modernised scheme has reinforced the custom. In what follows, are discussions of ownership and control of plots, the intra-household organisation of labour for farming, and decision-making and the distribution of benefits.

Ownership and control of land

In Lower Moshi women had never owned land. Before the modernisation of the scheme, men as heads of households customarily owned the plots, while women had rights to plots through their husbands, with the exception of female heads of households. Although chances for women to obtain their own land improved within the country under the new Land Policy of (URT 1999 and MLHS 1997), this did not help women in Lower Moshi much, because all land was already occupied. After the scheme was modernised, all the plots again remained in the hands of men, as a result of a decision of the planners to reallocate land to original owners after farms were levelled. The land acquisition modes continues to be in the hands of men, with very few exceptions (of women who were widows, unmarried or divorced). The men in all categories of households continued to be owners of irrigated plots, while women

own only through their husbands. Ownership of land through men is common in Tanzania (Bryceson 1995).

In addition, the preferential allocation of plots to men was in line with the existing practice that men cultivated cash crops, while women were responsible for food crops. This is in line with other studies in Sub-Saharan countries that show how women and men are responsible for and often grow different crops (Boserup 1970). Cash crops were termed 'male crops' because the resulting incomes were expected to be used by men to take care of the larger household expenditures and for longer term investments. Food crops were termed 'female crops' because women were responsible for feeding families. The irrigated plots, which were meant to produce rice to improve food security, were controlled by men, and (as night follows day) the produced crops were for the market and to earn money.

Apart from the irrigated plots, all households owned a number of rain-fed plots. These plots were mostly owned by men, who often assigned them to women. Women also bought or rented their own plots, but irrespective of formal ownership of plots, and what was produced on them, the harvest was considered to belong to the household as a whole. But contradicting a picture of intra-household harmony assumed by many policy makers in regard to the African rural household this study has discovered that some men and women, mostly in households of the subsistence and non-plot holder categories, own plots which they keep secret from other household members. Although not very widespread, owning and cultivating plots outside of the household economy is not insignificantly small (though for obvious reasons of sensitivity precise data were hard to ascertain) and is mainly practised as a strategy by both men and women to try and assure some individual income that they could spend as they liked, without needing approval of other household members. Men used this income for instance to buy luxury items, or to support other women, but women used it to feed their children, pay school fees or meet other regular expenses.

Division of labour and intra-household organisation of labour for farming

As in other irrigation schemes in Africa, farm households in Lower Moshi did not concentrate all their labour and capital investments in irrigated agriculture, but also continued to cultivate rain-fed plots while being extensively involved in various off-farm income generating activities. In this study, the division of labour among men and women in farm activities continued to be guided by cultural notions concerning male and female roles as well as their responsibilities for their families. This means gender has been one of the main structuring principles within communities and more specifically, in the organisation of agricultural production (Whitehead 1990; Whatmore 1991). Gender has therefore been found important in division of labour, which critically defines women's and men's economic and social opportunities and constraints. It determines their capacity to allocate labour time for productive activities and their differential capacity, flexibility and mobility to their livelihood generation. The gender-based division of labour within households therefore is one of the most recognised aspects of how a household pursues its livelihood and food security strategies.

What was similar in Lower Moshi when compared to earlier studies on introduction of irrigation is that labour requirements increased with the modernisation of the scheme (Jones 1986; Carney 1988). The demand for female labour rose sharply in different tasks in a production cycle (Cloud 1988; Whitehead

1990). For example women have been found to perform specialised operations like sowing, weeding and transplanting (Guyer 1980; Jones 1986).

In several occasions cultivation of food crops has been always seen as a woman's work, for the reason that women are obligated to feed the family (Niehof 1999). The use of tractors and other machinery in fact reduced men's activities, but increased women's workload. Men's work in ploughing was taken over by machinery; all they had to do was to oversee the work, which women could also do. In addition, most women were found doing men's tasks, especially when men were not around. Yet very few men were able or willing to perform women's tasks when women were not around. By and large, and even though most irrigated plots were owned and controlled by men, women were responsible for solving these additional labour demands. Indeed, if there is one overall conclusion from this chapter, it is that women are central to farming in Lower Moshi; most of the works, in both irrigated plots and rain fed farms was done by women, and organised by them. There seems a glaring disparity between the strategic significance of women's labour in farming in Lower Moshi and the amount of decision-making power they exercise. In this respect this chapter brings out that, women often belong to a kind of agrarian underclass, even if few (in commercial farming households) are as yet prepared to kick against the custom that constrains them.

How women coped with increased labour demands varied per category of household. The women in commercial farming households used their economic status to hire labourers to perform activities and delegate work to relatives, or they hired overseers to make sure that the work was performed as needed and in time, while they themselves were involved in other, often more lucrative, activities. The majority of women in subsistence and non-irrigated households did not have enough money to act in this way, which is why they formed exchange labour groups or used labourers who were paid in kind for performing agricultural activities. Sometimes they contributed money to hire a tractor to plough their rain-fed plots, and sometimes they hired girls or boys to help them with small income-earning activities. Unlike findings reported in studies in The Gambia, Cameroon and Kenya (Jones 1983; Jones 1986; Carney 1988; Dey 1990) and Burkina Faso (Zwarteveen 1996), in Lower Moshi women seemed not reluctant to provide their labour to plots controlled by men. Most women considered their labour contributions to male-owned irrigated plots as normal, and saw it as part of their responsibility as wives and mothers. They wanted to feed their children and meet other necessities, and as wives they also did it to protect their marriages. Because of this feeling of being responsible and obligated, the women were often inventive in coping with labour allocation among various plots and other income activities. Overall, agricultural activities were time and energy demanding and poorly rewarded. Most people tried as much as possible to limit their involvement in these activities, in favour of activities with a higher return. This is for instance why many young men have left the area and opt for trade or wage labour in town.

Distribution and use of benefits

Generally, the distribution and use of benefits are structured by gender according to division of responsibilities among men and women within households and varied among categories of households depending on socio-economic status. Since the irrigated crop is a cash crop from men's plots, they mostly control the distribution and use of benefits. Some men consulted their wives about spending of income from sale of rice, but most made these decisions on their own. This was in line with the

prevailing custom that men control the benefits of irrigated cash crops, from which they are expected to pay for school fees, build houses and invest in buying more plots or other income generating activities for the benefit and development of their families within households. Women were also responsible for growing enough food and get involved in income generating activities in order to feed themselves and their families. Women seldom complained of this arrangement. Even if the husband failed to contribute to the household, they would try their best to make sure they got something to feed their families. How they managed to balance income and expenditure, however, also depended on the overall economic position of their household. Due to prevailing culture, majority of women in Lower Moshi did not benefit from irrigated rice like those of Burkina Faso who had their own irrigated rice plots, which made them economically independent with a strong bargaining position (Zwarteveen 1997).

It was in commercial farming households where women were allocated irrigated plots and rain fed plots they were better off, because men's distribution and use of benefits did not affect them very much. They had income from other income activities, and also the irrigated and rain fed family plots designated 'female plots' produced enough to feed the family. Although men controlled the benefits from their own and female plots, the women felt satisfied. In contrast, women from the subsistence and non-plot holder farming households were more affected by lack of control over the distribution of benefits, because they did not have enough income from their own rain fed plots and other income activities. Although very few of them openly argued, their dissatisfaction showed in their attempts to spend more time on off-farm income-generating activities, of which they themselves could control the income. Some also rented plots without informing their husbands, so that the men would not claim the incomes from these plots. Women's relative involvement in decision-making over use of the benefits seemed not much, influenced by how much they participated in agricultural activities, or by how many plots they were assigned by their husbands. The analysed data indicate that, it was primarily through (high) off-farm incomes that women could increase their fall-back position and bargaining power in households. Poverty alleviation and gender empowerment in Lower Moshi are likely to remain slow processes since they depend on the slow growth of attitudes associated with better agricultural production, non-farm income generating activities and rising incomes.

CHAPTER 6

TRADITION OR MODERNISATION: WOMEN'S NON-PARTICIPATION IN WATER MANAGEMENT

6.1 Introduction

This chapter shows that the gendered separation over water rights and powers to claim water that prevailed before the scheme was modernised continued to exist in the modern irrigation system, to the exclusion of women irrigators. Water rights were originally linked to land rights, and since only heads of households owned plots, rights to water and rights to membership in the water users' organisation were also vested in heads of households, a group mainly comprising males. A very few female heads of household with rights to plots did become water users members. This meant that women's participation in the water users' organisation was low to nil. Traditionally, water control was also a strictly male domain in the Chagga highlands, as in other areas of Africa (Adams *et al.* 1997). A review of evidence in irrigation schemes from South Asia by Meinzen-Dick and Zwarteveen (1998), studies in Kenya by Hulsebosch and Ombara (1995) and Bastidas in Ecuador (1999) suggest that this minimal participation by women is common in water management in many places in the world, based on a clear gendered division between water acquisition and control tasks associated with men and irrigated tasks in the fields, often has been the responsibility of women.

This chapter shows how traditions and the modernisation process have worked together to exclude women from water management in the Lower Moshi irrigation scheme. The study examines how membership and participation in the water management organisation is linked to access and control over land and water. It suggests that women's lack of participation reflects gender disparities in property rights more generally. In the first section water rights are conceptualised, since this is considered important as an entry point for the analysis and understanding of gendered participation in irrigation management. The second section describes water rights and water users' membership within the Lower Moshi irrigation scheme. The third section describes women's participation in decision-making committees and meetings at various levels. The fourth section describes water distribution and allocation, and the extent to which it is gendered. The fifth section describes the involvement of men and women in resource mobilisation for maintenance. The sixth section concludes the discussion by showing how gendered participation in water management is related to gendered access to and control of water. This leads to an assessment of whether it matters for women to participate in water management.

6.2 Conceptualising water rights and water control

The discussion in this section shows that access to or control over water is not straightforward because water is a 'fuzzy' resource, partly reflecting its material character. Water is fluid and flows. Water access and control are always situated in, and reflected by, wider gender and power relations, as influenced by social, cultural, socio-economic and political factors. This is why water rights are difficult precisely to define and enforce (Meinzen-Dick and Bakker 2000). Water usage rights usually express how much can be used for certain crops by a particular person or groups of people. Rights to water can have different meanings, and it is necessary to distinguish between a) formal rights (formulated and authorised according to the principles associated with some kind of normative framework in force within an irrigation or water users' system) and b) rights in action, i.e. rights that are effectively exercised in water management practice (Beccar *et al.* 2002). Formal rights can refer to (a combination of) rights to the source, rights to the infrastructure and technology required to transport water, rights to decide about water distribution and rights to decide on who should have which rights (Zwarteveen 2006). In its most general meaning, a water right can be seen as the right that provides its holder with the authorisation to abstract water from a particular source, including the particular social privileges and obligations associated with such authorisation (Boelens and Zwarteveen 2002). According to Boelens and Zwarteveen (2002), when analysing water rights and control of water it is useful to distinguish three dimensions every water right must encompass - a socio-legal dimension, a technical dimension and an organisational dimension. The socio-legal dimension refers to the fact that a water right is an expression of agreement about the legitimacy of the right holders' claim to water. Such agreement must exist within the group of claimants, but it is equally important that rights over a resource be recognised by those excluded from its use.

Agreement about the legitimacy of a right holder's claim to water is intimately linked to social relations of authority and power, and can be based on a variety of grounds. It can be based on state legislation, and water laws and regulations, but it can also be based on local rules established and authorised by traditions and community organisations. Having the legal possibility (and social power) to take water in itself is meaningless without the other two dimensions of water control (Zwarteveen 2006). First, the technical dimension - the adequate means (infrastructure, technology and technical skills) actually to take water from a source and convey it to fields must be present. Second, the organisational dimension - it is necessary to organise and manage not just water turns and operation of infrastructure, but also the mobilisation of resources and decision-making processes around these issues. Responsibility for these management tasks may lie with government agencies, with NGOs or private companies, with community organisations or with a combination of all these. Having a right to water is often accompanied by the right-holders' right or option to participate in management decisions, and a number of duties and obligations, such as the requirement to contribute cash or labour to the operation, maintenance and management of an irrigation system within community (Zwarteveen and Boelens 2002; Zwarteveen 2006).

In seeking to understand water rights and control Zwarteveen and Boelens (2002) argue that it is not enough to look at the official terminology defining legal status of right holders. It is also required to look at actual water use and distribution practices, and to understand the different norms and discourses various users refer to when claiming access to water. These authors conceptualise water rights and analysed

them in a number of ways, such as distinguishing among types of claims and capabilities associated with the right. For example, within an irrigation scheme collective decision-making and collective claims of ownership water may be different from those of individuals. The claims and capacity at public level may cover many individuals, and some organisational representative of the entire scheme may be considered the right holder on behalf of a collective. The internal division and formulation of rights within an irrigation scheme may be determined by formal rules or may be left to decide by the water users. These include rules about for instance a description of what Water Users' Association (WUA) is, who is entitled to participate in decision-making and how water should be distributed among members. Water control in actual practice can be conceptualised as a process of bargaining, negotiating and advocacy, which explains how and why actual use and distribution of water occurs, in relation to the obligation and responsibilities of the relevant organisation or individuals. Bargaining can happen around the different dimensions of water control, including around operation of infrastructure.

For example, within an irrigation system, even though the water users can have the legal right to water, they may end up not getting the water because some farmers have impeded their right by bargaining or negotiating with a waterman to give them water in exchange for a bribe. Water can be allocated to certain plots of farmers, but as it flows in the canals some non-water users might divert the flow, or destroy division boxes to direct the water to their plots, not scheduled for supply at that particular time or on that day.

6.3 Water rights and water users' membership within community

This section examines how water user membership affects access to and control of water, as between male and female farmers, and at national, scheme and village levels. The section discusses the contents and meaning of water rights at all the levels within the scheme. Such an assessment is done to see if and how water rights are gendered, which will later be related to participation in water management.

At national level

The Lower Moshi irrigation scheme has legal rights to the water from its two rivers, based on the national Water Utilisation Act No 42 of 1974 (URT 1974). This act was amended in 1981, and declares all water to be the property of the republic, designating it as 'national waters' (URT 1981). The scheme's management had to apply for permission to use the water from the Rau and Njoro Rivers to the Ministry of Water and Natural Resources (MWNR), which issues permits to individuals or societies to use or divert part of the water according to the Water Utilisation Act. This permit is registered under the provision of water ordinance to divert and use water. It includes those waters, which flow over the surface of the ground or are contained in or are flowing from a spring or stream or natural lake or swamp or in a watercourse, and includes all water derived from subterranean sources by means of works. These works include canals, channels, weirs and other works constructed in connection with the diversion and abstraction of water, or for drainage for the purpose of irrigating crops. The water permit was registered in the name of the scheme, which included the project (KADP) and the farmers who owned plots.

At scheme level

Water for irrigation within the scheme was managed via the issuance of water rights (permits) expressed in quantitative flow units (e.g. cusecs) to water users against payments of an annual fee associated with this water right was the registration of users as members in WUAs and the establishment of WUAs as legal entities. According to the regulations, only the farmers within the scheme had the right to the water source and the infrastructure. As discussed in Chapter 3, although there were many farmers cultivating within the four villages of the irrigation scheme not all were formal water users members. The water user membership was tied to plot ownership and only farmers who lived within the scheme and owned plots were counted as formal water user members. Married women who were assigned plots through their husbands and all other men and women who did not own plots were excluded from being formal water user members.

Other informal water users were those farmers who had plots within the scheme, but did not live within the villages. Although they were paying the water fees, these farmers were not formal water user members. Formal water users members within scheme, as discussed in this thesis, were the farmers belonging to commercial and subsistence farm households as categorised earlier (see Chapters 1 and 4).

Although there was no more land for allocation in the scheme, new farmers could still acquire land through land purchases, inheritance, or through renting from farmers who failed to continue farming. In the case of sale or inheritance, the water right could also be transferred to the men and women farmers who obtained land. The farmers who rented out their plots could not transfer their membership, but could also not become members themselves. In all, the rules and regulations regarding membership of the water users' organisation were such that the number of farmers involved in irrigated rice farming was higher than the number of members of the water uses association. In this regard, female farmers in particular were more affected than male farmers.

Table 6.1 Water user membership by household categorisation: (N = 300)

HH Category	Gender of household heads					Type of marriage	
	Male		Female				
	No of Members	%	No of Members	%	Total %	Poly-gamous	Mono-gamous
Commercial	32	36.0	6	6.7	42.7	2	30
Subsistence	41	46.1	10	11.2	57.3	3	38
Non-irrigated	-	-	-	-	-	-	-
Total	**73**	**82.0**	**16**	**17.9**	**100**		

Source: Field data 2001-2004

Apart from married women not being given the opportunity to become members, a good number of de-facto and de-jure[34] female heads of households lost their

[34] De-jure, or female headed households can be formed by those women who are single mothers, divorced, widowed, or separated and those women deserted by their partner (no male partner present at any time). De-facto-female headed households are formed by the male's temporary absence from

membership through renting out their plots after failing to accumulate enough savings to cover rice farming expenses. In addition, those who bought additional irrigated plots were almost always men, resulting in an increase in the number of men in the water users' organisation as compared to women. Although the means of land ownership through purchase is open to every farmer, most women lacked money to fund purchases, while those who were married hesitated to do so because they might then lose their land to their husbands, or out of fear of creating misunderstandings in their marriages. Those married women who inherited land often left it in the hands of their male relative (brother or uncle). The sample of water users' members in Table 6.1 confirms the larger set of findings covering the whole scheme, as presented and discussed in Chapter 4. Women are few (17.9 percent female water users' members, as compared to 82 percent men). As explained in Chapter 2, all farmers who had water rights and who were considered members were organised to form a water users' organisation, and it to this entity that water right permits were granted. Within this organisation, men and women were voted to become members of various village committees, from which board members were then selected to form the main water users' organisation committee at scheme level. This was the organisation that together with the project (a government agency) managed and operated the irrigation systems at scheme level (Figure 6.1). It is the one that establishes rules for operating, managing and maintaining infrastructure. These scheme level organisations, consisting of member representatives and the government agency also mobilised resources and made decisions around such issues (to be discussed in Section 6.6).

Village level

While all villages located within the scheme have rights to water, not all are equally well positioned to access water. Those who were at the head end, especially in Mabogini, thought they had the right to take the water before it reached other farmers in downstream areas such as Chekereni. Their feeling of entitlement to the water was based on customary use of the water from the Njoro River. As referred to in Chapter 3, farmers in Mabogini took the amounts of water to which they felt they had a right, in spite of the formal allocation rules. They argued that the Njoro River system was their property, while the Rau River system belonged to the other villages, and felt entitled to break structures (and rules) to get what they claimed to be 'their' water. The Mabogini farmers not only took more water than their seasonal allotment, but even started cultivating additional areas, claiming even more water than before. Men were more visibly active in undertaking all kinds of actions to actually claim what they considered 'their' water. They were the ones who went to the offices and complained, and they also were the ones involved in breaking structures, while the women remained working in the fields. Traditionally, the acquisition of water was seen as a men's task, while farming and working in the field was seen more as a woman's task (Masao 1974) and this even extended to acquiring by force.

Because the head-end farmers in Mabogini took more water than their entitlement, downstream farmers experienced water shortages, especially during dry season. There were many complaints to the management by farmers from Chekereni, Rau and Oria and (as already mentioned) there were even physical fights between farmers from Mabogini and the other villages within the scheme. The tail-end

home e.g. through seasonal migration to find work and economic contribution to the family is marginal and the female left behind is the main provider.

farmers, especially from Chekereni, complained of gross water inequalities between farmers situated at the head and tail ends of the scheme. The actions of the Mabogini farmers also hampered the effective implementation and enforcement of the designed water rotations. Again it was mostly men who were involved in these complaints and fights. In addition to conflicts between the Mabogini head-enders and the tail-enders from the other villages, there were also other types of interferences with official water allocation schedules. For instance, some farmers negotiated with watermen for additional water turns, or sometimes plots belonging to members with a certain position of influence within the village got water before others. Also farmers who were related to the watermen were favoured. Again, it was mostly men who were involved in such negotiations, since the capacity to act in this way required money, or a position within village or network connections. Few women had this kind of power, and most lacked the money to bribe. A few women from the commercial farming households sometimes obtained water out of turn in exchange for money or the promise of local beer. Though the women from subsistence household categories were involved in income generating activities, they never generated enough money to divide between their households and the watermen. Nor did they have positions in the village hierarchy or the kind of employment that might have granted them the status, resources or influence to obtain favours from watermen. Only a few women related to the watermen were able to take advantage of kinship connections to get more water.

The water user members had the right to use water for irrigating rice, but since the water runs in canals that pass through the villages, other water uses were also allowed. Apart from agricultural activities, women and men in all household categories within the villages were given rights to use water for domestic uses such as washing, bathing and even for building houses. These domestic uses are gendered according to the responsibilities and division of labour. More men use water for building since it is men who are mainly engaged in this activity. Where a woman was head of household she hired men to help build her house, rather than do the work herself. It was mostly women and children who used the water for washing and tending stalled animals since these are duties for women and children. In many households members decided to use water for other purposes officially forbidden by the management. For example, many men, especially in subsistence and non-plot holder households, used irrigation water for brick making, as an income generating activity. They used the income to supplement poor agricultural earnings. In all household categories where they keep livestock, the canals were used to water animals. This was technically illegal, since livestock keeping or home gardening within the irrigation scheme was not included in plans. This issue became a source of much contention, especially where animals grazed within canal banks and drank from canals, causing damage. Additionally, many households living close to the canals siphoned water for home gardens.

6.4 Participation in decision making committees and meetings

This section looks at how men and women were involved in water decision-making at scheme and village levels. It analyses the actual participation of women (from male and female-headed households) and men in different positions of decision-making and their involvement in meetings as *informal* and *formal* water users' members. Participation in decision-making committees and meetings at all levels is

based on a traditional division of labour and responsibilities between men and women. Female and male heads of households sometimes expressed the importance of attending meetings, while married women preferred their husbands to attend since they were busy attending to other activities. Most women did not consider their involvement in the meetings as important, in part because of the agendas and atmosphere of actual meetings were seen as off-putting. A few women participated in meetings when their husbands were not around. One of the issues addressed in the study was that women's non-participation in organisations may make it difficult for them to voice their irrigation needs and priorities. Participation of men and women in committees and meetings was examined at scheme and village levels. An analysis was also done on whether women's involvement in other income activities empowers them for participation in water management.

Table 6.2 Water users and uses in Lower Moshi

HH categories	Domestic use (washing)		Livestock and gardening		House building and brick making		Brick making for sale	
	Male	Female	Male	Female	Male	Female	Male	Female
Commercial	*	*	**	**	**	*	-	-
Subsistence	**	**	**	**	**	*	***	-
Non-irrigated	**	**	***	**	**	*	****	-

* = few
** = some
*** = many
**** = a lot

Source: Field data 2001-2004

Participation in committees

Participation in irrigation management at this level is a reflection of ownership of plots, which favours men. It is mostly men who have been elected as members of committees because there are fewer women members. Few if any of these women were even considered when electing committee members, because the majority of members imagine that women have no place on such water committees. The traditional belief that only men should be in the water committee was very strong, in both men and women, and no women complained about this. Within the scheme, there were a number of powerful women who were educated and wealthy, but even they were not elected to positions. The association of men with public decision-making and water management a deeply entrenched social practice brought down from the traditional irrigation systems in the highlands (Masao 1974). In Lower Moshi, there were no special regulations or provisions to promote or encourage the participation of women in water users' organisations, even though the law requires a representation of at least 30 percent of women in all government related committees. Women themselves, especially when they came from male-headed households, showed no interest to become members in such committees. They considered water management a male domain, and saw themselves as already busy enough with other tasks as mothers, farmers, and income earners, which indeed is objectively the case. But attitudes are different for women from female-headed households. They have an interest to protect (i.e. they lack a husband to protect this interest for them) so they need to attend.

Irrigation water management is organised jointly by the Kilimanjaro Agricultural Development Project (KADP) and the Water Users' Group (WUG) CHAWAMPU, who represent WUGs at village levels. Within the irrigation scheme, there are paid system leaders within the two systems (Mabogini and Rau ya Kati), block leaders and watermen, who work together with the sub-committees to manage the scheme. The levels of organisation are also levels of decision-making, and this operates through meetings, under the constitution of the Lower Moshi executive committee. Although these levels are important in irrigation management for agricultural production, and even though women are the ones most involved in agricultural production, there have been no women representatives. The committee consists only of men representatives, and these include the manager (representative) from KADP, who is the chairman, and the main committee of the WUG at scheme level, consisting of 15 board members, from which the vice chairman and secretary are elected by ballot for three years by voting members (WUG representatives).

Table 6.3 Membership of the Water Users' Group committee

Position	1995-1999				2000-2003			
	Female representation		Male representation		Female representation		Male representation	
	SWUG	VWUG	SWUG	VWUG	SWUG	VWUG	SWUG	VWUG
Chairpersons	N	N	Y	Y	N	N	Y	Y
Secretaries	N	N	Y	Y	N	N	Y	Y
Treasurers	N	N	Y	Y	N	N	Y	Y
Committee members	N	Y	Y	Y	N	N	Y	Y
Water distributors	N	N	Y	Y	N	N	Y	Y

VWUG = Village level
WUG/ SWUG = Scheme level
Y = Yes (member)
N = No (not a member)

Source: Author's field notes 2001-2003

Both records and responses of farmers show that there was only one woman member (Mama Maria)[35] of water users' committee from 1995-2003 (Table 6.3). As explained in Chapter 2, in earlier times the board members were elected by all farmers, in principle making it was possible for women to vote for other women representatives. However, since 1995 only members of the WUGs (mostly men) elect the members (KATC 2000). The main committee also appoints a treasurer from among the male water users. Farmers (including women themselves) have not elected their fellow women because they felt women were not capable. The opinion was that office-bearers need to be able to be tough in terms of dealing with stubborn people and difficult issues, and many thought that women would not be tough enough. The women themselves said they did not think they could handle the posts because they were time consuming. There is also a village government sub-committee in each village from which an executive committee is elected which

[35] The name does not represent the true person.

represents and works with the main Water Users' Group committee and overall chairman.

Local records show that there has been only one woman (a widow) from a female-headed household who has been a member of a water committee at village level ever since the scheme was modernised (Table 6.3). Also a few women from female-headed households - mostly those with low education and economic status - have been found to represent women at very low level in other related committees in village governments. The reason for this is that at one time the villages were advised by the government that they should let women have positions in villages. But little pressure was then exerted to assure compliance, and the strong traditional belief among men that women cannot sit among men as water committee members, because that is typically a man's job, continues to persist. Some men who were against the idea of women being included in decision-making organisations said that most women have very low education and economic power, so it would be difficult for them confidently to speak in front of their husbands and other more highly educated men. Yet education is clearly not the whole explanation because there were many women who were educated and economically well off.

According to farmers' reports and author's observation, women did not have high chance of representing other women (see Table 6.4), regardless of their socio-economic status or education. The four Project villages -, Mabogini, Rau ya Kati, Chekereni and Oria were well organised - with village government executive committees, sub-village committees and cell leaders in each village. Such committees worked hand in hand with the WUGs in decision-making and implementation processes within each village. Each village government was organised with the village assembly headed by the village chairman. Although the village party members elected the village chairman after every five years, there has never been a woman elected to that position. All adults from 18 years of age and above in the village were members of the general assembly. The executive arm of the village government was the village council, whose secretary is the village executive officer, an employee of, and appointed by the district authority.

Table 6.4 Membership in Water Users' Group committees

Type of farmers	Chairman		Secretary		Treasurer		Committee members		Water distributors	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Commercial	Y	N	Y	N	Y	N	Y	N	Y	N
Subsistence	N	N	Y	N	Y	N	Y	N	Y	N
Non-farmers	N	N	N	N	N	N	N	N	N	N

Y = Yes (a member)
N = No (not a member)

Source: Author's field notes 2001-2003

At this level, there were no women representatives either. Neither women nor men WUG members would vote for women, because they did not trust that they could perform well. The women respondents said that they were never selected as leaders because men thought most women would not be as good leaders as men.

Participation in meetings

Meetings at scheme level

The Lower Moshi Irrigation Project constitution specifies that a general assembly meeting should be held at least twice a year. Since this meeting is regarded as a final authority for decisions it was important for all irrigators to attend, as members of the WUG. The meetings were usually convened outside the office of the Water Users' Association (WUA) at Chekereni village in Lower Moshi, during the beginning and in the middle of the year. The meeting started after a quorum was reached of half of all executive committee and WUG members. All water users from all villages were also expected to attend the general assembly meeting. Since not many women were plot owners, their representation in WUG was lower than that of men. This is also why there were not many women participating in the general assembly meetings. The meetings at this level had the purpose of 1) planning agricultural activities, working out how to meet the inputs of farmers, and evaluation of what had been achieved, 2) presentation of the executive committee's financial statement, 3) scheduling main canal cleaning works, and 4) the election of the executive committee officials.

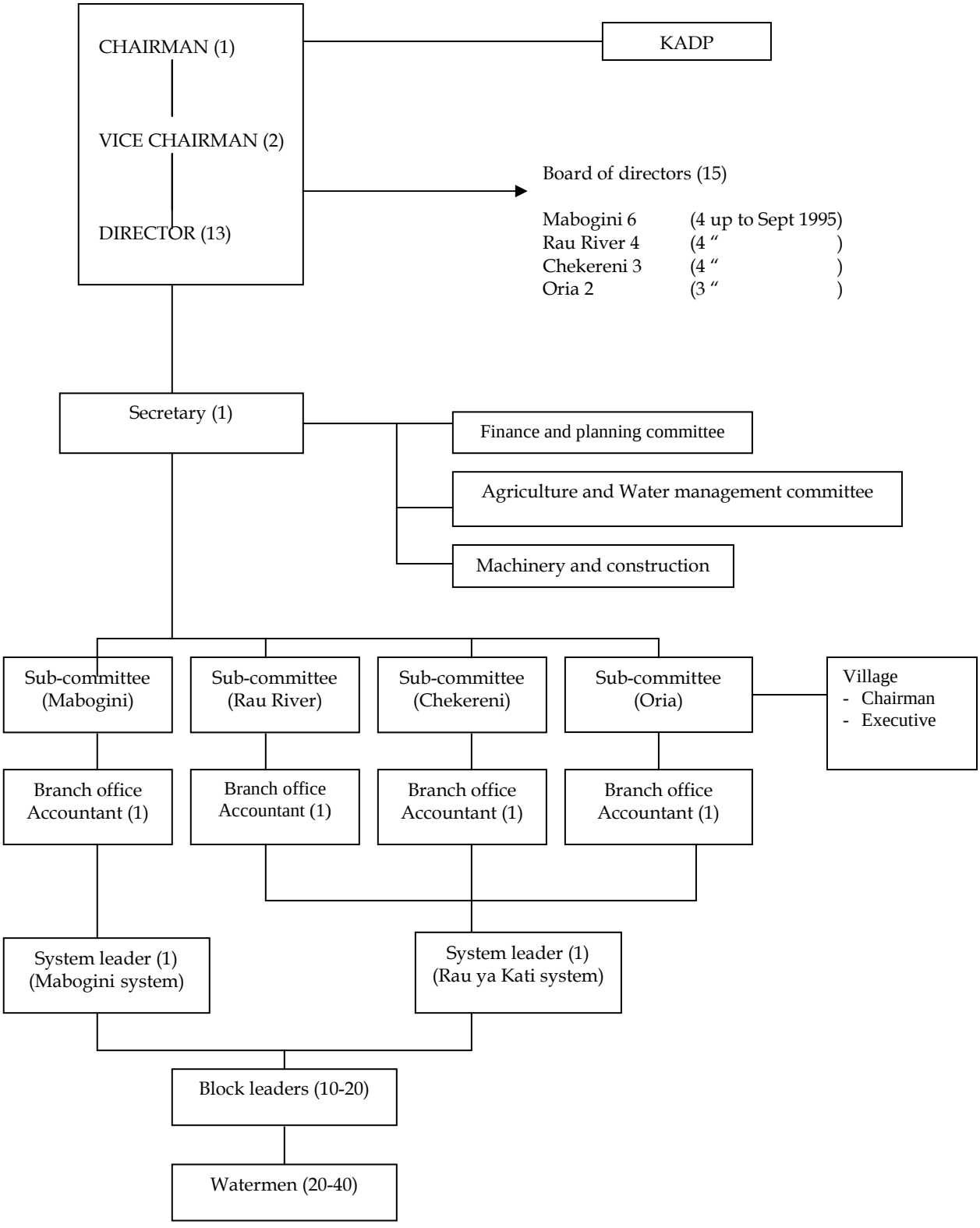

Figure 6.1 Organisation chart of Water Users' Group at Lower Moshi

Source: Tamura and KATC 1996

The process to call a meeting was through the village government leaders at the sub-committee levels of each village down to the 'ten cell' leaders of village streets. The call for the general assembly was released at least a month beforehand. Sometimes a loud speaker was used through the streets to make a public announcement. From the interviews with both men and women it showed that many members were not very much interested in attending. The major reason was that they felt there was no democracy. The male irrigators complained that attending such a meeting was a waste of time because the committee always pre-arranged what was to be discussed and asked some favoured people before the meetings to pose some questions, pretending that there was democracy. Some farmers said that sometimes even if they had burning issues, when we raised hands to speak they were never appointed to speak, so it is difficult for the farmers to say what they had wanted to say. Farmers thought such meetings were not for the poor, but for those who have money and a high status in the village. One informant said:

> *There has been a serious theft regarding the scheme money, but they do not want to discuss. And even for the election of members of [the] executive committee, there is no poor farmer that represents us. How can they know our problems? (Interviews 2003)*

Most of farmers just went to the meeting to listen and not to contribute. Women farmers were even fewer because most of them said they had other important things to attend to, rather than going there to waste their time. The women who were encountered in the general assembly meetings were about two or three from the female-headed households. These were women with primary and secondary education, and they were big farmers. Other women who were more educated did not want to attend such meetings because they said they did not like to listen to arguing and exchange of bad words. The general assembly was characterised as a man's meeting. Most of the married women said they did not attend because it was impossible for them to contribute points; they were less well educated, and also they did not like to be ashamed or even to hear their husbands being humiliated. In fact I attended two meetings at this level (in 2002 and 2003), both of them were very chaotic and some of the irrigators had to be withdrawn from the meeting because they almost came to blows. They decided to stand up and started to speak out of turn, and started complaining about the things that were done unfairly by the committee to farmers, and about people who stole the farmer's money, but were not jailed. This suggests that indeed there is scope for a more democratic decision-making process. At present, however, it is only the totally determined farmer who can make a point.

Executive committee meeting

This is another level of meeting at scheme level and is convened by the management representative (KADP), and involves the WUG executive committee, together with the sub-committees of each village, the chairmen of villages and the agricultural extension officers. These meetings were usually held at the CHAWAMPU head office to discuss 1) how to provide supervision or coordinate activities of the scheme level WUG, 2) how to agree on the cropping calendar and distribute the agreed plans to members, 3) how to agree on what to charge for water and tractor hire services, 4) availability of inputs including clean paddy seeds, 5) by-laws on water distribution, canal cleaning and maintenance, agronomic practices etc and enforce them so as to minimise conflicts, and , 6) how to resolve disputes associated with land reallocation problems among farmers in the project.

The meetings at this level were convened almost every month, because of the nature of the duties. In these meetings, again it was mostly men who attended, although there was one female extension worker. Whatever was discussed here was communicated to the other committees for implementation.

The village level meetings

The village level general assembly meetings were usually held outside the village government office more than three times a year depending on the tasks to be fulfilled. The WUG sub-committees and farmer representatives usually met every month to discuss the implementation of various activities, the collection of water fees, and debate reports etc. The people responsible to convene the meetings were the members of the water users' sub-committee and the village government chairman. The meetings at this level discussed issues of 1) allocation and monitoring of the distribution of water from the main canal within the branch, 2) planning, mobilising labour and carrying out maintenance within the branch, 3) managing conflicts and 4) appointing branch canal representatives to vote in the general assembly meeting. The structure of the village level committee was the same in all villages. There always is an irrigation leader and members who assist him in doing the work, i.e. watermen and gatekeepers. The usual process of calling a meeting is that before it is convened village leaders (chairmen and ten-cell leaders called mabalozi) inform the members about the meeting at least one to two weeks before time, so that farmers can plan to be present.

The information is followed up by a public announcement, using (if necessary) a loud speaker through the streets of the village to remind farmers of the meeting. In fact this system was copied from that of the traditional scheme before modernisation. All farmers, men and women, were usually asked to attend the meetings regardless of whether or not they were members of the WUG. As discussed before, there were no women holding posts in the village level sub-WUG (Tables 6.1 and 6.3), although there were some women in the village government because it is a national requirement. Yet in spite of this, and in contrast to the meetings at scheme level to which women never went, while some women did participate in the village general assembly meetings because of various reasons (Table 6.5). A possible explanation for this is that many women were sent by their husbands to represent them, so that they could be involved in other activities far from home. Other women explained that they attended to such meetings in order to know what is being discussed in relation to irrigated agriculture.

Table 6.5 Female participation at village level Water Users' Group meetings (N = 89)

Participation in WUG meetings	Household categories					
	Commercial		Subsistence		Total	
	MHH	FHH	MHH	FHH	No	Percentage
Do not participate	22	4	27	7	60	67
Sometimes/when husband is absent	6	-	7	1	14	16
Participate always	4	2	7	2	15	17
Total	32	6	41	10	89	100

MHH = Male-headed house holds
FHH = Female-headed house holds

Source: Author's Field data 2001-2004

Moreover most of the women said they could not attend the scheme level meetings because the agenda and atmosphere of actual meetings put them off, where there are always hot arguments. I managed to attend such meetings in all the four villages during my study time. The meetings in all villages had almost the same characteristics, with more women participating in Chekereni than in other villages. The reason for this was that there were more women as members of the water users group here than in the other villages. Also there were more female heads of households in Chekereni than in other villages. Most of these women are not well educated. I expected to meet more educated women in the meetings, but most of them said they were busy. This applied also to educated male farmers, many of whom do not attend such meetings because most of them are either employees or businessmen; therefore they lack time to attend the meetings. The gender participation at village level assembly is illustrated in Table 6.5, where it is apparent that a majority of women from all categories of households (67 percent) could not attend meetings due to various reasons including not being members, especially those who were non-farmers (not shown in the table). Women from rice farming households indicated that they had to engage in other income earning activities, because they needed cash income more than meetings, or that they were busy carrying out tasks for their households. Some women farmers said they would not participate in the WUG meetings because their husbands were also attending. They said that someone has to stay behind in order either to continue with the work on the plots, or to take care of families. Some women from male-headed households indicated that they did participate in meetings when their husbands were not present. As indicated in Table 6.5, 17 percent of women from male and female-headed households were found to always participate in WUG meetings. This was different from expectations. Since they were always busy with other tasks they only attended meetings when they considered it worthwhile, relative to other activities. Clearly, in this case they found it worth their time to attend.

Most men and women farmers participated in meetings only to know what was happening. As shown in Table 6.5, a small number of women (16 percent) from male and female headed households sometime attended the meetings. Most of those from male headed households attended because their husbands asked them to go during their absence, while those from female-headed households wanted to know what is being discussed though in most cases they failed to contribute their ideas. When such meetings are held it is rare for farmers' ideas to be listened to or taken into consideration. This is why such meetings are all too often accompanied by hot

arguments (with protagonists almost coming to blows over issues, especially between the irrigators and the leaders). Practical democracy has an entry threshold. It is only when farmers are confident that they will get a chance to put their point of view that they will settle to and abide by the rules for good meetings. At present, there is no tradition of such peaceful debate, and thus meetings teeter on the edge of unmanageability, with the chairs and committees looking for easy options (i.e. a docile audience that does no more than listen). Some women were scared of lifting up their hands in meetings for a chance to say something. Some women had feelings of inferiority, and thought that they would be ridiculed for their ignorance. They were afraid that they would not contribute valid points, and that their male counterparts would not listen them. Such feelings are also related to a cultural tradition that dictates that women are not to speak in front of men. This was explained as one of their reasons for reluctance to attend such meetings. This kind of attitude has made many women unable to contribute their views as regards their needs and priorities.

As a result, many preferred their husbands to attend while they used the time to take care of their plots or household chores. Some men did not attend because of their engagement in pressing income-earning activities. These men might then ask their wives to go on their behalf. These women, asked by their husbands, together with women from female-headed households, were really the only ones to attend the meetings. Political and economic differences among water users and leaders influenced the decision-making process and disagreement over points raised by farmers. Those who had better positions were more listened than those with lower positions. On several occasions I witnessed that leaders hardly listened to farmers' needs and/or complaints. They liked the farmers to listen to them, and not the other way round. It may require patient efforts over many years to build up better habits.

6.5 Water distribution and allocation practices

This section aims to show how water was distributed among farmers in different household categories once the irrigation system was modernised. It also aims to explore if non-involvement of women in water users' organisations has effects on quality, quantity and timeliness of irrigation services they receive. Therefore, the actual water management at scheme/village and household or farm levels will be described and analysed.

At scheme level

Water distribution at scheme level was done from the two major water systems, Mabogini and Rau ya Kati, under the control of a (male) water master. The control of water from the intake to the turnouts of tertiary canals was under the project office. There were several male gatekeepers, who were responsible to operate the turnout gates and were the ones who knew how much water to distribute according to the areas scheduled for irrigation within the villages. The gatekeepers were the main link between project management and the WUG at farm level. A rotational method was used in the system because, with this method of irrigation, the available flow of water can be used by a small number of farmers during a specific time - a requirement particularly during land preparation when large amounts of water are required in a short period. Furthermore, with this method, water could also be more equitably distributed to all farmers in the villages in a timely manner. As explained

earlier, within the scheme there were severe problems of water distribution between the head-end and the tail-end villages, especially during dry season.

At village level

The rules for water distribution were the same in all villages because the management of the scheme managed the allocation. Yet even though there was no explicit bias against some irrigators in water distribution, more female heads of farms than male heads of farms were affected by water shortages in some villages because of the pattern of occupation of the area, as described in Chapter 4 of this thesis. Most of the women irrigating in their own right (as heads of households) moved to the villages at a later stage, after men had moved in, and therefore some of them acquired plots which had difficulties in access to water. Indeed, access to well-irrigated plots is partly a function of money, since plots with good access to water are more expensive. This is why more men have been able to purchase additional better-watered plots than women.

When water is scarce during the dry season, even though water is allocated to all areas, it usually does not get to the tail ends, because the volume is low and farmers at the head end use the water for their plots without thinking about other farmers located at the tail end. The watermen tried their best to ration and allocate water in turns, but it was the farmers themselves who often failed to cooperate. Since there are more women farming in their own right in the tail end villages of Chekereni and Mabogini (as shown in Table 1.4, Chapter 1), there are many women in this place who suffered from water shortages. Those in Mabogini (at the head end) were mostly widows who had inherited plots from husbands, parents or relatives. In this area there was no water problem, and so women did not suffer the problem of water allocation. The women said that the management knew about the water problems at the tail end, but the problem has not been addressed seriously.

At farm (household) level

The needs of both men and women at household level were the same, because they all needed to increase crop production for food and to meet other needs for their families. And since most plots depend on female labour for agricultural activities, they all therefore needed enough water for paddling and transplanting activities and also water was important to reduce weeds in the rice plots. Women farmers from subsistence households mentioned that they experienced problems with the watermen. They pointed out that water sharing among farmers was often unequal for various reasons. Some men with money bribe the watermen to allocate water out of turn. It has been difficult for women who suffer from such practices to cope, and the effects are especially severe where they have only one plot to feed the entire family. Some women from this group tried to bribe the watermen with a promise of beer, but most preferred money.

This created a lot of irrigation difficulties among women. Some men also used their authority and status in the village government to request additional water turns, a possibility that was not open to female plot holders since most lacked such positions. Water stealing was rife among men, especially during night when most women feared to venture, scared – in any case – of the threat of fines. They said that men were undeterred, since they had money, and if caught pay the fine and continue stealing, whereas women have no money to cover fines. There are a number of

farmers with big plots around their houses, close to the canals, who siphon and steal water for their plots and home gardens, both day and night. Whenever such people are caught they pay the fine or bribe the person in charge and continue. The socio-economic status of farmers is thus the most important factors affecting unauthorised and illegitimate modification of water allocation practices. Gender is one important mediating factor co-determining such status.

6.6 Resource mobilisation for maintenance

This section looks at who participated in maintenance at scheme, village and household (farm) levels, and also explores the ways in which resources and labour are mobilised for maintenance.

At scheme levels

The KADP and the WUG mobilise funds, materials and labour for the maintenance of the intake. It also organises maintenance work to be carried out by gatekeepers and some labourers during the off-season period. Since the activities are regarded as male work there were usually no women included at this level. In addition, the exclusion of women from the maintenance of the intakes once again reflects the traditional belief that women are not supposed to work in the intake, because they will cause the river to run dry (Masao 1974). For the major periodic maintenance of the main and secondary canals, the WUG mobilises funds under KADP/government guidance. Both the project and CHAWAMPU collect materials for maintenance and employ labourers to repair the major intake and the main and secondary canals. Farmers themselves were responsible for the maintenance and repair of tertiary canals. In 1997 and 1998, farmers in Lower Moshi took up, with the assistance of contractors the concrete lining work of about 30.4 km of watercourses in the area, including those of the pilot farm, which cost them about US $91,200[36] (Interviews 2002). In this last case, this amount was contributed in addition to the water fee payments for irrigation system repair. All farmers – male and female- belonging to WUGs were compelled to pay the total amount from their harvests. According to the report, given in an attended water users' meeting, the work remained unfinished, yet farmers had paid the whole amount by using their harvests. This caused hot argument within meetings, as it was taken to be an indication that some amount of money had been stolen, never reaching the contractor. This caused a lot of misunderstanding and mistrust between water users (men and women) and the main water users' organisation.

At village level

Following the scheme arrangements, the maintenance irrigation calendar scheduled every year to be done after transplanting. Generally the maintenance of irrigation structures and facilities of secondary and tertiary canals within the scheme are carried out communally. The community is usually informed as to when people are needed to participate in the communal works called *mtharagambo*. The information is delivered through general assembly meetings and is confirmed a day or so in advance by announcement through a loud speaker. Traditionally, such

[36] The 1999-2000 exchange rate was US $1.00 = approximately 1,000 Tanzanian shillings.

announcements were made through blowing a horn (discussed in Chapter 2). Communal maintenance of irrigation facilities and farm roads is considered to be very important, and a major concern of every farmer, whether man, woman or child. Every villager, whether or not a member of the WUG, is supposed to participate in such communal works because everybody uses water from canals for household activities such as washing clothes, making bricks for house construction etc. The village government and management have made it a rule that every household should participate in this exercise. In principle, maintenance works are regarded as men's activities. In practice, however, many more women than men were involved; in almost all the attended maintenance days, there were more women participating than men. The reason for this is that most women are sent by their husbands to do the work, while the men attend to other duties, such as income generating activities.

Most of times, the majority of women participated in the work because they were employed as labourers in the place of the actual water users. Most women could be classified as members of male and female-headed households from the non-plot holders and subsistence farming categories. No women from the commercial farming households were encountered. Some husbands in subsistence households sent their wives to take part in such work, even though they have many other competing activities and go unwillingly; but because they are wives they have to obey as a sign of respect. Farmers who fail to attend the work are usually required to pay a fine. The fine is often exacted by taking some articles from the household property of people who have failed to pay in cash. Where villagers (whether men or women) are busy they try to designate another household member to do the work, to avoid the risk of a fine.

At farm or household level

The mobilisation of resources at farm (household) level is the responsibility of household members. Resource mobilisation for canal cleaning and maintenance work is done by household members, and considered a function of their intra-household relations. In most households both men and women were involved in making the arrangements. Depending on the category of households and type of maintenance work needed men and women may both be involved in mobilising physical or monetary resources. Most of the time, men provide monetary resources for hired labourers. Where women and girls are available, and are involved in irrigated agriculture, they do the simple maintenance work like weeding, while hired men do de-silting, if husbands and boys are not available.

6.7 Conclusions

This chapter further strengthens the conclusion of the previous chapter that there is a strong gendered division in water related rights and responsibilities, the upshot being that most physical responsibilities are delegated to women, and most of the decision-making powers and monetary responsibilities are assumed by men (Adams *et al* 1997). Even though women are central in irrigated rice production, and therefore the ones to know and decide when and where to use irrigation water, very few women participate in the formal management of the scheme. There were no female representatives at any level of water users' organisations, while the various decision-making levels related to water management within the scheme exhibit a conspicuous

gender imbalance. Women's absence in meetings and committees can be largely explained as resulting from traditional norms and rules, which strongly associate water management and control over water with men (Masao 1974), but it also reflects the gender-biased pattern of plot ownership discussed in the previous chapter. Men traditionally acquire, control and manage water, but official membership of the WUGs is also confined to plot owners – most of whom were also men. Gender norms have been found to restrict women from being active members in water users' organisation meetings, where the majority are men. As a result of this, though the women contribute a lot in irrigation and irrigated agriculture, there were no women representatives at scheme and village levels. Due to lack of representation, their involvement in other livelihood activities and household chores, women were affected negatively in various irrigation management and maintenance related activities. Such activities include meeting attendance; distribution and water allocation as well as mobilisation of maintenance work.

Many women could not attend the meetings at scheme level. They considered such meetings were as places where men argued with other men over scheme management questions. When it came to village level consultative processes, women could take part, but their attendance was poor. This is because most of them did not consider their involvement in the meeting as important. Most of them found it to be a waste of time because the meetings took a long time, and women considered other activities more important. Women did not think the meetings were places they could voice their concerns and opinions. Although a few women (especially from female headed-households) tried to participate in village level meetings, they rarely if ever contributed anything. The reason for this has been that most of them are not confident in themselves or cannot speak in front of men especially if their husbands are also present. As a result most of them went there to listen and know what is being discussed.

The distribution and allocation of water was organised collectively through the management and the WUG. Water was supposed to be distributed to all farmers according to the rules and conditions set, but water was not equally shared since there were major head-end and tail-end differences, with farmers at the head-end taking more water than their share, causing water shortages to those at the tail. In response, tail-end farmers generated new water allocation solutions, including selling and stealing. The scarcity of water was most problematic for those with least power and influence (based on positions, status or money), and women were numerous in this group.

Women and the poor are seen to be the victims of unscrupulous practices of male commercial farmers or males with political titles who used their economic and title power to get more water than other farmers, and often by dubious means. Participation of women (especially from subsistence farming category) in income generating activities did not empower them to influence change of water allocation in their favour. The income from most non-farm or on-farm activities was small, which was more needed to take care of their families. The income from such activities did not also influence them to be involved in decision-making committees.

At scheme level the management and the water users' organisation were responsible for the mobilisation of monetary resources from farmers to cover major maintenance of canals and intakes, but every villager was obligated to contribute labour to clean the canals and other minor maintenance. At village level, most women and youth participated in labour contribution because they were hired by those who could not participate, due to their involvement in other income activities.

At household level, many women participated in irrigation maintenance especially in the canals because their husbands asked them to participate on their behalf.

In general, the data in this chapter confirm the view that women are disempowered in irrigation not because the introduction of modern irrigation has transformed the social relations of irrigation management, but because traditional social relations of irrigated agriculture remain insufficiently unchanged by new technology in irrigation system. The problem is less irrigation than a set of traditional norms in which men can command the labour of wives, and women continue to believe it is their duty to accept the burdens placed upon them. Government has preached the empowerment of women through changes in land laws and through the establishment of quota for women in decision-making, but there has been little practical effort to help women make use of and benefit from these opportunities. Seen in this way, women's lack of participation and representation in water management, and their lack of formal and informal ways to influence how water is allocated and how resources are spent within the scheme is part of a larger water reality, which is highly male-dominated. The lack of women to attend and participate meetings and decision-making posts make them unable to contribute their views and attend their needs and priorities. It is argued that unless it is reinforced that women should participate in water management as decision-makers in the institutional framework little success will be achieved. As long as men do not assume the share of women's traditional tasks, the overburdened women cannot effectively participate in water management decision-making. Although non-involvement of women in water users' organisation did not show any effect on quality, quantity and timeliness of irrigation services they receive, but still it there were many unattended problems that women were complaining about. This shows that although women are not members in decision-making committee it was important for them to have a representative so that their interests and needs be could be met. The women's involvement is essential as they play a major role in food production, irrigation activities and taking care of families. The challenge is how to motivate men in general not to assume that water supply is a technical and traditional matter and thus women have no influential roles to play in this sector.

CHAPTER 7

GENERAL CONCLUSIONS

7.1 Study objectives and key findings

This thesis is set out to improve the understanding of livelihood and production changes emerging in a modernised irrigation system, focusing on the Lower Moshi system in Tanzania. It aimed to see how a technographic analysis helped to examine how project interventions and policies have influenced livelihood opportunities, through understanding of changing interactions around technology and water access, and its effects on gender and household relations. The Lower Moshi irrigation scheme is an example of many irrigation schemes that were modernised in Africa in the 1980s with the aim of increasing food production to improve the livelihoods of inhabitants. However, while this study of the Lower Moshi irrigation scheme demonstrates most of the general failures of irrigation in Africa observed in Chapter 1, it provides new findings on the nature of livelihood differentiation at work, that also have implications for future system design and development. This chapter look first at findings related to the key study objectives, before ending with some recommendations for future research and system designs

A technographic description of the irrigation system

The thesis used the technographic approach by Richards (2002), Richards (2007), which made it possible to map the actors, processes and client group in such a way that the analyst can see beyond the technology itself, the problems, the technological applications they are supposed to solve, and understand what parties and interests are being mobilised in arriving at solutions. In the Lower Moshi case, the government and international donor organisations were the ones that chose the irrigation and agricultural technology, with a modernisation ideology. A unified methodological analytical framework named context-mechanism-outcome configuration (Pawson and Tilley 1997), was adapted to structure and analyze the research process. This was developed further for studying irrigation using the sociotechnical framework for technography described by Bolding (2005), to open up elements often treated as 'black boxes'. The realism of physical water control (especially with changing water rights, water scarcity and unclear system boundaries), land-labour-crop relations, and staff-water user interactions have all proved important to understand changing livelihoods. These seem critical points for which future system developments should better study of local dynamics. The use of survey and interview methods helped open up these realities, but also raised questions about further field measurements needed to study these key sets of relations in the field. Thus the survey sample was followed up by detailed studies with selected households to get more insights and information on complex realities.

Theoretical and empirical debates on irrigated livelihoods

In Tanzania both colonial and post independence governments made efforts towards improvement of irrigated agriculture under a variety of planned interventions and changing policies and laws. At first, these focused more on improving the economy of the colony or the country, rather than individual farmers' livelihoods. In 1970s, especially during the Ujamaa Villagization policy, irrigation furrows were changed to have village status giving more focus on local farmers and local organisation. Establishment of village irrigation schemes was done purposively for improving the livelihoods of people in villages, through the improvement of the irrigation system technology.

However, such programs turned out to be unsuccessful for many farmers due to lack of cooperation, weak finance and poor water management and leadership among groups. The failure of the village irrigation schemes led to the establishment of the smallholder and large-scale irrigation schemes from the 1980s, which insisted on commercial crop farming in order to improve livelihoods and support the national economy. The establishment of the schemes transformed rural regions from subsistence to commercial agricultural economies in order to meet basic food needs and raising incomes of the rural poor. During this time, most donors working with the government of Tanzania established such schemes through *top down* approaches and sometimes with little knowledge of the people and social cultural complexities. Often the government and donor agency came with decisions on what type of technology to be implemented and how to implement them. The Lower Moshi irrigation scheme was established along such lines that have resulted in serious problems of water shortage and social differentiation in access to water and livelihood security. What this thesis indicates is indeed the outcome of the 'good' plan by the government and donor agency. Commercialisation is present for some few farmers, but for the majority, the processes of de-agrarianisation (Bryceson 1997) seem to emerge. Farmers in all categories have been forced to diversify their livelihood strategies, and many young people have become increasingly dependent on non-agricultural sources of income (Berry 1993; Bryceson 1997; Bryceson 1999; Francis 2000) and family farming has almost disappeared (Bryceson *et al.* 2000). The diversification in household's livelihood strategies has been accompanied by important social changes in inter- and intra-household relations. It has reduced the strength of social networks people could traditionally count on for securing access to resources, including labour (Berry 1993; Jambiya 1998; Mung'ong'o 1998). The irrigation community where subsistence farmers used to depend upon mixed cropping including irrigated agriculture for food is now a divided community of different socioeconomic statuses, with some wealthy households and other living in poverty.

Project interventions and policies and their influence on livelihood strategies

The study shows how plans and infrastructure construction came from the donor agency and the government, without involving the farmers within the scheme and even without in-depth feasibility study to know the environment and social culture of the inhabitants. Blueprint approaches to plot allocation and also to allocation of water rights were followed. The feasibility study done was only for the assessment of the irrigable land and water resources and infrastructure development. They considered only farmers' experience in irrigated subsistence crops and previous

cultivation of cash crops (coffee and cotton), ignoring the complexity of the earlier farming systems. Before modernisation, the farming systems were different in each village depending on soil fertility and access of water. These important differences were ignored, which are some of the reasons why farmers especially in the tail end have not benefited much from irrigated rice farming.

The creation of specified land plots for intensive rice production in only a part of the earlier irrigated area was a classic older design approach. This brought its own problems in exclusion of many men and virtually all women from control of a cash cropping activity. The government assumed that farmers who were not included in the project could improve their food security and livelihoods through buying rice at cheap prices from rice farmers and getting cash income through hiring out their labour.

Many production assumptions failed since the high yielding varieties of irrigated rice were expensive in terms of buying inputs, including tractor access and water itself, for an average or poor farmer. This was exacerbated by lack of credit facilities and low yields. As a result it has been only the rich farmers who have been able to continue cultivating irrigated rice and have benefited from the intervention. Rice that is sold locally in the shops and markets is expensive for a poor farmer. Generally life within the scheme has become even more expensive than in Moshi town because most food products are bought from Moshi town market and nearby villages to be sold in Lower Moshi. Some other necessary products in shops and market are expensive because the merchants think every farmer has money from irrigated rice.

The poor marketing system for irrigated rice also caused low or negative returns to the irrigated rice farmers. The main road that connects Moshi town and other regions to Lower Moshi scheme, made the donor agency and government assume a good market system with good prices to improve the economic status of farmers. The improvement of economic status has been difficult for average farmers because of their failure to agree and control the selling price due to differences in economic, their status and needs. The existing market liberalisation policy has not favoured farmers, so the businessmen are the ones who have been determining prices, which gives low value to farmers.

The donors also did not consider the neighbouring community within the locality who had also used the water resources throughout their lives. They overlooked or were not informed of the existing water rights within area. They assumed that after formal water rights were awarded for the irrigated rice area, and new intakes constructed, no farmer would abstract water anywhere else along the river. They have ignored the wider sociotechnical context of water use by farmers outside the scheme, which is influencing water scarcity within the scheme. This has caused serious implications and frustrated the plans of the intervention. Thus, the establishment of irrigation and agricultural technology set in motion three major conflicts, which contributed to serious water scarcity. The first conflict was between the farmers within the scheme and the farmers outside scheme; the second was between villages of the upper and lower river, and the third was among farmers of different power relations within villages. The agency was forced to cope with the water scarcities resulting from these conflicts through various mechanisms, including reduction of land to be cultivated, change of cropping calendar, and change of water allocation and distribution. Over time such conflicts exacerbated misunderstandings between the management, Water Users' Groups (WUGs) and water user members (farmers), and caused poor irrigation management and irrigated rice production. While uncertainty remains over the status off customary versus

statutory law, and there is no effort to mobilise more water, conflicts over water access and use seem set to continue.

The findings of the study show that changing access to irrigated water during irrigation development intervention has increased the gap between the poor and the rich households within the scheme. It also reveals that the rich have continued to benefit at the expense of the poor, whose livelihoods have become more insecure than before. This resulted from uneven reallocation of land plots to a small percentage of men and women farmers within the community. As a result, irrigated rice farming has been found to be the main livelihood strategy only of those with more land and who are capable of meeting rice production expenses. Those who benefited from rice farming and became rich have become even richer by investing income in various activities. Other 'average' farmers failed to continue with rice farming and diversified in order to cope with farming expenses and meet household food needs. In this study survey only 30 percent farmers in the scheme were depending on irrigated rice farming as the main livelihood strategy. The majority 70 percent depend on rain fed maize farming in the unpredictable rainy season and other small-scale income activities during the rest of the year. The majority of such farmers and even the subsistence irrigated rice farmers earn less than a dollar a day to meet household needs. This is worst for farmers intensely affected by water scarcity that forces them to cultivate only once per year. The extent of involvement and return of income activities has resulted in skewed socioeconomic differentiation among farmers in Lower Moshi.

Attention was given to a new water management structure, which was supposed to have managers, WUGs and farmers working together in operation and management. However the stresses in the scheme have caused the structure to work unsuccessfully. The management uses a top down approach in carrying out its various activities, while the farmers have limited say. There have been a number of incidences of money thefts at the WUG main level, which has ruined their relationship with the farmers (water user members) and cause a lot of mistrust. Most of the women who are farmers and irrigators are excluded from participating in WUG decision-making a meeting (see below).

This thesis has shown rice yields that appear to be exceptionally high in areas where water supply is timely delivered and all adequate inputs are available. There is a real need to confirm and study further the diverse yields and related production shortages found across the scheme. However these high yields remain largely among a few wealthy farmers while many other disadvantaged farmers struggle with less water and little access to other inputs. Thus there is a need to rethink the claim that the green revolution has failed in Africa, and that new irrigation developments are needed, for elimination of poverty. Rather there is a need to understand the differentiating paths of agricultural intensification and commercialisation in local production that have been happening under strong national and global policy influences. There have been some remarkable transformations in irrigated production and livelihoods in the Lower Moshi area, but they are not uniformly accessible to all and especially not to women. If water was more available all farmers could have different experiences.

Gender and intra-household relations in irrigated agriculture

The study shows that the irrigation development intervention has affected and been affected by gender relations in the areas of ownership of plots, division of labour,

intra-household organisation for crop production and distribution of benefits within different categories of households. First, failure to consider the gender relations in land redistribution has caused women to be excluded from the irrigation development intervention because men traditionally controlled land resources. The rice crop introduced was regarded as a man's crop, because it was categorised as a cash crop rather than a food crop. Traditionally there were two types of family plots (for cash and food crop), where gendered rights and responsibilities played an important role. Secondly, household gender relations and labour allocation and distribution were affected. Cultivation of irrigated rice, which used to be men's work, has become more mechanised, but there are still more agricultural activities when cultivating rice. This has resulted in more work for women than men and increased women's work load especially during wet season when women have to work in both rain fed maize plots and irrigated rice plots.

It was useful to study the households within the scheme as domains of cooperation and conflict (Sen 1990). Different forms of cooperation between wives, husbands, household members, relatives and labourers were found in male and female-headed households. These varied with respect to the collective goal of household survival, and for allocating labour to grow enough food or earn enough income to ensure household. Conflict occurred when production failed to meet consumptive requirements or when disagreements surfaced about sharing intra-household surpluses. They also occurred around difficulties in organising labour; especially with the multiple agricultural activities during peak growing seasons and when there was not enough money to hire labourers. Both women and men; especially among subsistence and non-plot holder farmers cultivated what they called 'secret plots' for either fulfilling family or individual needs. Women's labour was necessary for the irrigated rice/maize production and rain fed maize. In commercial households where farmers had good income both women and men were involved in the cooperative organisation of labour and agricultural arrangements. This was easy because of the access to hired labour, needing only supervision. It was more difficult in most subsistence farms when men were engaged in off-scheme employment and women were left to organise labour with little income. They were been found either to physically engage in labour (for themselves and in exchange labour) or sometimes hire workers.

The findings show some similarity across households in men not involving women in distribution and use of benefits from irrigated plots. Where women had plots, in wealthier households, their say in decision-making seemed somewhat more substantial. In the majority of subsistence farming households with few or no irrigated plots and low income, most women were not involved in control and distribution of benefits; yet had to find a strategy to feed the household. The labour contribution of women in average or poor households did not seem to warrant their right to control or distribute income.

Non-participation of women in water management

The participation of women in water management has been difficult because of prevailing gender relations intensified by modernisation within the scheme. Such relations are linked to traditional norms, generational cultures, rules and practices related ownership of resources (Masao 1974; Adams *et al.*, 1997) that used to exist in the highlands were transferred to Lower Moshi. The mentioned elements have made men to become more powerful in water management than women: it has allowed men to be the managers and decision-makers while women remain workers in

watering the plots in irrigated land. As a result of this, there have been no female representatives in any levels of water users' organisations. Although there were no official rules to restrict women's participation, gender norms and relations have been found to restrict women from being active members in water users' organisation meetings where the majority is men.

The lack of representation of women in all levels of decision-making committees means women's voice regarding their needs and priorities were difficult to be heard. This has been mostly influenced by formal membership and traditional institutions dealing with the aspect of water management. Since married women own land through their husbands they are not full members and so cannot represent the formal WUG. Although there are some few women from female-headed households who own land and are formal members, they still did not qualify for membership in the water user executive committee due to traditional influences of division of labour and responsibilities. The traditional influences, women's workload as well as lack of confidence with themselves and a feeling of no importance, all appear to contribute to their lower participation in general assembly meetings. Although a few women (especially from female-headed households) tried to participate in village level meetings, they never contributed any point. Other women participated in the meetings informally as representatives of husbands or as farmers who wanted to hear what is being discussed.

The distribution and allocation of water is organised collectively through the management and Water Users' Association (WUA), according to the rules and conditions set, but water is not equally shared since there have been imbalances between access of men and women to water. The non participation of women in decision-making committees and meetings did not affect them directly, but through other power relations. The distribution and allocation of water has been poor due to manipulation of rules and schedules through power relations, and farmers have generated water allocation solutions according to different working practices like selling and stealing. Such methods intensify unequal power relations among male and female farmers as we as the poor and the rich. The women's participation in other income generation activities did not help them much in empowering them to better allocation of water since most of the income was used for caring of their families. At household level, many women participated in irrigation maintenance, especially in canal repair because their husbands have asked them to participate on their behalf. Moreover, at village level, most women have participated because those who could not participate hired them as labourers. Since the women participate fully in agricultural, irrigation and domestic use of water, it is therefore important for them to be formally involved in water users' organisations. This can improve their bargaining power as water users within households and communities if improved, and help them voice their problems, needs and interests for effective water management and agricultural production.

7.2 Future directions in irrigation interventions and livelihood research

Although irrigation development intervention is useful for increased food production and improved livelihoods of farmers, it is important that detailed studies be carried out to know environmental conditions, the social culture of the people and gender relations (rights, responsibilities, control of resources, division of labour,

values of men and women), livelihood activities, and staple foods. When irrigation development intervention is considered as a policy instrument for improving livelihoods it should use the livelihood approach in its original form with its five capitals (Carney 1998). Only after such a feasibility of study of the area, should consideration for an intervention follow:

First, the technology introduced should be appropriate, manageable and beneficial to all farmers and not only a small selected group of farmers. Complicated infrastructure that is too expensive to be maintained will only jeopardise subsistence farmers instead of helping them. Inappropriate irrigation technology contributes to social disruption among water users and poor maintenance of infrastructure. Farmers are better placed than government or donor agencies to decide at system level.

Second, the crop chosen for cultivation for improved food security and increased income should be of farmers' choice. They know better about the crops that they can afford to cultivate, that are used for staple food and have water requirements that keep water available to all farmers. A choice of crop, which is a cash crop requiring high, inputs attracts farmers who have money while the targeted farmers are excluded.

Third, there should be equitable water and land rights that can also cope with irregularity in water supply. Such considerations are important for differential access to water where there are drought spells within years. Just like the original plans, farmers also thought that, to cope with such problems, building of dams, water harvesting and drilling bore holes could help reduce the water shortage. However, real understanding of options for equitable rights to land and water are needed.

Fourth, more attention is needed to the changing social structures found in the scheme, to know they can support irrigation and especially the role of women in this. This is especially important as male emigration takes family members away to search for waged labour or trading opportunities, while at the same time unknown young males migrate in as hired labour, and investors also migrate in to buy land plots.

Fifth, there should be clear defined policy that considers gender balance in decision-making institutions for irrigation and water management. It is also important for the policy to define specific times and clear processes for handing over responsibilities from donor agency and government to the local farmers. The main WUA and the actors of irrigation scheme management should work cooperatively with farmers (water users) and give them a voice in meetings. The water user members should also include all members who use water in the village not only farmers.

Sixth, attention should be given to establishing credit facilities that can enable farmers to loan cash for agricultural development and also enable farmers to engage into non-farm income activities. From the outset of the research, it has been clear how the livelihood opportunities of men and women have been negatively affected with also great insecurity of livelihoods. This has given clues of poor status of food and nutrition security in the area. New research could provide more understanding of specific household food security issues, poverty and nutrition status of women and children. More research is also needed to address farmers' knowledge on options of irrigated production and irrigation management and other off-farm income activities relevant to their economic conditions and a sustainable environment and their needs towards improvement of their livelihoods.

Such future research will help the success of the irrigation development interventions for small farmers that Africa needs. This argument is inline with what Chambers *et al*. (1989) pointed out that, like all development activities, irrigation

works when it contributes to the individual's needs for subsistence, security and self respect and that the environment can be made valuable by first valuing the people who live in it.

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APPENDICES

Appendix 1

A. Questionnaire for the sample survey (300 farmers)

Section 1

Background information

Name of the village: a) Mabogini b) Rau c) Oria d) Chekereni

Category: Irrigated rice farmer/ Non-irrigated farmer/ commercial/ subsistence

1. Age ……

2. Gender - Male/Female

3. Level of education : a) Primary – 1, 2, 3, 4, 5, 6, 7. b) Secondary - 1, 2, 3, 4, 5, 6
c) Adult education ……..d) Illiterate

4. Marital status - a) Single b) Married c) Divorced d) Separated e) Widow
- a) Polygamy/Monogamy -How many wives?...

5. Household size……..
6. Household composition – number of family members
a) Under five years: How many……M/F
b) 5 years to 18 years: How many …...M/F
c) Over 18 years: How many…….M/F

7. When did you move to the village?
a) 1935-1960
b) 1961-1970
c) 1971-1979
d) 1980-1990
e) 1991-2003

8. Do you own/rent a house/room? Yes/No

Section 2

Irrigated agriculture and livelihoods

Irrigate, crop production and marketing (for irrigated rice farmers)

9. How many plots do you own? …

10. How did you obtain the plots?
a) Inherited
b) Purchased
c) Rented
d) Allocated by village government

e) Bush clearing

11. Have you added other plots after reallocation? Yes/No
    If yes, how?
    a) Inherited
    b) Bought
    c) Rented
    d) Other

12. Have you sold/rented out plots? Yes/ No
    If yes what is the reason?
    a) Lack of water
    b) Could not afford expenses

13. What is the water status in your plots?
    a) Plenty of water
    b) Little water
    c) Hardly get water

    What is the reason?
    a) Due to poor distribution
    b) Location not good
    c) Shortage of water

14. What kind of crops do you produce in irrigated land?
    a) Irrigated rice
    b) Irrigated maize
    c) Vegetables

15. How many seasons do you cultivate irrigated crops per year?
    a) Once
    b) Twice
    c) Thrice

    Why?……

16. Why is the use of tractors a problem?
    a) A small number of tractors
    b) Some farmers use bribes to get their plots cultivated earlier

17. How do you get the inputs for rice cultivation?
    a) Purchase
    b) Get by credit and pay after harvest

18. What kind of labour do use for agricultural activities?
    a) Hired labour
    b) Exchange labour
    c) Family labour

What kind of difficulties do you get from the use of such labor? a) Expensive, can not afford b) Family members have migrated c) Not easy to get

19. How much irrigated rice do you harvest per plot per season (in bags)?
    a) 8-9 bags
    b) 10-11 bags
    c) 12-14 bags
    d) 15-16 bags
    e) 17-18 bags
    f) 20-24 bags
    g) 25 bags

20. Do you cultivate rain-fed maize?
    a) Less than 1 acre
    b) 1 acre
    c) 2 acres
    d) 3 acres

21. How much do you harvest per year?
    a) Less than a bag
    b) 1 bag
    c) 2 bags
    d) 3 bags
    e) 4 bags
    f) More, namely …

22. Why do you cultivate maize?
    a) Use it for food
    b) Can also be sold and money used to meet other needs

23. Which method do you use to sell rice?
    a) Customers come to my plot after harvest
    b) I negotiate before harvest
    c) Have customers outside the scheme

    Why do you use this method to sell rice?
    a) Need money fast
    b) Pays more
    c) Can not afford to buy bags and incur transport costs to sell it elsewhere

24. In what form do you sell rice?
    a) Paddy
    b) Polished rice

    How much do you sell per bag?
    a) Tsh 13, 000 per a bag of 100 kg within plot
    b) Tsh 15, 000 per 100 kg bag outside plot during season
    c) Tsh 18,000-20,000 outside scheme during off-season

25. Which livelihood strategies that households depend most?
    a) Irrigated rice
    b) Both irrigated rice
    c) Rain-fed maize
    d) Other income activities
    e) A combination of income activities for different uses

    Why?
    a) Rice income is enough to take care of our needs
    b) Irrigated rice is used non-food needs
    c) Rice farming is expensive, needs income from other sources

26. What type of income activities do you depend upon?
    a) Less than ten dairy cattle and goats
    b) On-farm labour
    c) Small-scale trade
    d) big business/trade
    e) Well paying employment
    f) Low paying employment
    g) More than ten dairy cattle and goats
    h) Commercial vegetable farming

Non-irrigated rice farmers

27. Have you ever owned irrigated land? Yes/ No.

    If yes, why don't you have it anymore?
    a) Sold it because could not affordable
    b) Sold it because there was no water
    c) I gave it to my children

28. What livelihood strategies do you depend on?
    a) On farm labour
    b) A combination of on farm labour and small scale trade
    c) Small-scale income activities
    d) Large-scale income activities
    e) rain-fed maize
    f) High paying employment
    g) Low paying employment
    h) Rain-fed maize cultivation

29. Why do you combine so many income activities?
    a) Income not enough for the livelihoods
    b) So that I can pay for school fees
    c) For investments in other income activities

Section 3

Gender relations in irrigated agriculture

30. Before the inception of irrigated rice, how was subsistence crop production organised in the households? Who decided for the production of crops? Who were responsible for provision of labour in the plots of different crops? What activities are done by women, men, boys and girls; and what activities are done together? Who was the owner of the plots? Does the participation give more leeway to participate in decision making in the household?

Who were responsible for the benefits and income? Was it men or women? Why?

31. After the inception of irrigated agriculture, rain-fed crops were also being cultivated and other income activities being carried out. How is the organisation of household crop production? Who is responsible for the organisation types of crops to be cultivated as well as labour allocation for agricultural activities? Which activities are done by women, men, boys, and girls; and what activities are done together?

32. How is the organisation of crop production and responsibilities of intra-household activities? Is the division of labour the same as before the inception of irrigated agriculture? What is the reason for this? Do you experience any potential conflicts and compromises arising from individuals?

33. Is the organisation of crop production different among male and female headed households? Why?

34. How is the distribution of benefits among female and male headed households? Who handles the income? Do you get any changes in meeting household needs within homes depending on who is handling benefits? Is the same as before the inception of irrigated agriculture? If changed, what is the major cause of changes?

Section 4

Participation of women in water management

35. What are the criteria used for farmers to be recruited as Water User members within the scheme?

36. How many members from a household are allowed to be members in the water user group?

What members' representatives do the irrigation management committees have? How do they get recruited and for how long?

37. How is gender participation in irrigation management? Are women part of the decision- making organ? What is the ratio of men and women participating in water management decision making committees? Do men and women attend meetings at all levels concerning water management and agriculture? If not, why?

38. What are farmers'' opinion regarding gender participation in Lower Moshi irrigation scheme, and what are the opportunities for improving women

participation so that they can also have benefits. What benefits can farmers get from participation in Water Users' Associations?

39. How is water distributed and allocated at scheme level, village level and among men and women farmers at farm level? Is the distribution and allocation done favourably to meet the requirements for irrigated rice?

40. What water management and maintenance activities are done by women, men, boys and girls? What activities are done together? Why? How is the decision made regarding participating in water management and maintenance activities? Are women willing to participate?

B. Checklist questions for the scheme community

Section 5

The irrigation scheme and its management

41. What is the evolution of the irrigation community in Lower Moshi? When did it start? How did it develop after settlement?

Who were the people who first moved to the community and where did they come from? What reasons made them to move to the area? Did they find people living in the area? What influence did they make on the irrigation and water management within the community?

42. What were the reasons for the decision for the improvements of the irrigation system, before and after irrigation scheme development? What were the improvements made in both incidences? Was it on physical (infrastructure) and irrigation water management? How it before and what is the present situation? What crops were cultivated during the two incidences? What was the reason behind?

43. Did the irrigation system in the old community have more water? Was it without serious water conflicts? Why? What is the water distribution and allocation situation within the modernised irrigation system? Are there any water allocation problems? Why? What have been the strategies toward solutions?

44. How was the operation and maintenance carried out in the old community systems? Is it the same as the present scheme? If not, what are the differences? Who is responsible for the management? How is the money obtained to manage the system and who controls it? Are farmers included in the management? How? Do they face problems between the management, the Water Users' Group and farmers? Has they been solved?

Appendix 2

Tables 1-5 show estimated population in Lower Moshi and in Moshi rural district, food crop production in Kilimanjaro region and diseases associated to irrigated rice production in Lower Moshi.

Table 1 Estimated population of different villages in Lower Moshi 2002/2003

Villages	No of Households	Population				
		Males	Females	Youth	Children	Total
Mabogini	977	2, 916	2,778	1,724	1125	**8543**
Rau River	427	909	963	468	657	**2,997**
Chekereni	951	1,788	2,095	1,699	1,256	**6,838**
Oria	1,394	2,840	2,747	987	1,188	**7,762**
Total	3,749	8,453	8,583	4878	4226	**26,140**
% of population		32%	33%	19%	16%	**100%**

Children = 0-14 years, youth = 15-35 years, adults 36+
* Data that was available in each village government, compiled and calculated by author

Source: Author's Field data 2001/2004

Table 2 Ethnic groups of heads of households (N = 3749)

Tribe	No of households	Percentage (total)	Christians		Moslems	
			No	%	No	%
Wa-Chagga	2137	57	1575	42	562	15
Wa-Pare	675	18	375	10	300	8
Other tribes	937	25	525	14	412	11
Total	3749	100%	2475	66%	1274	34%

*Data adapted from village government offices, compiled and calculated by author

Source: Author's field data 2001/2004

Table 3 Population of Moshi rural districts 1967-2002

	1967	1978	1988	1995	1998	2000	2002
Population ('000)	362	312	341	391	414	475	504
Inter-censual period	1967-78	1978-88	1988-95	1995-98	1998-00		2000-02
Percentage change	-14	9.2	14.7	5.9	14.7	6.1	

Source: National Bureau of Statistics 2002

Table 4 Estimated production of food crops (tones) Kilimanjaro region 1996/7-1999-2000

Crops	1996/97	1997/98	1998/99	1999/2000	Average/Year
Maize	188,912	237,356	226,143	67,913	180,081
Sorghum	864	1,200	946	794	951
Paddy	37, 358	20,149	31,900	35,046	31,113
Beans	20, 714	42,097	35,088	12,809	27,677
Cassava	55,000	52,200	53,390	50,500	52,773
Bananas	39,800	999706	849,175	561,225	612,477
Irish potatoes	41,800	36,000	28,800	35,000	35,400
Sweet potatoes	12,200	72,800	30,440	31,200	36,785
Total	**396,648**	**1,461,508**	**1,255,882**	**794,987**	**977256**

Source: Kilimanjaro Regional Agricultural Office, Moshi 2001

Table 5 Average cases of diseases reported by patients at health centres in Lower Moshi

Type of diseases	1996	1997	1998	1999	2000	2001	2002	2003
Malaria	3914	4290	4899	3220	2390	1080	1160	1530
Schitosomiasis	48	215	112	84	10	12	14	16
Amobiasis	420	321	329	45	28	119	270	56
Types of worms								
Ascaris	98	159	110	39	34	70	286	48
Hookworm	236	240	99	63	15	40	28	20
Ringworm	80	57	59	-	-	-	-	-
Skin diseases								
Scabies *sacroptos*	241	129	54	42	24	18	12	10
Fungus	54	74	76	27	21	21	15	10

*These diseases are associated with irrigated rice production, but most of them have been decreasing over the years due to treatment and prevention

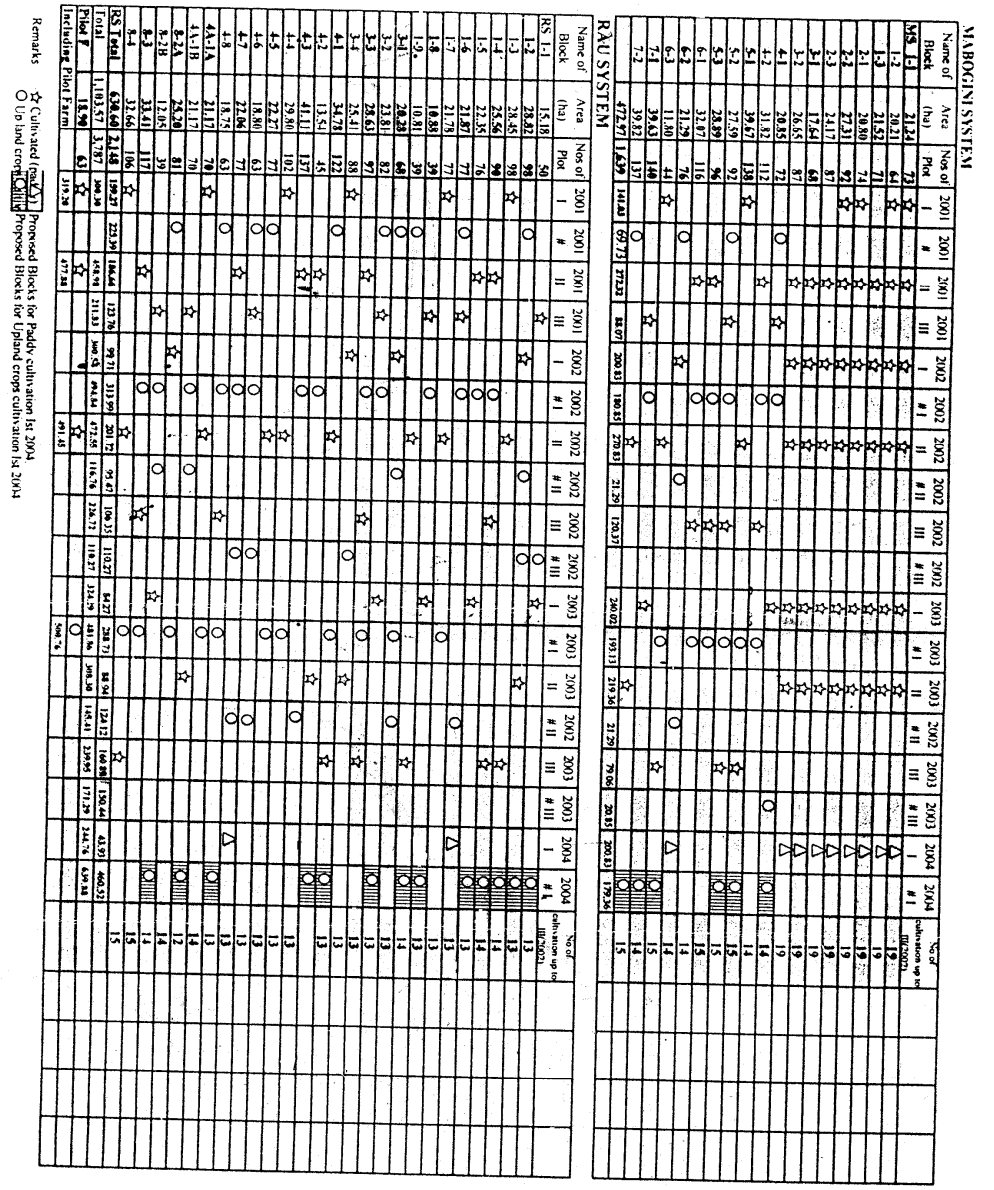
*The data is obtained from the health centres, some of them may not be accurate due poor recording, but they give a clue to the diseases mentioned by farmers during interviews

Source: Compiled from health centres by author 2001-2003

Appendix 3

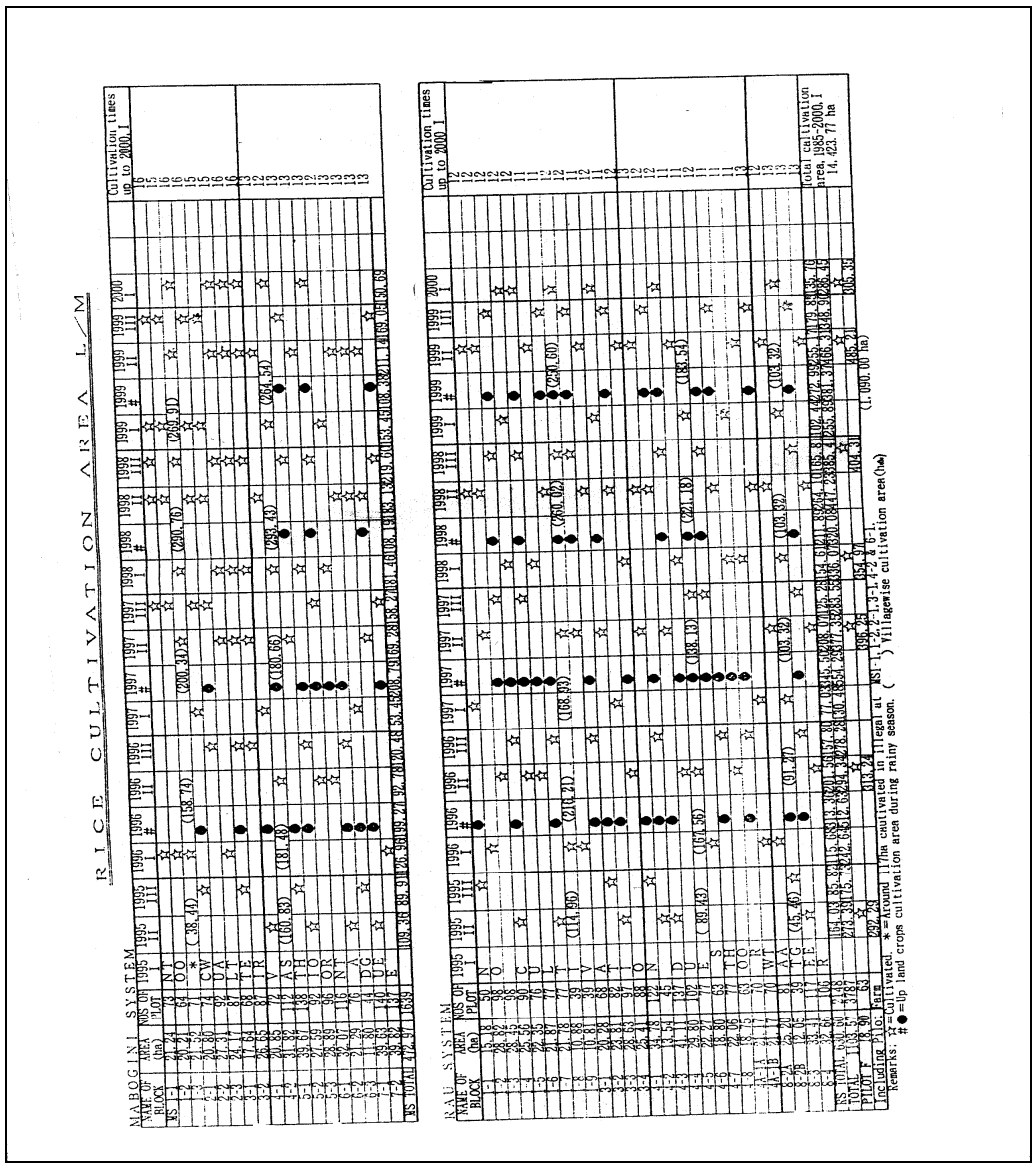
Tables 1 and 2 show cultivated areas (ha) for rice and upland crops in Lower Moshi irrigation scheme (Mabogini and Rau systems)

Table 1 Cultivated area of irrigated and rain fed (upland) crops, proposed blocks for irrigated and upland crops in 2004



Source: KADP Office 2002

Table 2 Rice and upland crop cultivation in Lower Moshi 1994-1998



Source: KADP Office 2002

Appendix 4

Due to problems of water shortage within scheme, some farmers decided to cultivate other crops in their irrigated plots using either rainfall or the little irrigation water. The Tables 1-4, below are production of maize, sunflower, water melon and onions.

Table 1 Production and in put costs for maize (0.3 hectare)

Activities	**Amount in Tsh.**
Maize seeds 2 Kg à Bag 3900 x 3 bags	11,700.00
Ploughing	12,000.00
Planting	10,000.00
Water for irrigation	3,000.00
Urea 1 bag	20,000.00
Labour cost for application	3,000.00
Weeding 2 times à 8,00	16,000.00
Insecticide spraying two times 200mls à 1700.00	3,400.00
Watchman one month before harvesting	4,000.00
Harvesting	10,000.00
Transportation	7,000.00
Shelling of maize	5,000.00
Cost for 10 bags à 400.00	4,000.00
Total	109,100.00
Actual yields = 12 bags/0.3 ha	
Selling price = 18,000.00 x 12 = 216,000.00	
Total revenue – total variable costs	
(216,000.00 – 109,100.00) = 106,900.00	
**Net profit = 106,900.00	
NB: In case the plot is rented then Tsh 20,000.00 has to be deducted	

Source: KADP Records 2002-2004

Table 2 Production and input costs for sunflower (per 0.4 ha)

Description	Sub-total	Total
1. Revenue		
12 bags @ 60 kgs = 720 kgs		
720 kgs x 0.25 (oil content) = 180lts x 1,500.00	270,000.00	
Sunflower seedcake 500kgs x 40 sh.	20,000.00	
		290,000.00
2. Variable costs		
Rental charge	20,000.00	
Ploughing	13,000.00	
Costs of seeds 3 kgs x 4,000.00	12,000.00	
Planting	10,000.00	
Weeding 10000 per acre x 2	20,000.00	
Fertilizer cost 50 kgs Urea	20.000.00	
Fertilizer application 3 md x 1700	4,000.00	
Irrigation costs	8,000.00	
Bird scaring	15,000.00	
Harvesting	10,000.00	
Gunny bags 12 pieces x 400	4,800.00	
Transportation	7,000.00	
Subtotal	143,800.00	
Others (total VC x 10%)	14,380.00	
Total VC	**158,100.00**	**158,100.00**
Gross margin		**131,820.00**

Source: KADP records 2002-2004

Table 3 Watermelon production and input costs for one acre (0.4ha)

Activities	**Amount in Tsh**
Ploughing	13,000.00
Ridging	
7,000.00	
Seeds (250 g)	12,000.00
Holes making	7,000.00
NPK 6 kg	3,000.00
Urea 6 kg	3,000.00
Weeding x 2 à 8,000	16,000.00
Fungicide (Dethane M 45) 2 kg	12,000.00
Insecticide (Selecron 1 litre)	22,000.00
Harvesting (once)	10,000.00
Total costs	105,000.00
Output	
Yield: Plants: 500 x 3 fruits x 3kg = 4,500 kg	
Income: 4,500 kg x Tsh 100/= = Tsh 450,000.00	
GM expected: Tsh 450,000.00 – 105,000.00 = Tsh 345,000.00	

Source: KADP records 2002-2004

Table 4 Onion production and input cost for 1 acre (0.4 ha)

Activities	**Amount in Tsh**
Plot rental charge	20,000.00
Ploughing	13,000.00
Harrowing	8,000.00
Preparation of seeds 500 Tsh/plot x 106 plots	53,000.00
Nursery cost:	
Preparation 500Tsh/plo x 20 plots	10,000.00
Nursery care 2 x 1,800.00 man days x 30 (20 plots)	108,000.00
Cost of seeds 2 kg x Tsh 40,000.00	80,000.00
Transplanting	50,000.00
Weeding (106 plots) 2 times	180,000.00
Fertilizer cost 80 kg of urea x 300	40,000.00
Fertilizer application (2 times)	10,000.00
Irrigation cost	30,000.00
Insectcide cost (Selecron 0.5 litres)	11,000.00
Insecticide application	5,000.00
Harvesting 106 plots	90,000.00
Gunny bags (2nd hand) 100 pcs x Tsh 600/=	60,000.00
Transportation 100 bags x Tsh 1000/=	100,000.00
Sub total cost	868,000.00
Others (total VC x 10%)	86,800.00
Total VC	**954,800.00**
Actual yield = 100 bags @ 120 kg / 0.4ha 100 bags @120 kg x 25,000 = Tsh 2,500,000.00 (Total revenue – Total variable cost) Tsh 2,500,000.00 – 954,800.00 = Tsh 1,545,200.00	

Source: KADP records 2002-2004

SUMMARY

This thesis is a study of a modernised irrigation scheme in Tanzania. It aims to understand how irrigation and agricultural technologies have interacted with local society to transform production, paying particular attention to gender relations and changes for women farmers. The thesis seeks to contribute to a better understanding of what kinds of livelihood and production changes (negative and positive) eventuate under 'modernised' irrigation systems, and how these contrast with conditions under the older local irrigation systems the scheme has replaced. The central research question of the thesis is to understand how irrigation modernisation in the 1980s shaped, and has been reshaped by, the livelihood needs and options of water users. The thesis analyses the initiatives and interactions of agents at various levels – i.e. international, national, community and farm levels – as they attempt to make use of and adjust to the technical and operational demands of a modern scheme. In methodological terms, this thesis is guided by a technographic approach, as advocated by Richards (2002), Richards (2007) and Bolding (2005). A technographic approach 'focuses on the complex interactions between social groups, collective representations, innovation processes, technical artifacts and nature'. In this case technography is applied to a socio-technical institution, the Lower Moshi irrigation scheme, located in semi-arid lowland terrain at the foot of Mount Kilimanjaro.

The research work took place over three seasons. In addition to careful examination of project documentation, and interviews with project staff, the study also undertook a randomised sample survey of 300 farmers in the four main project area settlements, and made detailed observational studies across the agricultural cycle of a smaller number of farm holdings owned and operated by both men and women farmers. Since only about 30% of farmers within the scheme actually cultivate irrigated plots sampling was designed to ensure proper representation of non-irrigating farmers, since the activities of this poorer (non-irrigating) group is crucial to the understanding the socio-economic dynamics of the scheme more generally. Finally, some attention was paid to off-scheme communities. Many of the technical problems experienced by the scheme (notably, the failure to distribute water in volumes originally planned) relate to concurrent socio-economic and technical changes taking place in up-stream communities, in particular, and an account is offered of some aspects of these off-project agro-technical changes, and of the disputes that then arose over water rights.

The thesis first offers an historical summary of irrigation in the Kilimanjaro region, based on secondary sources and project documentation. In this part of Africa the mountains are wet and forested, and the surrounding plains are dry. The Chagga people (Wa-Chagga) were densely populated on the mountain, farming the wetter slopes intensively in the 19th century, and it was an aim of colonial government to resettle "excess" population in the plains. Some development of irrigation took place from the 1920s to encourage this relocation of population, and a diverse population (mainly but not exclusively Wa-Chagga) settled in Lower Moshi district to farm, assisted by possibilities of irrigation. After independence, the Japanese government offered funding and technical assistance to the Tanzanian government to modernise, re-develop and extend irrigation in Lower Moshi, and a new scheme came into operation in the 1980s, with a strong emphasis on intensive rice production, using high-yielding (Green Revolution) semi-dwarf varieties such as IR54.

The central finding from this part of the analysis (covered mainly in Chapters 1 and 2) is that the planners did not sufficiently take into account that irrigation in Lower Moshi and among Wa-Chagga and neighboring populations was no new thing. Many of the technical and social problems the scheme subsequently faced can be traced to the fact that farmers were already familiar with irrigation techniques and had developed traditional institutional arrangements to handle water rights and labour burdens. Farmers outside the scheme undercut it by being quick to adopt some project innovations, and to adapt their own practices accordingly. They also diverted water from flowing into the scheme, arguing that access to water from the mountain was an established traditional right under British rule, and still respected by the independent government of Tanzania. The scheme thus failed to develop the area originally intended, and is chronically short of water, undermining the confidence of farmers within the scheme in its management procedures. A further important finding is that women were largely excluded from the associations involved in traditional irrigation water management (apart from providing labour on specific occasions) and gendered notions of task and property rooted in local tradition have continued to influence land inheritance and water rights within the modern scheme.

Actual as opposed to planned workings of the scheme are addressed in Chapters 3 and 4, and an account is offered of the introduction of new agricultural technology. Impacts or changes in relation to crop production, hired employment and other production strategies, and income distribution among population are discussed, along with impact on livelihoods. The scheme has had a highly layered impact. Those able to secure plots with reliable water do, indeed, make money out of intensive rice production, but the percentage is rather small, since the project is not able to irrigate reliably, or at all, many areas within the scheme. Farmers in tail end areas with unreliable water, or able only to farm land the project has never succeeded to irrigate, lack the capacity to influence management to change water distribution in their favour. The scheme lacks capital to invest in technical solutions to inadequate water distribution, but in any case the major problem lies in reduced flow, in part a product of up-stream diversions by non-scheme farmers. The project management has failed to assert its legal water right, since the government agrees that traditional rights also apply. Scheme management and maintenance suffer as a result. Farmers without water do not see why they should help maintain the scheme or pay dues. Some solve their problems by becoming “free riders” and acquire water by illegal means; others focus on (less profitable) dry-land crops. A range of these conflicts is examined, including contradictions between different classes of scheme settlers, e.g. wealthier farmers with better access to the scarce water and poorer farmers (including women plot owners) found in tail end areas. A complex interaction of modern property regimes and customary values in the modernisation process is reported. Irrigation project managements in Africa need to take account of these legal and cultural complexities.

Intra-household gender relations are a specific focus in the later chapters of the thesis (5-6). Women play a crucial role in the agricultural labour process, both in irrigated and non-irrigated agriculture. They are (by custom) the major providers of household food, while husbands focus on earning cash for other household expenses. The introduction of a cash crop (rice) complicates this division of responsibility. Women continue to provide labour on irrigated plots, but men assume the main decision making role. A small number of women has acquired rights to irrigated land on the scheme (through purchase or inheritance) but a majority are in the position of farm workers or tenants. Irrigated rice increases women's labour burdens and

responsibilities, since this is a cash crop and they still have to work on household food crops as well. The scheme has continued to show many of the problems of public irrigation development in Africa since the 1970s discussed in the introduction. However, the situation in Lower Moshi is not as reported for parts of (West) Africa, where women have been supplanted by men in (modernised) rice farming. Here women never enjoyed rights over irrigated crops. What has happened on the scheme is that their burdens have intensified. In cases where women have no husbands they tend to be among the poorest farmers residing within the scheme, with little reliable water or farming only rain-fed crops. In short, the scheme has widened the gap between rich and poor, and intensified existing gender inequalities, in regard to ownership of plots, agricultural output, division of labour, and coping strategies. The thesis also shows that there are strong gender differentials in water rights and in participation in water management. Alienation of women from management and repair undermines scheme renewal. Irrigation management must develop a stronger focus on gender issues to overcome challenges of inequitable water access, if it is to provide any wider opportunities for better livelihoods, food security and nutrition in the area.

SAMENVATTING

Dit proefschrift is het resultaat van onderzoek naar een gemoderniseerd irrigatiestelsel in Tanzania. Het beoogt inzicht te geven in hoe technologie voor irrigatie en landbouw in wisselwerking met de lokale gemeenschap de productie heeft veranderd, met specifieke aandacht voor genderverhoudingen en veranderingen voor vrouwen. Het proefschrift poogt bij te dragen aan een beter begrip van het type veranderingen in levensonderhoud en productie (in negatieve en positieve zin) voortkomend uit 'gemoderniseerde' irrigatiestelsels en hoe deze contrasteren met de omstandigheden in de oudere, lokale stelsels die hiervoor moesten wijken. De centrale onderzoeksvraag van het proefschrift is hoe de modernisering van irrigatie in de jaren '80 ingreep in en zelf werd beïnvloed door de behoefte in levensonderhoud en speelruimte van gebruikers. Het proefschrift analyseert de initiatieven en interacties op verschillende niveaus (internationaal, nationaal, gemeenschaps- en bedrijfsniveau) in de aanzet tot gebruik en aanpassing van de technische en operationele vereisten van een modern stelsel. Wat betreft de methodologie is dit proefschrift een toepassing van een technografische aanpak, zoals beschreven door Richards (2002), Richards (2007) en Bolding (2005). Een technografische aanpak 'richt zich op de complexe interacties tussen sociale groepen, collectieve representaties, innovatieprocessen, technische artefacten en de natuurlijke omgeving'. De technografie is hier toegepast op een sociotechnische institutie, het *Lower Moshi* irrigatiestelsel, gelegen in het semi-aride laagland aan de voet van Mount Kilimanjaro.

Het onderzoek vond plaats over meerdere seizoenen. In aanvulling op zorgvuldige bestudering van projectdocumenten en interviews met de projectstaf is er een enquête gehouden onder een aselecte groep van 300 boeren in de vier vestigingsgebieden van het project en zijn er gedetailleerde observaties gedaan van de landbouwcyclus van een kleinere groep boerenhuishoudens, in eigendom van en gerund door zowel mannen als vrouwen. Aangezien slechts 30% van de boeren in het stelsel daadwerkelijk geïrrigeerde velden bewerkt, was de steekproef zo opgezet dat ook niet-irrigerende boeren goed werden vertegenwoordigd, aangezien de activiteiten van deze niet-irrigerende groep cruciaal zijn voor een goed begrip van de sociaaleconomische dynamiek van het stelsel in het algemeen. Als laatste element is er ook aandacht besteed aan activiteiten van gemeenschappen buiten het stelsel. Veel van de technische problemen die zich voordoen in het stelsel (in het bijzonder het niet kunnen leveren van de geplande hoeveelheden water) zijn gerelateerd aan gelijktijdige sociaaleconomische en technische veranderingen die plaatsvinden in de bovenstrooms gelegen gemeenschappen en een weergave van enkele van deze agrotechnische activiteiten buiten het stelsel laat zien hoe dit heeft geleid tot geschillen over waterrechten.

Het proefschrift biedt eerst een historische weergave van irrigatie in de regio Kilimanjaro op basis van secundaire bronnen en projectdocumenten. In dit deel van Afrika zijn de bergen bebost en humide en de omliggende vlaktes droog. In de negentiende eeuw leefde het Chaga volk (*WaChagga*) dicht opeengepakt op de berg, waar ze de natte hellingen intensief bebouwden. Herhuisvesting in het laagland was een van de doelstellingen van de koloniale overheid. De ontwikkeling van irrigatie vond plaats vanaf ongeveer 1920 om de bevolking tot verhuizing aan te zetten. Een

diverse groep mensen (voornamelijk maar niet uitsluitend *WaChagga*) vestigde zich in het *Lower Moshi* district om landbouw op te zetten, ondersteund door de mogelijkheden tot irrigatie. Na de onafhankelijkheid gaf de Japanse overheid financiering en technische ondersteuning aan de Tanzaniaanse overheid om irrigatie in *Lower Moshi* te moderniseren, verbeteren en uitbreiden. Een nieuw stelsel werd in gebruik genomen in de jaren '80 met een sterke nadruk op intensieve rijstverbouw, gebruik makend van de hoogopbrengende (Groene Revolutie) kortstrovariëteiten zoals IR54.

De belangrijkste bevinding van dit deel van de analyse (te vinden in Hoofdstuk 1 en 2) is dat de planners van het stelsel er onvoldoende rekening mee hebben gehouden dat irrigatie in *Lower Moshi* en bij de *WaChagga* en omringende volken geen nieuw fenomeen was. Veel van de technische en organisatorische problemen waarmee het stelsel vervolgens had te kampen, zijn terug te voeren naar het gegeven dat de boeren bekend waren met irrigatietechnieken en regelingen op basis van traditionele instituties hadden ontwikkeld om waterrechten en arbeid te verdelen. Boeren buiten het stelsel haakten aan door eveneens bepaalde innovaties uit het project over te nemen en hun eigen praktijk derhalve aan te passen. Deze boeren voorkwamen ook dat water naar het stelsel zou stromen, redenerend dat het recht op water van de berghelling een traditioneel recht was, bevestigd door het Brits gezag en nog steeds gerespecteerd door de onafhankelijke Tanzaniaanse overheid. Het stelsel slaagde er dus niet in het geplande areaal in ontwikkeling te brengen en heeft een structureel watertekort waardoor het vertrouwen van de boeren in het beheer van het stelsel is ondermijnd. Een ander belangrijke bevinding is dat vrouwen merendeels werden uitgesloten (met uitzondering van specifieke taken) van de samenwerkingsverbanden waarmee het water van oudsher werd beheerd en dat traditionele genderbepaalde ideeën over taken en eigendom werden bestendigd en invloed hadden in de vererving van land en waterrechten in het moderne stelsel.

De werkelijke en geplande werking van het stelsel worden behandeld in Hoofdstukken 3 en 4, gevolgd door een weergave van de introductie van nieuwe technologie. De impact en veranderingen in de gewasproductie, ingehuurde arbeid en andere productiestrategieën, inkomstenverdeling binnen de bevolkingsgroepen en de effecten voor de voorzieningen in het levensonderhoud worden eveneens besproken. De impact van het stelsel heeft een sterk gelaagde omvang. Degene die een veld in bezit houden met stabiele watertoevoer zijn verzekerd van inkomsten uit intensieve rijstteelt maar hun aandeel in het stelsel is gering aangezien het stelsel nauwelijks in staat is om water op een betrouwbare wijze te leveren terwijl de meeste delen van het stelsel helemaal droog staan. Boeren in de benedenstroomse delen met onbetrouwbare watertoevoer of zij die land bewerken dat nog helemaal niet door het project is ontgonnen, ontbreekt het aan invloed om de waterverdeling in hun voordeel te wijzigen. Het stelsel heeft een gebrek aan middelen om te investeren in technische oplossingen voor een inadequate waterverdeling maar hoe dan ook is er totaal gebrek aan water, deels het gevolg van bovenstrooms watergebruik door boeren van buiten het stelsel. Het projectmanagement bleek niet in staat het formele recht op water te materialiseren aangezien de overheid eveneens het traditionele waterrecht erkend. Zowel het beheer als het onderhoud van het stelsel hebben daar onder te leiden. Boeren die geen water krijgen zien geen reden om bij te dragen aan het onderhoud of te betalen voor hun aandeel. Sommigen lossen hun problemen zelf op en tappen als *free riders* illegaal water af, anderen richten zich op (minder opbrengende) droge landbouwgewassen. Verschillende van deze conflicten zijn

onderzocht, inclusief tegenstrijdigheden tussen verschillende klassen van boeren in het stelsel, bijvoorbeeld rijkere boeren met betere toegang tot het schaarse water en armere boeren (inclusief vrouwelijke grondeigenaren) in de benedenstroomse delen. Een gecompliceerde wisselwerking tussen moderne eigendomsverhoudingen en gewoonterecht in het moderniseringsproces is het gevolg. Projectontwikkelaars van irrigatie in Afrika moeten beter zijn voorbereid op deze juridische en culturele complexiteit.

Genderverhoudingen tussen huishoudens zijn het onderwerp in de verdere hoofdstukken van het proefschrift (5-6). Vrouwen spelen een cruciale rol in het arbeidsproces in de landbouw, zowel in de geïrrigeerde als de niet- geïrrigeerde landbouw. Zij zorgen (van oudsher) voor de voedselvoorziening, terwijl de mannen een inkomen verdienen waaruit de overige uitgaven betaald kunnen worden. De introductie van een marktgewas (rijst) compliceerde deze taakverdeling. Vrouwen bleven arbeid leveren op de geïrrigeerde gronden maar de mannen gingen er vanuit dat zij zeggenschap hadden. Een kleine groep vrouwen had rechtmatig toegang gekregen tot geïrrigeerde velden in het stelsel (door aankoop of uit een erfenis) maar de meerderheid van de vrouwen is landarbeider of pachter. De geïrrigeerde rijstverbouw verhoogt de arbeidsdruk en verantwoordelijkheden van vrouwen aangezien het een martkgewas is en zij eveneens nog voedselgewassen moeten verbouwen.

Het stelsel vertoont vele van de problemen in de ontwikkeling van overheidsgestuurde irrigatie in Afrika sinds de jaren ’70, zoals in de inleiding is aangehaald. De situatie in Lower Moshi wijkt af van andere delen van Afrika (m.n. West Afrika) waar de traditionele taken van vrouwen in de rijstverbouw in de (moderne) geirrigeerde stelsels geheel zijn overgenomen door mannen. In Lower Moshi hebben vrouwen nooit rechten gehad in geïrrigeerde gewasverbouw. Door het stelsel is hun takenpakket verzwaard. Vrouwen die geen man hebben, zijn de armsten in het stelsel met nauwelijks garantie op water of enkel droge landbouw bedrijvend. Kortom, het stelsel heeft de kloof tussen arm en rijk vergroot en bestaande genderongelijkheid versterkt met betrekking tot eigendom van velden, opbrengsten uit de landbouw, verdeling van arbeid en de mogelijkheden om te overleven. Het proefschrift laat ook zien dat er sterke genderverschillen zijn in de waterrechten en de participatie in het waterbeheer. Vervreemding van vrouwen ten aanzien van het beheer en onderhoud ondermijnt de verbetering van het stelsel. Irrigatiebeheer moet zich meer richten op genderverhoudingen om de problematiek van ongelijke waterverdeling het hoofd te bieden indien het bij wil dragen aan meer mogelijkheden om in het levensonderhoud te voorzien en aan voedselzekerheid en kwaliteit van de voeding in het gebied.

ABOUT THE AUTHOR

Kalunde Kissawike was born and raised in Tanzania, where she attained her primary and secondary levels of education. But the author had opportunities of visiting and live in various African, United States of America and European countries for number of years at young age. She pursued her Bachelor degree at Agricultural and Technical State University at Greensboro and her best performance qualified her to immediately join the University of North Carolina at Greensboro in the United States where she obtained her Masters in Science degree in the 1980s. Her major studies were Foods, Nutrition and dietetics, Home Economics, with a minor in sociology of family. After her enrolment in the program she had interest and plan of being involved in nutrition interventions to reduce the problems of malnutrition in Tanzania through a preparation of low cost diet to feed children in order to improve their health. With this kind of plan in mind she opted to conduct a Masters' research titled "Effects of zinc on protein in the growth of young weanling rats". It was a pure laboratory work, which involved feeding the rats (for a period of time) to a prepared diet of different proportions of vitamins and minerals, watching their weight gain, examination of their blood samples and ashing of their liver samples for analysis of minerals. While in the USA the author widened her interest towards the knowledge of nutrition of old people, and therefore followed short courses program offered at the University of California in Los Angeles and was qualified for a certificate in Gerontology.

After completion of studies and her return to Tanzania, in July 1987, the author was employed by Sokoine University of Agriculture in Morogoro, in the department of Food Science and Technology, the section of Human Nutrition and Home Economics studies until to date. From that year, she had been involved in teaching courses of Human Nutrition, Food security and Home Economics. She was also involved in various research activities under the same profession in various urban and rural areas of Tanzania. The author has participated several short courses, seminars, workshops and conferences in the 1990s and early 2000 in various countries outside and within Tanzania. Most of such experiences were more in the area of Nutrition and community development. Some examples of short course programs included International Public Nutrition, Food security, and Public Health in Oslo, Norway, Promotion of rural development in the tropics and sub-tropics (Food and Agriculture development Centre at Feldafing, Germany, Management of Agricultural colleges at Windhoek, Namibia, Gender, agriculture and household food security in Tanzania etc. These rich experiences changed interests of the author from laboratory to community development issues. With this kind of change of mind set, the author began to be more involved in community development problem solving related activities. For example in 1993 she was among researchers who were involved in a national consultancy work with FAO, on the study of "Effects of HIV/AIDS on Agricultural production systems and food security in three regions (Mbeya, Rukwa and Tanga) of Tanzania". This study was part of other studies conducted in Uganda and Zambia, which was followed by an international workshop held in Dar-es-Salaam in Tanzania.

After the author was admitted for PhD program in Wageningen University, she undertook selected courses in irrigation, gender in irrigation and irrigated

agriculture, food security, land management and other methodology courses in order to prepare for research in irrigation community. The exposure to the new research experiences of irrigation development intervention in Lower Moshi, has widened the author's future research plans toward other development interventions in the area of gender, food security and nutrition, and other irrigation and irrigated agriculture issues, which aim to solve livelihood and rural development problems in various communities.

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