PN-ACA-564

FROM THE GROUND UP
CASE STUDY SERIES - NO. 6

Indigenous Knowledge in Resource Management: Irrigation in Msanzi, Tanzania

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November 1994

Edited by
Center for International Development and Environment
World Resources Institute

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Published in Kenya by
World Resources Institute (WRI)
Center for International Development and Environment
1709 New York Avenue, NW, Washington, DC 20006 USA
Tel.: (1-202) 638-6300; Fax.: (1-202) 638-0036
Tlx.: 64414 WRI WASH

and

Acts Press
African Centre for Technology Studies (ACTS)
P.O. Box 45917, Nairobi, KENYA
Tel.: (254-2) 565173, 569986
Fax.: (254-2) 569989

Printed by English Press Ltd.
P.O. Box 30127, Nairobi, KENYA

Cataloguing-in-Publication Data

Indigenous knowledge in resource management: irrigation in Msanzi, Tanzania/ Ophelia Mascarenhas and Peter G. Veit. Washington, DC, USA: World Resources Institute and Nairobi, KENYA: Acts Press, African Centre for Technology Studies (ACTS), 1994.

(World Resources Institute (WRI) and African Centre for Technology Studies (ACTS) From the Ground Up Case Study Series; 6)

Bibliography: p.

ISBN 1-56973-007-5

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Series Introduction

In 1987, the Center for International Development and Environment of the World Resources Institute, in collaboration with African development institutions and Clark University's International Development and Social Change Program, initiated an ambitious program in Africa known as **FROM THE GROUND UP**. The program seeks to increase local, national, and international institutions' capacity to strengthen community management of natural resources. The guiding belief of **FROM THE GROUND UP** is that important insights can be gained by analyzing effective community-level efforts in natural resource management. In practical terms, taking this approach means identifying communities that are already pursuing ecologically sound self-development and analyzing the reasons behind their success—local leadership, viable institutions, suitable technologies, etc. Collaborating institutions in Africa have studied and documented the cases in the series to date; manuscripts by other African organizations on successful local initiatives in sustainable development can be submitted to the Manager of the **FROM THE GROUND UP** program to be considered for publication.

FROM THE GROUND UP shares the results of its case studies and their policy implications with other communities, national policymakers, and the international development community. Publications, conferences, workshops, training programs, radio, and video are all used to reach these audiences. Over the long term, these findings will promote decentralized small-scale natural resource management policies, influence the allocation of development resources to the grassroots, and foster self-reliance and sustainability within the communities.

WRI's **FROM THE GROUND UP** case study series is designed for professionals in the development community—governmental and nongovernmental development and environment planners and field workers, international and national development assistance officers, and concerned academics. The series is intended to inform policy-making, stimulate discussion on environment and development, and fit into training programs for development officers. The African Centre for Technology Studies, based in Nairobi, Kenya, and WRI are jointly publishing the **FROM THE GROUND UP** series for distribution in Africa and elsewhere.

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Acknowledgments

This report was made possible through the assistance and support of several people and organizations. We would first like to thank the people and leaders of Msanzi village who welcomed the research team into their community, provided accommodations, and gave of their time to participate in the research. Special mention must be made of the village chairman, Alberto Kifulo; the village secretaries, Noel Kazumba (1989) and M. Kisanga (1990); Sebastian Chumia, son of Chumia Mulela (who introduced drainage/irrigation into Msanzi); and Bedo Linso, Chairman, Msanzi Irrigation Committee.

We would also like to thank those government officials in Rukwa Region whose assistance was invaluable in bringing this report to fruition. In that regard, we are especially indebted to Mr. Mwingira, Planning Officer, Rukwa Development Programme, Rural Development Programme (RUDEP); Graham Tesky, RUDEP Coordinator; Thorhild Elizabeth Borud, RUDEP Community Development Advisor; E. Masuki, Project Officer, RUDEP Irrigation and Horticulture, in charge of implementing the Msanzi Irrigation Project; and Mrs. Mtemi, Community Development Officer, Sumbawanga District.

Paul Manda, a sociologist from the University of Dar es Salaam, participated in the initial field research in Msanzi and established a good working relationship with the village elders and the secretaries. Faustin Maganga, of the Institute of Resource Assessment, University of Dar es Salaam—whose interests are in regional planning—participated in the follow-up field study in 1990 and assisted with household interviews and application of the Participatory Rural Appraisal methodology.

Grateful acknowledgment is also made to various members of the Steering Committee of the **FROM THE GROUND UP** (FGU) program for their advice, particularly Richard Ford (Clark University, USA), David Richards (formerly of the World Resources Institute, USA), Adolfo Mascarenhas (University of Dar es Salaam), and Liberty Mhlanga (Zimbabwe). Discussions on the concept and purpose of the FGU program held during two early steering committee meetings—in Harare in 1988, and in Nairobi in 1989—were instrumental in shaping the research for this particular study as were Thomas Fox's (WRI) comments on the first FGU case study in Tanzania, conducted in Ulinji Village, Rukwa Region.

Funds for research and analysis were provided by the United States Agency for International Development (USAID) and Pew Charitable Trust through WRI, for which grateful acknowledgment is made. Editorial and production assistance was provided by Kathleen Courrier, Hyacinth Billings, Lauren Morris, and Elizabeth Schandelmeier at WRI and by Seth Beckerman and Mike Berdan. Final production work was handled by *Dynamic Desktop Services*.

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In Msanzi community in southwest Tanzania, farmers have been effectively utilizing irrigated agriculture for more than 60 years. In 1933, one Msanzi farmer designed and orchestrated the construction of a small canal to use flood water from a nearby river to irrigate a small coffee plantation on an adjoining plain. In 1966, a group of farmers, led by the original farmer's son, constructed a community-wide, gravity-fed, furrow-based irrigation and drainage system based on his father's thirty-year-old system. This second-generation irrigation system supplemented and expanded rain-fed agriculture, established dry-season cultivation, and protected farms from flooding during the rainy season.

Since its establishment nearly thirty years ago, the second system has been significantly expanded—by the early 1980s, approximately 110 hectares were under irrigation. Working together, the farmers of Msanzi have adapted and improved their system to overcome critical constraints, obstacles, crises, and external "shocks."

Six factors frame effective water management and irrigated agriculture in Msanzi:

- Several crises that disrupted agricultural production and adversely affected human welfare provided the incentives to construct, and then rehabilitate, the system.

- Both the water-management system and the resulting irrigated agriculture are the result of pioneering and leadership from local innovators.

- Local leaders have used their power and influence to infuse new ideas and techniques, mobilize local labor and resources, and manage the system.

- Irrigated agriculture is possible because of important natural resource assets—in particular, reliable water sources, fertile soils, and available labor.

- Cash cropping opportunities have provided important incentives to manage water for agricultural production.

- External assistance—especially, technical assistance—has been critical to the continued functioning of the irrigation system.

This study of a single community in Tanzania has implications for other farmers, government officials, and development assistance officers concerned with local-level natural resource management—especially water management for irrigated agriculture. Section IV of this report offers specific recommendations for regional, national, and international policy-makers and program implementors in regard to the roles that local innovators, indigenous knowledge, and traditional practices play in managing natural resources for socioeconomic development.

I. Introduction

Situated on the East African coast, Tanzania, which includes the islands of Zanzibar and Pemba, has a total area of 945,087 square kilometers, 886,040 of which are land. The population, which has been growing at an annual rate of about 3 percent, was estimated to be 26 million people as of 1990 (WRI 1994). The country is culturally diverse with more than 120 ethnic groups, no one of which accounts for more than 10 percent of the total population. There are sharp variations in the distribution of this population: 64 percent of the people live on 20 percent of the land. The highest population densities—more than 250 people per square kilometer (the national average is 29.3) —occur in urban centers, on fertile upland areas, and along the shores of Tanzania's many lakes (Mascarenhas, A. 1983; Maro 1990). In the 1960s, Tanzania was one of the most rural countries in Africa; but by 1995, almost 25 percent of the population is expected to be living in urban centers (GOT 1981/1983a, 1988; WRI 1994).

Tanzania is also ecologically diverse: it includes both Africa's highest and lowest points—Mt. Kilimanjaro (5,950 meters) and the floor of Lake Tanganyika (358 meters below sea level). Most of the country is situated on the East African Plateau (1,000 - 1,500 meters above sea level), which is itself broken by several mountain ranges. These include geologically old mountains (the Pares, the Usambaras, the Uluguru, and other low ranges that form the Eastern Arc), as well as some created relatively recently through volcanic activity (Mt. Kilimanjaro and Mt. Meru in the north, and the Rungwe Mountains in the south). Numerous depressed areas and lakes, including portions of Lakes Victoria, Tanganyika, and Malawi, complete the landscape.

Nearly one-half of Tanzania's land is classified as forest (approximately 1.5 percent of the country is closed-canopy forest), and about 40 percent is permanent pasture (GOT 1989, 1994; Hamilton and Bensted-Smith 1989; Newmark 1991).[1] About 21 percent of mainland Tanzania receives more than 750 millimeters of rainfall with 90 percent probability, and approximately 3 percent receives more than

1 About 26 percent of the country is in the public estate. Sixteen percent of this land is fully protected.

1,250 millimeters (Morgan 1969; LRDC 1987). Nearly 90 percent of the country has sufficient rainfall for arable production of at least drought-tolerant sorghums and millets (LRDC 1987).

Despite the agricultural potential of the land, only about 7 percent of the country is cultivated; of this, less than 2 percent is irrigated (GOT 1982a, 1989, 1993, 1994; Mascarenhas, A., et al. 1985; FAO 1987a; LRDC 1987; DANIDA 1989). Despite these low percentages, agriculture accounts for nearly two-thirds of the gross domestic product (GDP), more than 80 percent of export earnings, and provides a livelihood for most of the economically active population (LRDC 1987; UNDP/WB 1989; ADB 1991; WB 1992; WRI 1994). More than 85 percent of the cultivated land is under small-scale farming (i.e., family plots averaging less than 2.5 hectares). An estimated 50 percent of total agricultural output—including nearly all food crops, 80 percent of export crops, 98 percent of cattle (approximately 13 million head), and virtually all small livestock (including about 13 million sheep and goats)—are produced by these smallholders (GOT 1982a, 1983b, 1984, 1993, 1994; Kauzeni 1988; DANIDA 1989; Havnevik 1989; UNDESD 1993; WRI 1994).

Following independence in 1961, agricultural production grew at an annual average rate of 4.9 percent (as measured in constant prices). Between 1969 and 1984, however, that rate declined to less than 1.9 percent. This mirrored a general decline in economic performance: between 1969 and 1974, the average annual GDP growth rate was 4.8 percent, but from 1978 to 1985 the rate was only 0.9 percent (IBRD 1961; UNDP/WB 1989; WB 1989, 1992; ADB 1991; WRI 1994). Beginning in the mid-1970s, the economy was adversely affected by public policies and expenditures promoting socialism and self-reliance. A national policy of resettling the scattered rural population into government-sponsored villages drastically affected production. Other adverse factors included petroleum price increases, droughts, the war with Uganda, and the break-up of the East African Community. Although the government was able to significantly improve education and health services during the 1960s, by the early 1980s these gains could not be sustained because of the overall economic downturn (Kauzeni 1988; WB 1989).

In 1986, Tanzania embarked on an Economic Recovery Programme (ERP) that involved devaluating the currency exchange rate, liberalizing imports and exports, and establishing higher producer prices. As a result, agricultural output and export earnings increased, while inflation declined. Since 1986, the annual growth rate of the gross national product (GNP) has averaged more than 5 percent (UNDP/WB 1989; WB 1989, 1992; ADB 1991). While the ERP has improved the national economy, few of those benefits have reached rural populations. Instead, aspects of the ERP have further undermined living conditions for the rural poor. With a per capita GNP of only U.S. $110, Tanzania ranked as the world's second poorest country in 1991 (WB 1992).

Despite the negative impacts of some public actions, many communities in Tanzania have achieved some form of sustainable socioeconomic development. A field study undertaken in Msanzi village in

southwest Tanzania examined an indigenous irrigation and water-drainage system that has increased agricultural production (through both expansion and intensification) and improved the well-being of the local citizenry. The purpose of this study was to analyze the critical factors that led to effective water-management practices in Msanzi and to identify those policy and program options that could encourage other rural communities to make similar developmental advances. In a country where government-designed, "modern" large-scale irrigation schemes have proven to be too expensive to construct, maintain, and manage (and whose benefits are often dubious), the experiences of the Msanzi community offers a particularly valuable learning opportunity.

This study was carried out by three researchers from the University of Dar es Salaam with the assistance of local government authorities. Fieldwork was conducted in September of 1989 and 1990 with each exercise lasting two and a half weeks. To collect field data, Participatory Rural Appraisal (PRA) tools were used, including resource maps, transects, seasonal calendars, trend lines, historical time lines, group discussions, key informant interviews, household questionnaires, and participant observations (Mascarenhas, O. 1990; NES et al. 1990).

II. Msanzi Village: Indigenous Water Management for Increased Agricultural Production

The ecological and socioeconomic circumstances surrounding the development, expansion, and maintenance of the indigenous irrigation and water drainage system in Msanzi village are detailed below.

Location and Ecology

The village of Msanzi is located on the Ufipa Plateau in Sumbawanga District, Rukwa Region, in southwestern Tanzania. (*See Figure 1.*) The settlement lies at the western base of the Kira-Longo Hills, roughly 35 kilometers southwest of Sumbawanga, the regional capital, and 1,300 kilometers southwest of Dar es Salaam, the nation's largest city and major port. Dodoma, the capital, is located in the center of the country, about 800 kilometers northeast of Msanzi.

The Sumbawanga-Matai road divides Msanzi's two distinct land systems: the Kira-Longo Hills to the east and the Sintali Plain to the west. (*See Figure 2.*) The Kira-Longo Hills, which range between 1,600 and 2,150 meters above sea level, are characterized by steep slopes and small, intermittent valleys. The sandy-clay hill soils (Orthic Ferralsols) are dark reddish in color and finely textured. The dominant vegetation is open woodland and savanna, though some areas, such as river banks, have large trees with canopy covers exceeding 70 percent.

The steep slopes of the Kira-Longo Hills mean that the drainage density is high. Both the Msanzi and Sukwa Rivers originate there, joining in the village to form the Nsingewi whose gently sloping valley gradually broadens from 100 to 400 meters. The soils in these three valleys are comprised of alluvial depositions from the Kira-Longo Hills. Deep, moist, and rich in organic matter, they are highly fertile.

In contrast to the Kira-Longo Hills, the Sintali Plain is a broad, gently sloping, eroded bedrock surface lying at an altitude of 1,600 to 1,840 meters. This gently undulating plain becomes almost featureless in the west. Most of its extent is

Figure 1. Map of Rukwa Region, Tanzania

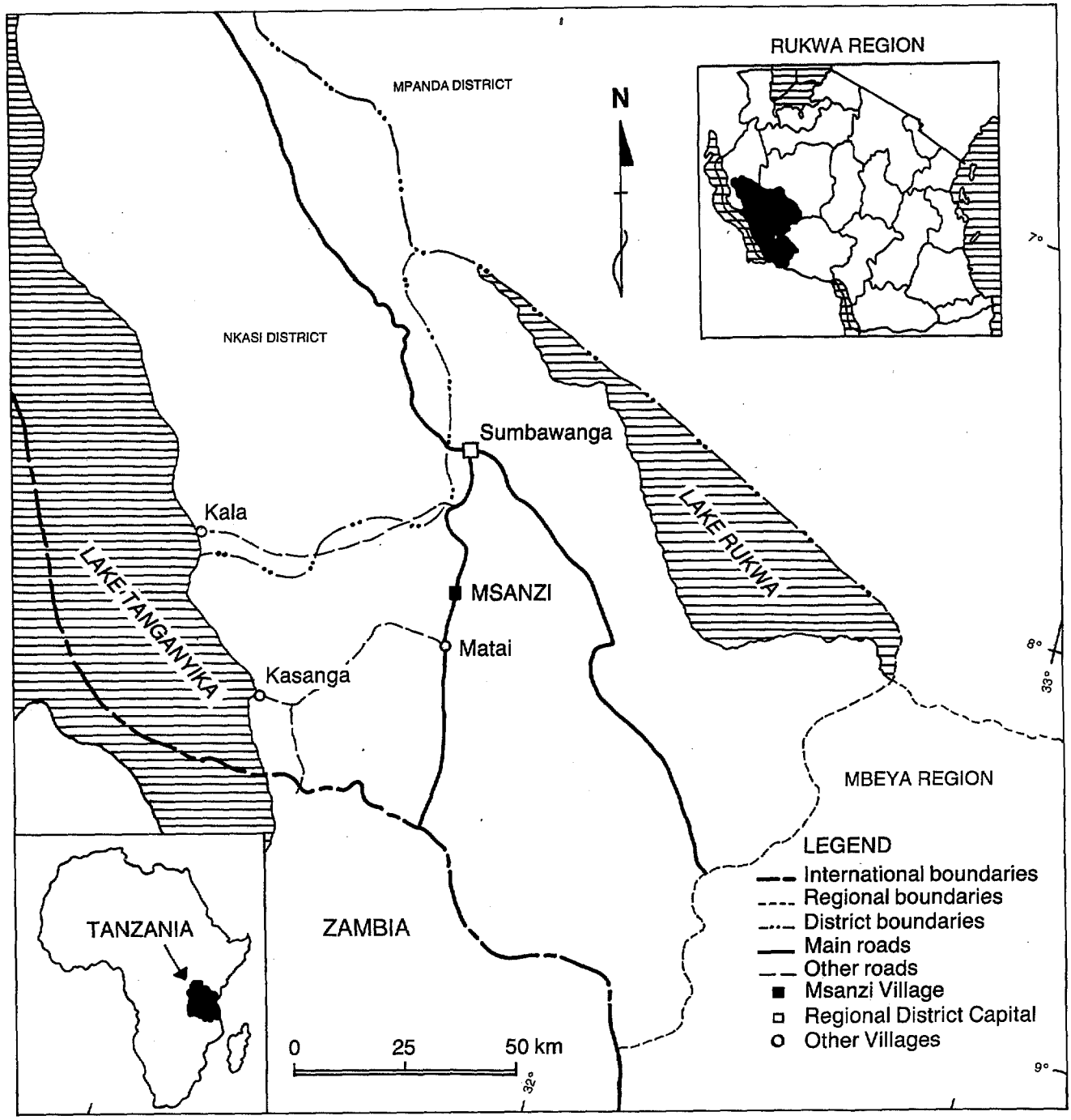
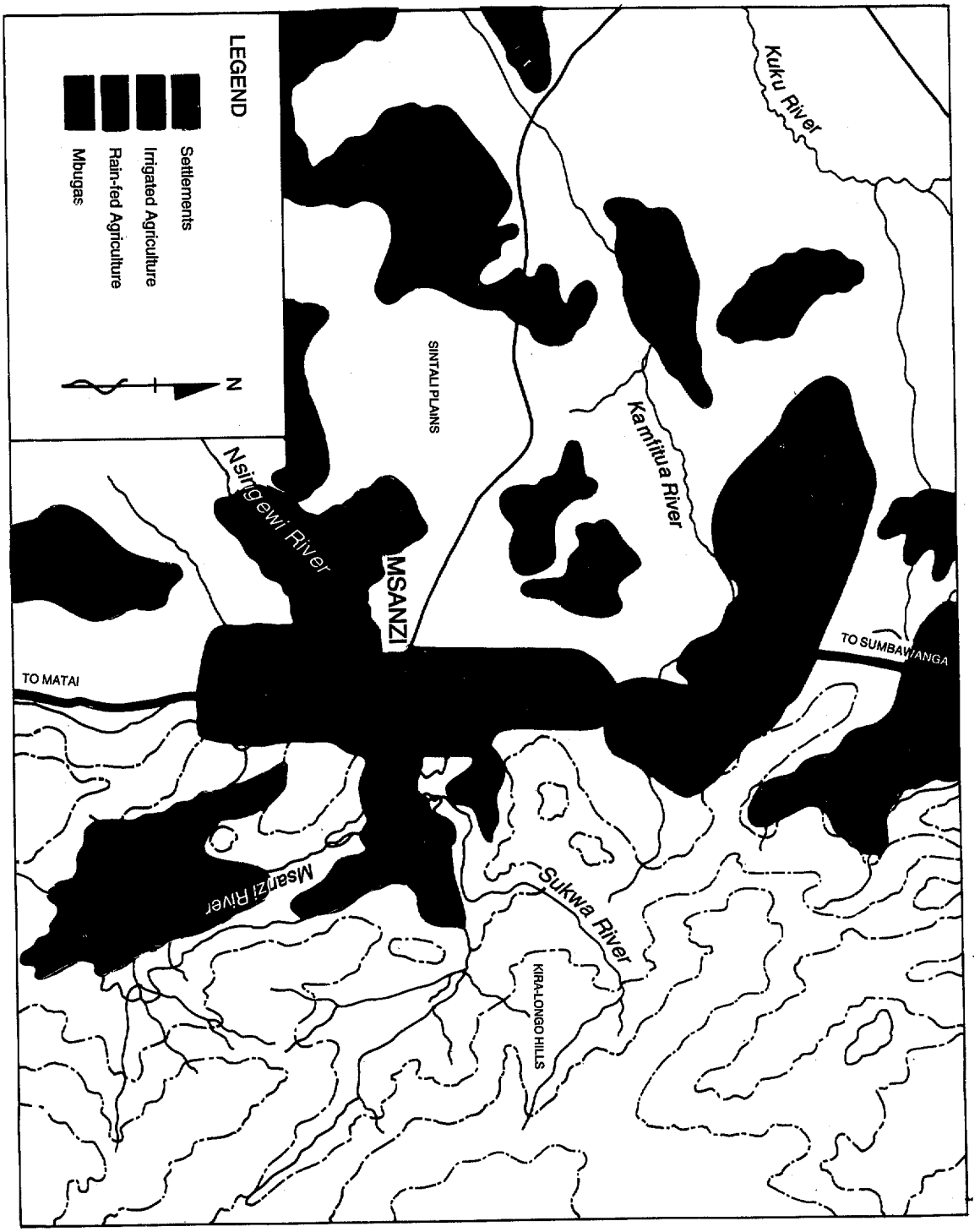


Figure 2. Resource Use Map of Msanzi Village



covered with a thin veneer of coarsely textured, dark grey, loamy sands and gravel (Cambic Arenosols). Also present, however, are a number of lush seasonal *mbugas* (wetlands) which are important to the local people for dry-season grazing. The area is primarily grassland with some woodland and riverine vegetation.

The Kira-Longo Hills and its forests have a moderating effect on local climatic conditions. Ambient air temperatures in both the hills and plains are mild all year-round. Overall, the region receives between 800 and 1,000 millimeters of rainfall annually, with more falling in the hills than the plains. Most rainfall occurs in a single wet season that extends from November to April, but isolated showers are common throughout the dry season, even during the driest months of June, July, and August. The natural forest cover tempers the water flow from the hills and helps ensure that the Msanzi, Sukwa, and Nsingewi Rivers flow throughout the year. Particularly heavy rains during the wet season, however, can cause flooding in the valleys and plains.

Land-Use Changes

Rural settlements in Tanzania traditionally consisted of dispersed, extended family homesteads or groups of homesteads called hamlets or *vitongoji*. Each hamlet contained approximately 50 nuclear households. Originally a single hamlet, Msanzi became the local nucleus of a government "villagization" program in the 1970s. With 3,628 people in 1990, Msanzi is considered a large village. It is subdivided into several "zones"—Msanzi, Kambyala, Lemarya One, Nachula, Kaminya—each of which corresponds to a previously separate hamlet.

Msanzi has a relatively well-developed infrastructure. At the time of this research, it included one primary school, three churches, a mission station, a dispensary with two medical aides, an office complex, a village library/meeting room, and a daily covered market with permanent stalls. It also had two butcher shops, three maize mills, a small guesthouse, several local bars, one "godown" (warehouse), and a well-stocked private shop. A single, privately-owned pick-up truck was the only vehicle. It served as the basis of a daily transport service.

Until the mid-1970s, Rukwa was isolated from the mainstream of government-sponsored development and was considered one of Tanzania's least developed regions. Rukwa produced few of the nation's traditional agricultural export crops (coffee, cloves, cotton, tea, cashew nuts, sisal, and tobacco); its economy was poorly monetized, and its infrastructure and social welfare services were weak (King et al., 1979; Mohammed 1985; Mascarenhas, O. 1986, 1987). Small-scale agriculture provided the farmers with sufficient food to meet their own nutritional needs. It also provided them with small surpluses which they would exchange for essential goods (Jespersen 1970; Sandberg 1974; Ulvund and Mkindi 1976). As a result of these barterings, the Ufipa Plateau came to serve as a granary for people in neighboring parts of the country. Most people there also owned cattle—some households had herds of more than 100 head.

In addition to their agricultural activities, many villagers collected wild fruits, greens, and roots. Some also hunted wildlife, principally in the forests of the Kira-Longo Hills. Further, these forests were a source of firewood, medicinal plants, and building materials.

In the late 19th century, *ntemele*, a form of shifting cultivation, was the most commonly practiced farming system, especially in the Kira-Longo Hills. *Ntemele* involved cutting trees and brush over an area many times larger than that which was to be cultivated. The cuttings were allowed to dry before being burned at the center of the clearing to form an ashbed on which millet—the traditional staple crop—was cultivated for two to three years. Afterwards, the land lay fallow for ten or more years.

As the local population increased and the nearby forests were thinned, *ntemele* became an unsustainable practice. At the turn of the century, some farmers resorted to other forms of shifting cultivation, ones that involved lower ratios of forest cut to land cultivated and higher ratios of cropping to fallow periods. Most farmers also began to use the land immediately surrounding their homes and hamlets more intensely.

In Msanzi, which was then a single hamlet, farmers took to planting their main crops in the valleys of the Msanzi, Sukwa, and Nsingewi Rivers so as to capitalize on the natural fertility of the soils. In nearby areas, *intumba* farming became the dominant agricultural practice. *Intumba* involved the manual construction of mounds on which beans were cultivated the first year, millet the second year, and maize the third. Thereafter, the land was left fallow for up to ten years. Soil fertility was maintained through fallowing, burning fallow bush, green mulching crop residues, and the cultivation of beans, a nitrogen-fixing legume. Besides conserving the soil's fertility, *intumba* farming helped establish maize as an important local crop. It eventually replaced millet as the staple.

In 1951, two events occurred that helped usher in another major change in local farming practices. First, the British colonial government, in an effort to curb soil erosion, imposed a ban on hill burning, thereby restricting all forms of shifting cultivation in the Kira-Longo Hills (GOGB 1955). Second, ox-plow cultivation was introduced by a returning resident, in this case a retired officer of the Kings' African Rifles. Ox-plow cultivation is less labor intensive and tedious than either *ntemele* or *intumba* and thus enables farmers to cultivate larger plots.[2] It was quickly adapted by Msanzi farmers and soon displaced *intumba* as the dominant agricultural practice. At first, ox-plowed fields were cultivated for two years in a maize/bean rotation and then left to lie fallow for four to six years. Over time, however, the fallow period has been reduced.

Besides working the main fields, most women on the Ufipa Plateau, including the Msanzi, traditionally cultivate *ntapila* —small, dry-season gardens. *Ntapila*

2 Ox-plows are considerably more efficient than human labor: to plow one acre, an ox-plow requires two days while human labor requires between six and eight.

gardens are planted near waterways, on streams and river banks, and—when water is low or the season exceptionally dry—on moist river beds. *Ntapila* gardens are watered by hand using watering cans or buckets. Because water is generally available near the homesteads and the fertile valley soils are highly productive, *ntapila* gardens are widespread in Msanzi.

Ntapila gardens supplement the daily diet by providing green vegetables, herbs, and seasonings. Equally important perhaps, they produce the food often needed to cover deficits during the *kipindi cha njaa* (hungry season)—January through March—when food from the previous year's main farms has usually been exhausted and the current year's has not yet been harvested. Of particular significance in this regard are sweet potatoes, green maize,[3] and green beans. In times of drought, millet is also cultivated.

Effective Resource Management

In 1933, unusually heavy rains caused the Msanzi River to overflow, thus flooding Msanzi's main farms. The *intumba* fields of one farmer, Chumia Mulela, were flooded to such a degree that the water could only be drained by digging a trench. Mulela organized traditional *kualika*[4] labor to dig a single, small canal or furrow from his fields to the outlying Sintali Plain. In doing so, he realized that he could use the excess water to irrigate the easternmost portions of the plain. Until then, this land had been used principally for cattle grazing (particularly in the *mbugas*) and hunting.

Mulela used the redirected water to establish a small plantation of coffee seedlings. Although the valley fields of other farmers were also flooded in 1933 as well as in subsequent years, and Mulela's coffee plantation went on to provide him with a cash crop, no other farmers followed his lead. Nor did Mulela himself ever adapt his system to accommodate his larger fields in the valley. For over thirty years, his small coffee plantation was the only irrigated land in Msanzi.

Then in 1966, a severe drought caused significant crop failure and widespread hunger. Mulela's son, Sebastian Chumia, then a *diwani* (district counsellor), recognized the potential of his father's canal for improving local agricultural productivity and reducing farming risks. Together with his father and several local elders, Sebastian Chumia designed an irrigation and drainage system.

The core of this new system was a main canal that tapped water from the Sukwa River just above its junction with the

3 Green maize is maize on the cob that has not fully matured. In preparing *ugali*, a main dish, green maize kernels are dried, milled into flour, made into dough, and then cooked. Immature kernels can also be steamed and eaten whole.

4 *Kualika* (literally "to invite") laborers work on reciprocal, usually agricultural, activities on a rotational basis. Traditionally, each *kualika* group included a core of extended family members and their immediate neighbors. In appreciation of their help, the workers were typically offered beer by the owner of the farm where the work was being performed.

Msanzi River. From there, it ran eastward to the Sintali Plain, paralleling the Nsingewi and following the natural slope of the land (*See Figure 3.*) Although it was prompted by the drought, the new system was designed to accomplish a variety of water management services:

- Supplement rainfall and residual moisture to wet-season farms in the Msanzi, Sukwa, and Nsingewi River Valleys;
- Expand dry-season cultivation which had previously been limited to *ntapila* gardens;
- Expand valley cultivation, particularly in the lower Nsingewi River Valley;
- Expand cultivation and lengthen the growing season on the Sintali Plain. (No dry-season cultivation, except perennial crop production, was expected here.); and
- Drain excess water during the wet season.

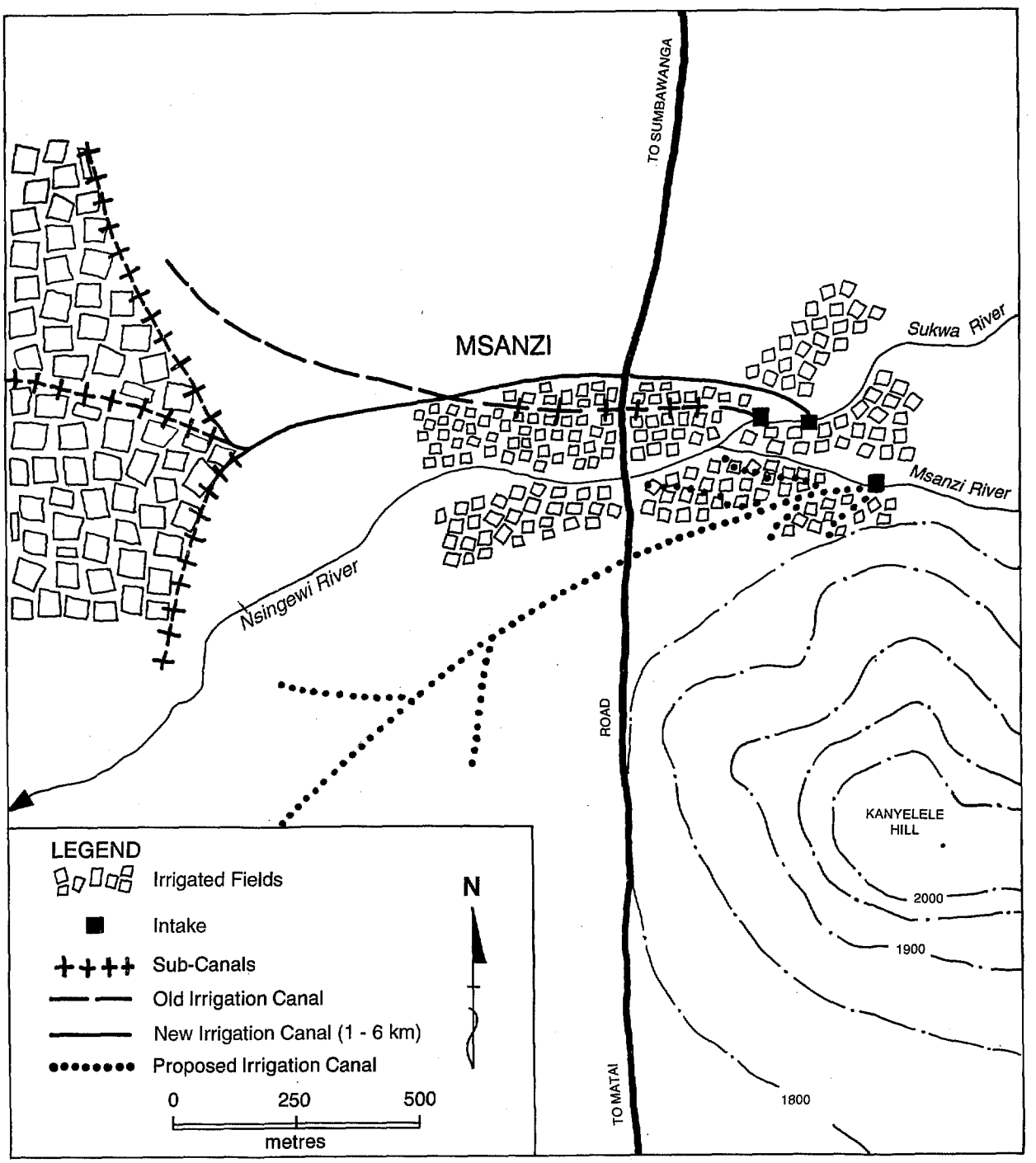
Although the farmers of Msanzi were aware of Mulela's successful coffee plantation, they were skeptical of the prospects for the proposed irrigation system and were therefore reluctant to invest their time and labor in digging canals and furrows and manually preparing plots. (Ox-plow cultivation is not possible on irrigated valley farms transected by multiple furrows and ditches.)

Capitalizing on the incentive provided by the drought and his influence as district councilor, Chumia eventually induced Msanzi's farmers to clear additional valley land and build the proposed irrigation system. The canal they constructed was an unlined trench whose intake was a weir of sticks and stones. (*See Figure 4.*) In the Sukwa and Nsingewi Valleys, lateral furrows ran from the main canal to fields which were further subdivided by ditches. On the Sintali Plain, the canal branched into multiple furrows which terminated in individual farms. In addition, several trenches were also constructed to feed water directly from the Msanzi, Sukwa, and Nsingewi Rivers to valley plots. The banks of all the channels were purposefully not cultivated in order to reduce soil erosion and protect them from collapse.

Upon completion of the new system, each of the approximately 50 households in the hamlet of Msanzi was allocated one-tenth to one-fifth hectare of irrigated valley land and less than one-half hectare of irrigated land on the Sintali Plain. The land was distributed by the village leadership, which was comprised of a traditional chief and his four or five counselors/advisors (male elders). A total of approximately 30 hectares, about 10 hectares in the valleys and 20 hectares on the plain, were irrigated that first year.

At first, no formal water-users' committee or canal overseer post was established to maintain the system and no restrictions or regulations were made on water usage. Instead, the farmers informally accommodated each other's needs. Farmers at the lower end of the system, for example, watered their plots early in the morning, leaving the afternoon's flow for those whose fields were higher up. Before the annual rains, the village leadership organized the farmers to clear the main canal, which they all shared, and repair damage from the

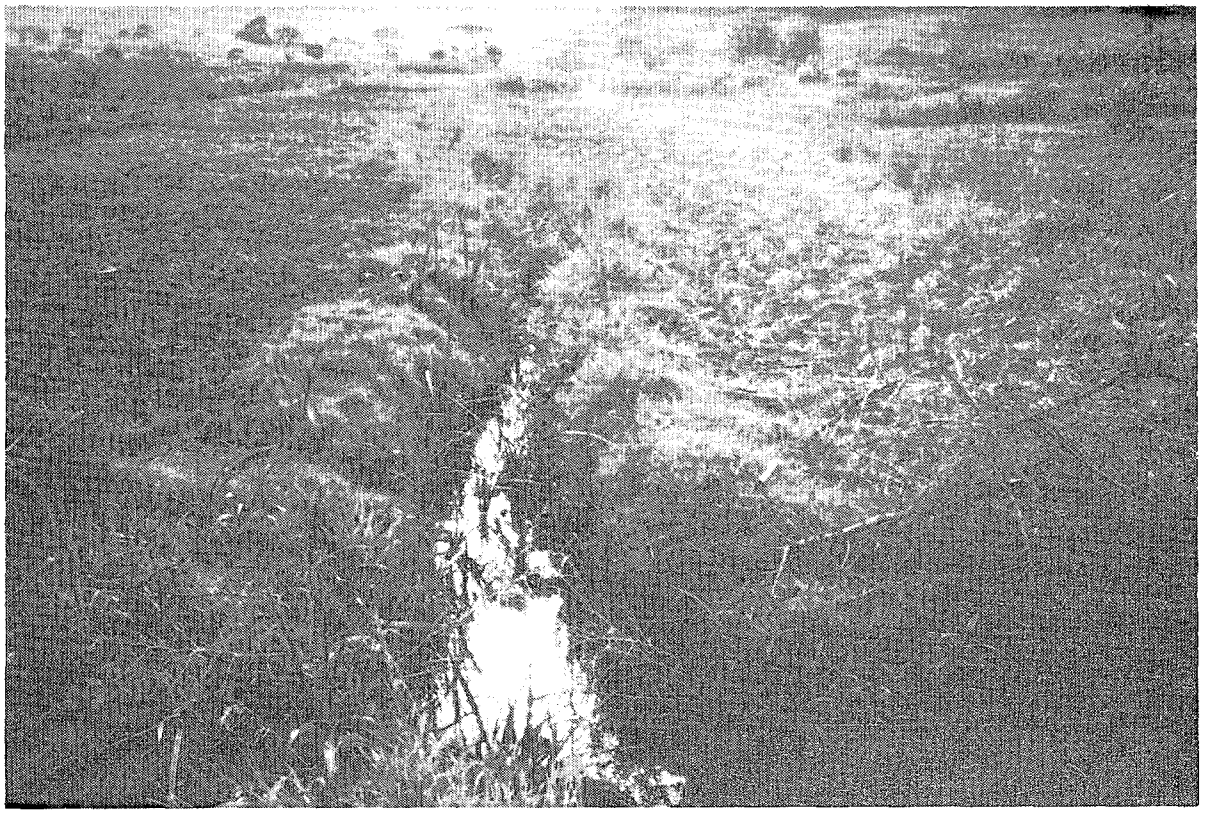
Figure 3. Existing and Proposed Irrigation Systems in Msanzi Village



previous season. The lesser canals, furrows, and ditches leading from the main canal were maintained by the affected farmers, often using *kualika* labor. Minor repairs were made throughout the year as needed.

In the valleys, the naturally fertile soils enabled the farmers to cultivate two crops per year. The agricultural cycle started in August/September when the canals and furrows were cleared and repaired. In September, farm plots were built up between the lateral furrows using the soils washed into the canals by the previous year's rains. Intercropped maize, beans, and potatoes were planted several weeks before the start of the rains and irrigated as needed. The farms were weeded in

Figure 4. Unlined Canal of Traditional Irrigation System in Msanzi Village (Photo)



September and October. Irrigation stopped in November when the rains started, and the crops were left to mature. By the time the heavy rains of January and February came, the crops were usually well enough established to withstand the inevitable flooding in the valley. Beans were harvested in January, maize and potatoes in March.

Between April and July, the fields were prepared for the dry-season vegetable gardens that featured onions, tomatoes, spinach, cabbage, and beans. Some crops, particularly onions and tomatoes, were planted and harvested several times each season, depending on local demand and labor availability. Though larger than traditional *ntapila* gardens, these dry-season farms were managed in a similar manner, primarily by women. Most of the harvest was sold at local markets.

In their Sintali Plain fields, most farmers produced one crop of maize each year. These fields, which were prepared principally by ox-plow, were planted in October and harvested in April/May. The relatively infertile soils prompted most farmers to apply fertilizers—usually cattle manure, but in some cases chemical fertilizers. Despite the use of fertilizer, by the early 1970s, maize yields from plain farms had dropped from 10 to 12 bags of maize per hectare to 5 to 7.5 bags (Jespersen 1970; Sandberg 1976).[5] There was no dry-season cultivation at this time other than that associated with perennial crops. As Chumia Mulela had done thirty years earlier, a few farmers also established small plantations, usually of coffee.

In the valleys, agricultural productivity in Msanzi increased dramatically: from 250 - 1200 of maize irrigated per hectare to 1700 - 2200 per hectare (without fertilizers). These advances made farming much less risky and greatly improved household food security. Within two years, some households were beginning to commercially market significant quantities of surplus crops for the first time.

Despite the increased productivity, most farmers continued to cultivate traditional "private" farms (*mashamba ya binafsi*) around their homesteads. Because maize was now being produced in abundance on the irrigated fields however, these "private" farms were no longer considered to be the main farms of most households. Although they were now smaller, they still tended to produce a wide variety of crops, including maize, beans, millet, groundnuts, potatoes, and pumpkins. Most of these "private" farms continued to be prepared by ox-plow.

The Effects of Villagization

In the 1970s, three events significantly changed the situation in Msanzi. In the early 1970s, the government—in an attempt to improve agricultural productivity and social services—encouraged the resettlement of Tanzania's scattered rural population into planned and permanent villages. Villagization resulted in the formation of cooperative or *ujamaa* settlements (Nyerere 1962, 1966, 1968; Cliffe and Saul 1972; Mushi 1978; Hyden

5 One bag equals 90 kilograms of decobbed, unshelled, dried maize.

1980; Coulson 1982; Fortmann 1982; GOT 1982b; Chambers 1985; Kauseni 1988). The hamlet of Msanzi was designated as an *ujamaa* community, and it became the resettlement area for several other nearby hamlets. Within the period of a few months in 1973, Msanzi hamlet, with less than 100 households (500 to 600 people), became Msanzi village. By 1978, when a national census was undertaken, the population had increased to 2,567 people.

The villagization process involved substantial changes in land-use rights for the purposes of redistributing land for infrastructure, agriculture, and habitation (von Freyhold 1979; Raikes 1980; Mascarenhas, A. 1983; Mlay 1986; Mtetewaunga 1986; Maro 1990; Hoben 1992). This land reform, however, was never formally legalized. According to the government's plans, each *ujamaa* household was to have one hectare of land to cultivate at its own discretion. In Msanzi, each household was given about one-tenth hectare of irrigated valley land, about one-half hectare of irrigated land in the Sintali Plain, and an additional one to two hectares of rain-fed land in the hills. Redistribution meant that some of the original Msanzi hamlet residents lost some of their traditional land, both in the hills and around their homesteads. But the traditional land of most original and new Msanzi residents was not reallocated, and these people retained customary rights to farms that, because of resettlement, were now anywhere from one to ten kilometers distant.

In addition, farmers were forced to establish two new types of agricultural fields—cooperative farms and block farms. On the cooperative farms (*shamba la ushirika*), production was controlled by the government, labor was provided by the villagers, and the proceeds were to be used by the village government for community development, though occasionally a small portion of those proceeds would be divided among the households. Msanzi's 40-hectare cooperative farm was situated alongside the Sumbawanga-Matai road, just outside the village. It produced rain-fed maize and beans.

Block farms (*mbega kwa mbega*) were large tracts of land subdivided into smaller holdings which were allocated to individual families. The productive pattern in the block farms was planned and organized by the village government, but the proceeds went to the individual families. In Msanzi, the block farms were located in and around the village itself and on both sides of the Sumbawanga-Matai road. Each household was given about one-half hectare—all in addition to its three other allocations. The main crop was maize.

In Msanzi, as elsewhere in Tanzania, neither the cooperative farm nor the block farm was popular; both were poorly managed and low yielding, but the cooperative farm was especially so. A factor behind these poor results was the minimal investments of labor and resources made by the farmers who preferred to concentrate their time and energy on their irrigated valley fields and their traditional farms in the hills (Mushi 1978; von Freyhold 1979; Hyden 1980; Raikes 1980; Fortmann 1982; Chambers 1985; Collier et al. 1990).

Villagization also led to the undermining of traditional village leadership. As

stipulated in the 1975 Villages and *Ujamaa* Villages Act and subsequent legislation, each community is to create a Village Assembly which is comprised of all residents over 18 years of age (Cliffe and Saul 1972; Mushi 1978; von Freyhold 1979; Hyden 1980; Raikes 1980; Fortmann 1982; GOT 1982b; Chambers 1985).

The Village Assembly, in turn, elects a 25-member Village Council which serves as the local executive government. Committees for Security and Defence, Planning and Finance, Crop Production and Marketing, Building and Transport, and Education and Welfare were to be formed by the Village Council, though additional committees/ subcommittees could also be established as needed. The Village Council is vested with the legal authority and political power to design development plans, initiate actions, develop by-laws, and raise revenues for administrative and development purposes (generally through taxes, such as those on crop sales, beer brewing, and small crafts).

The lowest level of village governance in Tanzania is the Ten-House Unit, a group of ten households who mobilize labor for member activities and communal projects. More commonly known as a "ten-cell" group, each unit selects one member as its leader. This person is responsible for the security and welfare of cell households and theoretically represents the group in formal decision-making processes. In practice, however, he is often co-opted by the Village Council.

The second significant event came in 1975 when the government, as part of a multifaceted decentralization campaign, began realigning the nation's administrative units (Sandberg 1974; King et al. 1979; Mascarenhas, O. 1986).[6] By 1976, three new regions and 20 new districts had been added, bringing the total to 20 regions and 111 districts in mainland Tanzania. Rukwa became Tanzania's twentieth region, an inclusion which helped sever its historic isolation. Government administrative facilities, infrastructure, and services were established in Sumbawanga, providing links to the central government as well as to neighboring administrative headquarters.

The Commercialization of Maize

The third major event was the commerçialization of maize, a consequence of new national food security policies (GOT 1982a, 1983b, 1984; Mascarenhas, O. 1986, 1987). From 1978 to 1983, the Tanzanian government designated Rukwa Region as one of four major maize-producing areas and offered farmers three powerful incentives:

1) The government made available subsidized agricultural inputs, such as hybrid seeds, chemical fertilizers, and pesticides;

2) A pan-territorial producer price was established that ignored differentials in transportation costs, thus amounting,

6 The administrative units of the central government are (in descending order): regions, districts, wards, and villages.

in effect, to a transport subsidy for Rukwa maize; and

3) National food security policies obligated official marketing organizations—the National Marketing Cooperative and Cooperative Unions—to purchase all available maize, thus creating a guaranteed market.

Farmers throughout Rukwa, who traditionally had not produced a major cash-crop, seized the opportunity. The farmers of Msanzi began double-cropping maize on their irrigated valley plots, and some farmers began cultivating dry-season maize on their irrigated plots on the Sintali Plain. In the Kira-Longo Hills, fields were mono-cropped with maize, and fallow periods were shortened—in some cases, to one or two years.

The increased production of maize, however, came at the expense of subsistence crops: traditional food crops were reduced or abandoned altogether and overall agricultural diversity decreased dramatically. The agricultural reorientation also had repercussions further afield: neighboring people who had historically traded for Msanzi grain went home empty-handed.

The commercialization of maize and the dramatic increases in population and density that came as a result of villagization led to a widespread conversion of pasture and other land use to farmland. With fewer opportunities to manage large herds, many farmers simply reduced their herd size through livestock sales. Also playing a role was the reduced availability of household labor—guaranteed maize markets had absorbed most of the villagers' time and energy.

The commercialization of maize (and subsequently of vegetables) had a number of sociological repercussions as well. The monetization of local economy resulted in men taking greater control of agricultural production, especially harvesting and marketing, traditional domains of women. The increased levels of production, however, meant more work overall for women and, thus, their further marginalization.

Rising levels of disposable income enabled many farmers to begin hiring human and animal labor. At the time of the study, at least 70 percent of the men were hiring ox-drawn plows to prepare the land. Women used their money primarily for services, such as milling maize. Such wage labor opportunities became particularly important to those households in need of supplemental income or those that could not produce sufficient quantities of food to tide them over during periods of shortages, especially the hungry season.

To accommodate the additional people and the increased demand for farmland, more land was cleared in the valleys and on the Sintali Plain. The existing irrigation system was correspondingly expanded: the main canal was extended farther onto the plain, and additional furrows were constructed both in the valleys and on the plain. Before villagization in 1973, fewer than 40 hectares of land were being irrigated, including roughly 12 hectares in the valleys. Ten years later, about 110 hectares of land were being irrigated, including about 37 hectares in the valleys.

The clearing of this additional land increased soil erosion and the threat of flooding, especially in the valleys. Overall soil fertility was significantly reduced, not only because of erosion, but also from shorter fallow periods, reduced crop diversity, and the removal of nitrogen-fixing legumes, such as beans, from regular crop rotations. Although many farmers continued to practice green manuring, chemical fertilizers became essential to maintain fertility and ensure high productivity, particularly for farms on the Sintali Plain. The use of chemical fertilizers, however, increased production costs and reduced profits, thus further marginalizing poorer households. It also increased health and other risks, especially for women and those hired laborers who actually applied the chemicals.

As a result of the nearly three-fold expansion in irrigated land, potentially irrigable land became increasingly scarce and valuable. At the time of the study, about 20 percent of Msanzi's population had no irrigated valley plots. The average household landholding was just over three hectares—one-half hectare of village land around the homestead, one-fifth hectare of irrigated valley land, and the remaining land on the Sintali Plain (one-half to four hectares) or in the Kira-Longo Hills (one to three hectares). There was, however, considerable variation in landholdings: poorer households averaged a little more than one hectare, while better-off families often had more than six. Established families who had retained access to their pre-villagization, traditional lands in the hills sometimes had more than 20 hectares.[7]

According to custom, land is not sold in Rukwa. Instead, it is used freely or rented for a token fee. With the commercialization of maize, however, land renting became widespread in Msanzi. By 1989, a significant percentage of the land was being leased. Some of the larger landholders (or others with "excess land") rented it to those who had no irrigated fields or those who could afford larger plots. At the time of this study, land rents were T.Sh. 14,800 per hectare of irrigated valley land per year and T.Sh. 7,400 per hectare of non-irrigated land (in 1989, US $1.00 = T.Sh. 160). In an area where the annual income of poorer households is less than T.Sh. 5,000 (US $31.25), such rents constitute a considerable, and often prohibitive, investment.

Villagization was abandoned (although never legally rescinded) in 1977, but many of its impacts remain (von Freyhold 1979; Hyden 1980; Raikes 1980; Fortmann 1982; GOT 1982b; Chambers 1985; Kauzeni 1988; Hoben 1992). In Msanzi, as well as in other parts of rural Tanzania, most people continue to reside in the *ujamaa* village. The Village Assembly, the Village Council and its committees, and the "ten-cells" remain the principal institutions of local governance. Most families continue to cultivate their allocated plots in the former block farm, although production is now

7 Another indication of economic stratification is cattle ownership—while many households had three to five cattle, some owned 30 to 50 head. During the period of field research, there were roughly 1,840 head of cattle in Msanzi.

controlled by the owners themselves. In Msanzi, as elsewhere, the cooperative farm was abandoned and the land distributed.

In 1983, the government stopped subsidizing sanctioned marketing agencies and compelled them to run on a for-profit basis (GOT 1982a, 1983b, 1984). These agencies ran into debt and were no longer able to purchase maize at official prices—which soon dropped below the "established" rate of T.Sh. 1,000 per bag. The liberalization of the marketing system also increased the flexibility of private traders who could now buy less expensive maize closer to the major urban markets. Traders who ventured to Rukwa were forced to offer prices well below national averages in order to offset higher transport costs (Mascarenhas, O. 1986, 1987). As a result, a good deal of Msanzi maize was never sold that year. The next year, Msanzi farmers reduced production levels.

In an attempt to maintain their income levels, Msanzi farmers began to diversify. Irrigated agriculture, especially dry-season valley cultivation, was increasingly utilized to grow beans, sugarcane, bananas, and vegetables—especially onions, potatoes, tomatoes, and cabbages which were still in high demand both in Msanzi and Sumbawanga. Concurrently, some innovative and better-off farmers began irrigating their Sintali Plain fields in order to establish (or expand) fruit and coffee plantations. Banana, maize, and beans were also intercropped.

The Collapse of the Irrigation System

The increasing number of water users and commercial opportunities led to more extensive clearing, especially along canals and furrows in the river valleys. New furrows and trenches were constructed to irrigate the newly cleared land by individual farmers pursuing their own personal interests. As a result, the irrigation system expanded haphazardly. Without a local irrigation or water-users' group, the existing system was not managed strategically and water use was unregulated and unmonitored.

During the 1983/84 growing season, severe soil erosion caused the main canal to collapse and sink just before it reached the Sintali Plain. Some lateral canals were stranded as high as one meter above the level of the main canal, thus rendering them useless. Besides bringing virtually all irrigated agriculture on the Sintali Plain to a standstill, the collapse of the main canal substantially interrupted service to the valley. Before the collapse, the system had been irrigating approximately 37 hectares in the valley and 73 hectares on the plain. Afterward, only about 37 hectares were being irrigated, almost all of them in the valley. Without a steady source of water, many plantations suffered and most fields were abandoned. On those that were not, farmers switched to less productive rain-fed agriculture.

Rehabilitating the irrigation system thus became an issue of paramount importance to the farmers of Msanzi. Irrigated agriculture had initially supplemented production from traditional farms in the

hills and around homesteads, but the needs of the increasing human population had soon made it essential to the economic survival of most Msanzi households. This was especially true of dry-season valley production and irrigated farming on the plain.

The farmers, however, did not know how to repair their collapsed canal and they had no contacts with any external technical agencies. As a result, most of them were forced to intensify production on their remaining fields and, where possible, expand their plots, including those in the river valleys. This only put even more pressure on village land, the natural resource base, and the remaining irrigation system. In late 1987, severe flooding destroyed most of the valley crops, an event which only underscored the need to rehabilitate the irrigation system.

The year before, a Rural Development Programme (RUDEP)[8] had been inaugurated in Rukwa Region and had begun working in Msanzi village. Its first mission helped establish a nursery for fruit trees, a national program that had the added advantage of serving as a workable introductory venture. The floods of 1987, however, made it clear that rehabilitating the irrigation system was a much more pressing need.

That year, two RUDEP officials helped the Msanzi villagers establish a Development Board to formulate and manage their projects, in part because the Village Council was inactive and had a weak chairman. The Development Board included an Irrigation Committee made up of five men elected by their fellow villagers.

Assisted by RUDEP officials and some of the other villagers, the Irrigation Committee submitted a proposal requesting RUDEP's assistance in building a permanent irrigation and drainage system that would expand irrigation both in the valleys and on the plain.[9] The proposed system included two new main canals of about two kilometers in length, one of which tapped into the Msanzi River, the other, into the Sukwa. The canals were to run parallel to the Nsingewi River and bring water to both the eastern and western portions of the Sintali Plain. Each would have lateral furrows to expand irrigation into the valleys. The theory behind the proposed project was simple: if excess water from the valleys could be better drained during the wet season and less water drawn from the rivers during the dry season, fewer valley crops will be lost to flooding and more water will be available for irrigation.

In early 1988, Msanzi and RUDEP signed a formal agreement to rehabilitate the irrigation and drainage system. The villagers would provide the skilled (masons/carpenters) and unskilled labor to dig and line the main canals and all furrows. RUDEP would build the intake dams and culverts; provide building techniques and education, such as irrigation

8 RUDEP is supported by NORAD, the Norweigen bi-lateral foreign assistance program.

9 At the time, RUDEP was providing similar assistance to another indigenous irrigation system in Rukwa Region.

system management; supply transport for stones and sand (to be collected by the villagers); and provide important external resources, such as cement and other building materials.

Prior to initiating any of these activities, however, RUDEP undertook some feasibility studies. The studies suggested that irrigation should not be expanded in the valleys as existing plots had sufficient water for dry-season irrigation and there was only enough water in the rivers to irrigate 85 hectares on the Sintali Plain—less than 17 percent more than was being irrigated before the collapse of the main canal. RUDEP's conclusions may have been based on potential down-stream effects (i.e., reduced water flow in the Nsingewi River) should both canals be built and irrigation substantially expanded on the Sintali Plain. In any case, RUDEP substantially altered the design of the system and, as a result, its commitments to Msanzi as a result of its findings.

The redesigned system featured a single main canal (without lateral outlets into the valleys) running out to the eastern Sintali Plain in a manner similar to that of the traditional canal. (*See Figure 3.*) According to RUDEP's analysis, this new, cement-lined canal would be able to supply water more effectively because there would be less seepage and because quicker transport would moderate the flow of flood waters in the valleys. It would also be less susceptible to the damage caused by soil erosion since the lining would ensure a smoother flow.

In 1988, the responsibilities of the Irrigation Committee of the Msanzi Development Board were transferred to the Irrigation Sub-Committee (ISC) of the Village Assembly's Crop Production and Marketing Committee.[10]

The ISC met every Saturday to allocate responsibilities, plan work, and assess progress. Work was organized on a rotational basis with four "ten-cell" leaders providing labor from the households under their leadership. By the time of the second field study (September, 1990), the main canal had been dug and was being lined with stones and cement by the villagers under RUDEP supervision. (*See Figure 5.*) As per the terms of the agreement, RUDEP had provided the materials for the intake dam and was in the process of constructing it. When the new canal was completed, it was expected that the ISC, together with the Crop Production and Marketing Committee of the Village Council, would allocate plots, regulate water use, maintain the main canal and furrows, and coordinate anti-erosion measures.

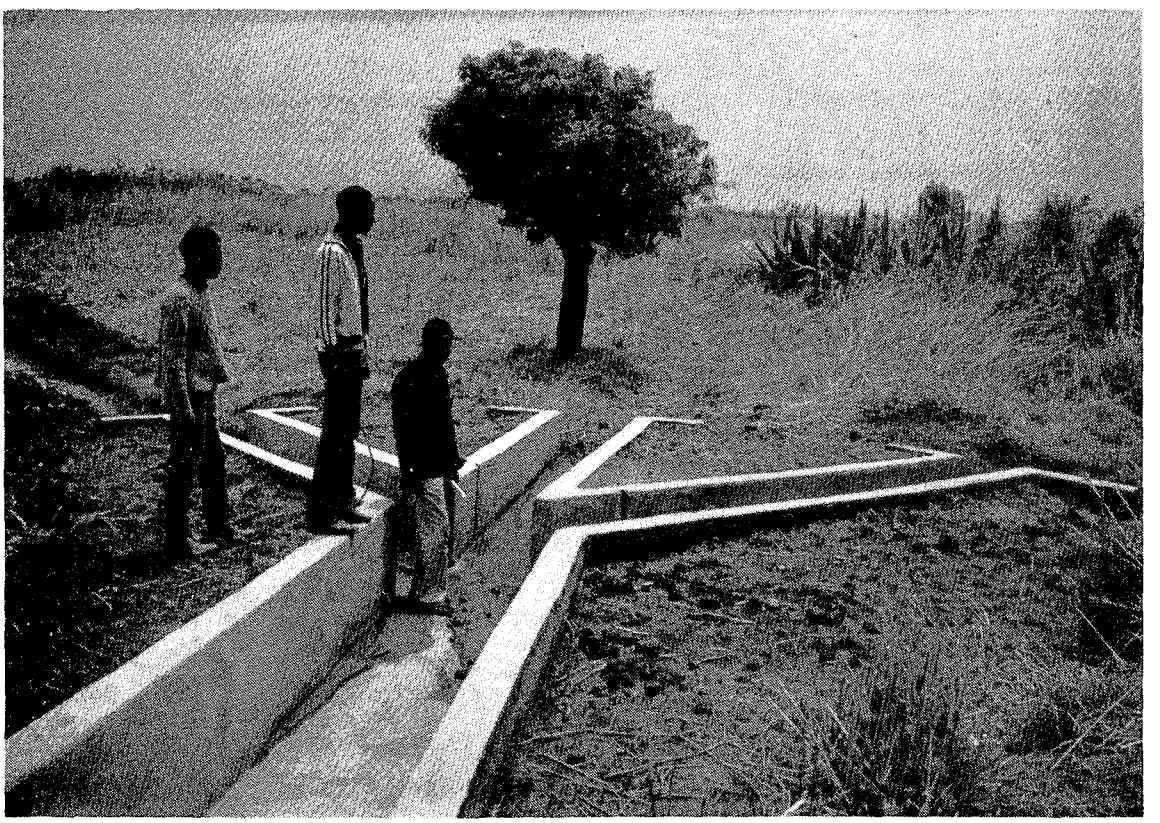
10 In 1988, all RUDEP-established Development Boards were deemed to be illegal and were abolished by the central government on the grounds that they were inconsistent with the established village government structure. At the time of this study, the ISC—which consisted of the same five men who made up the Irrigation Committee—were overseeing Msanzi's obligations under the terms of the revised agreement signed with RUDEP. Increasingly, they also had taken over the day-to-day management of the system.

Limitations and Adaptations

Despite its utility, the villagers knew that the RUDEP-designed canal could not possibly meet local needs since the demand for irrigated land had outstripped availability—even before the collapse of the main canal. Though also designed to increase efficiency, the RUDEP-sponsored canal will only irrigate 12 additional hectares on the plains and none in the valleys.

The villagers firmly believed that the scarcity of irrigated land would only increase economic inequities and, thus, land conflicts. Despite the conclusions of RUDEP's feasibility studies, they also believed that there was sufficient water in the rivers to offset periodic water shortages, expand irrigation in the lower Nsingewi River Valley, and extend irrigation to the western Sintali Plain. According to their estimations, the volume of water in the Msanzi River is about the same as in the Sukwa. They contend that water shortages on the plain prior to the collapse of the main canal were due to the small size and inefficiency of that canal, not to a shortage of water at the source.

Figure 5. Cement-lined Canal of New Irrigation System in Msanzi Village (Photo)



As a consequence, the villagers decided to go ahead and build the second canal envisioned in the original Irrigation Committee proposal. As of the time of this study, the villagers, as organized by the ISC, were in the process of building this canal—which taps water from the Msanzi River and runs to the Sintali Plain on the west side of the Nsingewi River (*See Figure 3*)—from local materials using the technical skills learned from RUDEP. Village funds are to be used to purchase the needed external inputs. Unlike the Sukwa canal, this canal will have lateral outlets so that irrigation in the lower Nsingewi River Valley can be expanded. If their efforts prove successful, the Msanzi farmers will have effectively adapted a modern and previously external technology to their own unique local circumstances and needs.

As the number of farmers continues to increase, however, and all irrigable land is developed, allocated, and intensified, pressures on the rehabilitated system can only increase. As a result, the villagers recognize the importance of addressing the ongoing issues of water use, land distribution, system maintenance, and crop production. A strong water-users' group will be critical to effective water management; early indications suggest that the ISC is moving in this direction. In addition, a cooperative of farmers in the lower Nsingewi River Valley was recently established to coordinate production and marketing.[11]

The farmers are also involved in a number of activities designed to protect the watershed. Although irrigated agriculture had diverted attention from forest farming, in 1971 a village by-law was passed forbidding the burning of forest and grass and ensuring forest cover on the hills and valley slopes. This local-level ordinance is backed by national laws restricting hillside burning. In 1990 many villagers, including 19 voluntary groups of three to nine people each, were also active in reforestation projects.

The protection of the watershed is also aided by religious beliefs that hold that certain large trees or forested patches are the homes of gods or the abodes of spirits and that death or other punishments await anyone who cuts the trees and forests. Land use in these recognized "sacred groves" is restricted, and the religious-based regulations are strongly adhered to by the local people.

11 Such local institutions were legalized and formally recognized by the government in 1986.

III. Core Elements of Effective Resource Management

The farmers of Msanzi have successfully adapted their traditional irrigation system to meet the demands of changing local circumstances, including broad external events such as villagization and commoditization as well as internal "shocks" such as floods, drought, and, most recently, the collapse of the main canal. Several factors and conditions have contributed to the design, construction, management, and maintenance of this effective irrigation and water drainage system. These factors are both related and interdependent.

Risks to Livelihood and Improved Local Welfare

Agriculture, the mainstay of Msanzi's economy, was disrupted by several crises that adversely affected human welfare. These events provided the impetus for local farmers first to develop, and then to rehabilitate, their water management system. As detailed in Section II, three crises were particularly instrumental in the development and adaption of irrigated agriculture: a severe flood in 1933; a serious drought in 1966; and the collapse of the main canal due to erosion in 1983/84.

These crises mobilized local action because they drastically disrupted agricultural production and had immediate and adverse effects on the villagers' well-being—in some cases, even jeopardizing basic subsistence needs. Irrigated agriculture—which generally improves production and enables farmers to better support their families and improve their quality of life—was a logical alternative. Because of its high productivity, irrigated agriculture became an important component of local livelihoods in Msanzi shortly after its introduction. In time, that dependence grew even larger.

In rehabilitating their system, the primary objective of the Msanzi farmers was to mitigate the effects of the ongoing crisis. In addition, the rehabilitation also reduced the likelihood of such events occurring again and improved their socioeconomic welfare. The irrigation and water drainage system they devised gave them greater control over the supply of water, thus reducing their reliance on unpredictable rainfall and the risk of crop loss from flooding and drought.

The system also offered opportunities to intensify and expand the production of both subsistence and cash crops.

Msanzi's irrigated agriculture is considerably less risky than the rain-fed agriculture traditionally practiced in the region. The irrigation system delivers water to supplement rain-fed crops when rainfall is below average or off schedule, and improves drainage during heavy rains. Irrigation thus enables farmers to better control the factors that make rain-fed agriculture risky in the first place. The consequences of a more reliable and productive agricultural system, are often improved livelihoods and social well-being.

Between 1966 and 1987 when there was no water-users' association, the community did not respond to locally recognized threats to the ecosystem in strategic manners that ensured the long-term sustainability of the irrigation system. Instead, management and maintenance of the canal and furrows was done on an *ad hoc* basis, system expansion was unregulated, and water usage was haphazard. The community's responses were rational in that they provided quick and low-cost solutions to the problems at hand, but given the limited nature of its material and financial resources, they were insufficient in guaranteeing the continued viability of the system.

For example, excessive land clearing and unsustainable agricultural practices—influenced by such external factors as villagization, the commercialization of maize, and local marketing opportunities—increased both the threats from, and the impacts of, each disaster. Naturally occurring floods and droughts were exacerbated by clearing vegetation from hills, valleys, river banks, and along the canals, furrows, and fields. Given Msanzi's limited resources, these were prudent responses, but they contributed to the soil erosion which eventually caused the collapse of the main canal.

The net result of all these short-term remedies was a stressed water-management system and inefficient water use, both of which increased the likelihood of floods, soil erosion, crop loss, and even hunger. Ultimately it led to the collapse of the system in 1983/84.

Local Innovators and Indigenous Knowledge

The development and adoption of irrigated agriculture in Msanzi was the result of foresight by local innovators whose experimentation and culture-based knowledge[12] was used to design the basic water-management system and to

12 Local knowledge usually consists of dynamic insights, skills, and capacities which are derived from many years of experience or passed down through families for generations. Local knowledge is also modified and adapted over time through informal experimentation and adjustments made in response to environmental and socioeconomic circumstances (Biggs and Clay 1981; Bunch 1982; Richards 1985, 1989; Chambers et al. 1989; Fujisaka 1989a, 1989b, 1992; McCorkle 1989; Thrupp 1989, 1991; Barrow 1991; Loevinsohn et al. 1991; Warren 1991).

continually adapt it to changing political, socioeconomic, and environmental conditions.

Many people have contributed to the design of the current system. Women, for instance, have traditionally been responsible for watering home gardens and dry-season vegetable gardens. In 1933, a single individual, Chumia Mulela, developed and implemented the first gravity-fed, furrow irrigation system. In 1966, his son Muela, and other local elders, used his basic design to construct a complex irrigation and drainage system for the use of the whole community. Current plans to rehabilitate the system (prepared with assistance from RUDEP) are based on this traditional system.

Besides the technical innovations that have enhanced the functioning of the basic system, Msanzi farmers have also increased its effectiveness through management practices that take account of changing local circumstances. In an effort to develop even more effective farming practices, most farmers in Msanzi routinely experiment with promising new technologies. Some of these experiments are based on local ideas and indigenous knowledge, while others originate from extension officers, development assistance agents, and other outside sources.

Many of these local innovations or modifications have implications for other farmers in Msanzi and have, therefore, been selectively adopted and incorporated into the growing body of "culture-based" insights. Among these innovations are the use of communal labor to construct and maintain the main canal, the use of ox-plows.to prepare irrigated farms on the Sintali Plain, and the use of ecologically and socioeconomically appropriate cropping patterns on irrigated fields. The series of successful responses to crises has only strengthened Msanzi villagers' faith in the value of experimentation.

Although most of Msanzi's farmers are open to experimentation, many innovations with broad appeal and significant impacts have come from individuals of above-average social standing. Among these are ex-government officials, civil servants, army personnel, and teachers who have worked outside the region, acquired some wealth, and brought back with them "new" resource management ideas and techniques. The individual who introduced ox-plow cultivation, for example, was an army retiree who had made considerable contacts outside the village.

Regarding irrigation, Chumia Mulela owned a relatively large tract of land and his son, Sebastian Chumia, was a district counsellor. Wealthier, and more well-connected, farmers not only have more resources at their disposal to experiment with, they also have less to lose, relatively speaking, should those experiments fail. Contributions by the more privileged members of the community are likely to continue: at the time of this study, for example, one of Msanzi's wealthiest farmers was pioneering citrus tree plantations on the Sintali Plain.

Community Leadership

The development of an effective irrigation system in Msanzi has also been dependent

upon those local leaders whose power and influence proved essential to the mobilization of local labor and resources, the infusion of new ideas and techniques, and the overall management of the system.

Msanzi's leaders come from both the formal (i.e., traditional or governmental) and informal sectors. Some of Msanzi's leaders are also its important innovators. While most were leaders before their innovations, others have come to be regarded as leaders by virtue of their contributions. These people are often seen as skilled or gifted visionaries. Their willingness to help local people even though they are not being paid for developing and spreading the new technologies earns them praise and respect. As a result of their newfound social status, their advice is frequently solicited.

Although some local leader-generated innovations have spread through the community by virtue of their easily verifiable superiority, others have not. For example, despite Chumia Mulela's well-known and clearly successful irrigated coffee plantation and the farmers' own first-hand experience of numerous floods, droughts, and famines, no other Msanzi resident established a similar water-management system in the period between 1933 and 1966.

The establishment of a community-wide irrigation system required the actions of a recognized local leader. Sebastian Chumia used his position as a *diwani* to persuade local farmers of the importance of irrigated agriculture and to help organize the labor and resources necessary to construct the proposed system. His success was also due to the drought and hunger that affected most households in 1966.

The absence of a viable village government (e.g., an inactive Village Council, a weak village chairman, and no irrigation users' group) was recognized by RUDEP as a serious constraint when it began working in Msanzi. As a result, one of RUDEP's first activities was to spur the establishment of a Development Board, including an Irrigation Committee, to spearhead the rehabilitation effort.

The Irrigation Committee, which was transformed into the Village Council's Irrigation Sub-committee in 1988, has been instrumental in the rehabilitation process. It helped design the new system, mobilized local labor and resources, and lead the efforts to begin constructing a second canal and expand the irrigation network. At the time of this study, the ISC was also becoming more involved in the day-to-day management of the system and was expected to take the lead in allocating new irrigated plots, regulating water use, and coordinating system maintenance once the physical rehabilitation project was completed.

Resource Assets

Irrigated agriculture is possible in Msanzi because of the presence of critical resource assets. Small-scale irrigation typically requires a reliable water source, fertile soils, and the labor to construct, maintain, and manage the water system. In much of rural Africa, these resources are either scarce and/or unreliable (FAO 1969, 1986, 1987b; Blackie 1984; Mrema 1984; Morris and

Thom 1985; Coward 1987; Carter 1989; Speelman 1990; Vincent 1990).

Where farmers have access to reliable water sources and inherently fertile soils, such small-scale irrigation systems are fairly common (Masao 1974; Chambers and Morris 1977; Hogg 1983; Blackie 1984; Fleuret 1984; Mascarenhas, A., et al. 1985; Adams and Anderson 1988; Burra and van den Heuvel 1989; Carter 1989; Adams 1990; Loevinsohn et al. 1991; Lema 1992; Grove 1993; Funnell 1994).

Msanzi, however, is blessed. The Sukwa, Msanzi, and Nsingewi Rivers provide reliable, year-round sources of water, and the fertile alluvial soils found in the three valleys require few agricultural inputs. The fact that the valleys are also in close proximity to the village is of substantial benefit to the women of Msanzi who have to combine field work with household responsibilities.

Msanzi's generally favorable ecological conditions mean that irrigated agriculture is less costly and requires fewer inputs than it would under more adverse circumstances. Even so, irrigated agriculture in Msanzi is still labor-intensive. As a result, many farmers have come to rely upon oxen and hired labor. Because it saves time and human labor, oxen are used to plow most of the irrigated maize farms on the Sintali Plain.

Despite the increase in ox-plowing and hired labor, household labor remains the primary energy source for irrigated farming, as well as for all other on-farm agricultural activities. Because of its critical importance, family labor is a valuable and carefully regulated household asset.

Despite its labor demands, irrigated agriculture is still the preferred practice in Msanzi. Several savings and improvements help make it possible for Msanzi's farmers to meet the increased labor demands of irrigated agriculture.

- Irrigated agriculture in the river valleys enables farmers to plant their fields one or two months earlier than with rain-fed agriculture. This flattens the labor peak that historically occurs when rain-fed crops are planted.

- Dry-season cultivation—now possible with irrigation—taps human labor during the "off-season" when there are fewer on-farm agricultural labor demands.

- Tree crops, now popular on the Sintali Plain because of irrigation, require less labor than maize, and the timing of that labor is more flexible.

- The irrigation canals and furrows are cleared, repaired, and otherwise maintained when on-farm labor demands are low.

- The increased productivity of irrigated agriculture has enabled many farmers to reduce their other farming activities, thereby saving associated labor costs and other inputs.

Because of the fortuitous combination of these elements, seasonal labor peaks, the expense of hired labor, and access to other energy sources, do not act as bottlenecks to irrigated agriculture in Msanzi. In many

rural communities, however, especially those where household labor and the capital to hire labor is severely limited, seasonal labor peaks continue to constrain resource management and economic activities.

Economic Opportunities

While crisis-generated concerns over food security stimulated the development and rehabilitation of the irrigation system in Msanzi, cash-cropping opportunities have provided additional incentives to effective water management since 1978.

Between 1978 and 1983, government inputs and subsidies for maize production provided the necessary financial incentives for Msanzi farmers to begin producing maize for commercial markets. Increased maize production was accomplished in several ways: by intensifying production on irrigated farms; by multiple cropping; by enlarging existing farms; by establishing new fields; and/or by substituting maize for other subsistence crops.

In 1983, when the government discontinued its subsidy program, most farmers in Msanzi cut back on maize production. But a market continued to exist in nearby Sumbawanga for fresh vegetables (onions, tomatoes, potatoes, cabbage, green beans) and fruits (oranges, bananas, papaya). Msanzi farmers still produced maize for subsistence purposes, but increasingly switched their valley agriculture, especially dry-season farms, to vegetable production. At the time of this research the average household income from the sale of irrigated crops was about T.Sh. 30,000 (US $187.50). But earnings from just dry-season cultivation could be as high as T.Sh. 50,000 (US $312.50)—the price of 50 bags of maize at the once "official" price. Such harvests of maize, however, can only be achieved through a sizable investment in cultivating large fields, renting ox-plows, and purchasing fertilizers, pesticides, and seeds.

At the time of this study, fruit tree plantations on irrigated fields on the Sintali Plain were increasing.[13] Previously, fruit trees had not been grown on a significant scale anywhere on the Ufipa Plateau; most of the fruit consumed in Sumbawanga had come from the neighboring region of Mbeya. Some farmers were also considering cultivating rice in the valleys. Rice, which is highly productive per unit of land, can also be stored for long periods of time and was in high demand in Sumbawanga.

Unfortunately, these economic opportunities also contributed to resource degradation—especially deforestation and soil erosion—because of the lack of effective management of the existing irrigation system. Cash-cropping opportunities fueled the increasing demand for irrigated plots and contributed to the rising value of irrigated and potentially irrigable land. Together with villagization-caused population increases, it contributed to excessive land clearing, unchecked

13 The increased profitability of vegetables and fruit over maize further increase the value of irrigation. Vegetable and fruit production also diversifies farming and improves soil fertility.

expansion of the existing irrigation system, and wasteful water-management practices. In the process, irrigated agriculture became even more important to the local economy: at the time of the study, most households depended on irrigated agriculture to meet basic subsistence needs, and cash crops from irrigated lands had become an essential component of virtually every Msanzi household's economy.

With the collapse of the main canal in 1983/84 and the immediate impacts on Msanzi villagers' welfare, these same economic opportunities became the principal impetus to rehabilitating the system. They are now contributing to the increased attention being given to *effective* water-management and system maintenance. Ensuring the long-term viability of the irrigation system is also a major concern of the farmers.

External Assistance

External assistance has been critical for the continued functioning of Msanzi's irrigation system. To date, the most important technical assistance has been provided by RUDEP, which helped rehabilitate and "modernize" the collapsed main canal.

When the main canal collapsed in 1983/84 and restricted irrigated agriculture to the river valleys, the rehabilitation of the system and the re-establishment of irrigation on the Sintali Plain became a priority for virtually every farmer in Msanzi.

Yet, despite its importance, rehabilitation of the canal did not begin until early 1988 since local people had neither the technical knowledge and capacity to repair the system themselves nor any contacts with outside individuals or institutions who could provide that assistance. The Village Council was weak and inactive, and there was no formal water-users' group. While they worked to establish the necessary contacts, the farmers had few options but to expand valley irrigation to make up for the loss of irrigated agriculture on the Sintali Plain. This expansion resulted in additional soil erosion and contributed to the floods and crop losses that occurred in 1987.

When RUDEP began working in Msanzi in 1986, the farmers' initial request was for help in rehabilitating the irrigation system. This effort became the project's second activity; a nursery for fruit trees had already been selected by RUDEP as an initial pilot project.

The speed at which the rehabilitation effort is being implemented is indicative of the importance farmers attach to irrigated agriculture. At the time of this research, the two-kilometer-long Sukwa canal had already been renovated and was being lined with stones and cement. In addition, work had also begun on the second main canal.

RUDEP's assistance has been of vital significance for several reasons. One of its primary objectives is to promote community development through local initiatives and self-help. In pursuit of this goal, RUDEP helped establish local capacity (Development Board/Irrigation Committee) to design and manage appropriate village-level projects, projects such as the rehabilitation of the Msanzi irrigation system. In particular, RUDEP contributed

the feasibility studies, the technical skills to construct certain parts of the new system, and some material resources. What they did not contribute was any direct funding. In light of the community's own work on the second canal, it also seems as if RUDEP taught the Msanzi farmers some of the technical skills that they had been lacking.

It is important to recognize that Msanzi's farmers have been selective in using the information they acquired through RUDEP's assessments. For example, they discounted the feasibility study's conclusion about the amount of river water available for irrigated agriculture.

IV. Implications and Recommendations

The core elements of the Msanzi irrigation experience have implications for national and local governments, donor agencies, and private voluntary and nongovernmental organizations concerned with promoting effective water and other natural resource management for community development in Tanzania. These implications can best be seen in the context of the country's irrigation efforts and decentralization policies and programs.

Irrigation in Tanzania

Studies have identified as many as 850,000 hectares in Tanzania with immediate potential for irrigation development. An additional four million hectares could be similarly developed over the long-term, but they would require considerable technical and capital inputs (GOT 1982a, 1984, 1993; Mascarenhas, A., et al. 1985; LRDC 1987). The annual runoff to the Indian Ocean and Tanzania's major lakes has been estimated at 74 billion cubic meters. The potential for irrigation from groundwater has yet to be estimated, but in some areas is known to be significant (Mascarenhas, A., personal communication).

Despite this potential, less than 2 percent (150,000 hectares) of the cultivated area in Tanzania is currently under irrigation. Approximately 18 percent of the irrigated land is in the hands of large-scale private and public farms. The remainder is irrigated by smallholders—79 percent (112,500 hectares) in the form of traditional irrigation and 3 percent as "modern" irrigation (GOT 1982a, 1993; Mrema 1984; Mascarenhas, A., et al. 1985; FAO 1987b; LRDC 1987). Major areas of smallholder irrigation include the slopes of Mt. Kilimanjaro, Mt. Meru, the Pare and Usambara Mountains, and the flood plains of the Rufiji, Wami, Ruvu, Pangani Rivers. (Masao 1974; Mrema 1984; Adams and Anderson 1988; Adams 1989; Burra and van den Heuvel 1989; Burra 1990; Grove 1993; Lema 1993). The Rufiji flood plain constitutes the single largest area under traditional irrigation.

While some traditional smallholder irrigation systems have been in existence for hundreds of years, government involvement in irrigation development dates only from the 1930s. Until the early 1950s, the government—through the Smallholder Irrigation Advisory Service and later a unit of the Ministry of Agriculture and Cooperatives—provided sporadic assistance

to traditional irrigators, principally by providing technical advice, but occasionally by providing the material resources needed for making small-scale innovations and improvements, such as the construction of small dams.

In 1953, a Water Development Department was established within the Ministry of Water and Energy as the primary government agency for irrigation in Tanzania (GOGB 1955). It was subsequently renamed the Water Development and Irrigation Department (WDID). From 1955 to 1965, the British, and later the independent government, attempted to transform a number of traditional smallholder irrigation schemes into "modern" systems. These schemes were planned, constructed, and paid for by the central government. Farmers were primarily responsible for water distribution, land preparation, and crop selection and scheduling. During that decade, more than 20 such schemes (50 to 300 hectares each) were built by WDID at a cost of about U.S. $5,000 per hectare (GOT 1982a, 1984; Mrema 1984; Mascarenhas, A., et al. 1985). The program continued into the early 1980s, but at a much reduced level of effort. Between 1969 and 1974, only 8 percent of the funds allocated for irrigation went to traditional irrigation systems (Mascarenhas, A., personal communication).

The first large-scale irrigation farm was established in the 1930s near Moshi by a private enterprise. The first public scheme was constructed in 1948 in Morogoro Region, but it was abandoned in 1951. In the early 1970s, government involvement in irrigation increased dramatically. The majority of funds went into the establishment of several large-scale farms for the production of high-value cash crops such as rice, sugar, and coffee. These farms, which were anywhere from 400 to 3,000 hectares in size and cost between U.S. $5,000 and $11,000 per hectare, were managed by centralized, parastatal agencies.

By the late 1960s, it was increasingly apparent to the government that its approach to irrigation development was not living up to expectations: the process was slow, expensive, and not meeting the needs of small, rural farmers. In 1970, an appraisal of the sector found that most government schemes (both "modern" smallholder and large-scale) had a return of less than 10 percent—the collective result of low yields, poor management, and high maintenance costs (Mascarenhas, A., personal communication). Rather than recommend a new approach, however, the appraisal concluded that irrigation was not an effective means of increasing agricultural production. Despite the failure of government-promoted irrigation schemes and the appraisal's recommendation, the combination of prolonged droughts during the mid-1970s and early-1980s and the high priority accorded self-sufficiency and food security ensured continued government interest and involvement in irrigation development.

In the mid-1970s, a number of new irrigation initiatives were launched. In 1974, a promotional campaign and a national assessment of irrigation potential were undertaken to identify the most promising sites for future development. Support from the country's ruling political party came via the pages of *Kilimo ni Siasa*

(Agriculture Is Politics) and *Kilimo cha Kufa na Kupona* (Agriculture for Survival), its regular party-line publications. The WDID was disbanded in favor of a new Irrigation Division within the Ministry of Agriculture. This new ministerial alignment meant that many hydraulic engineers were replaced by agronomists in the government's key irrigation institution. As a result of further restructuring, the responsibility for smallholder irrigation was shifted from the central government to the regional administrations, each of which established an Irrigation Section under the Regional Agricultural Development Office. The new emphasis on regional development resulted in the preparation of Regional Integrated Development Programmes (RIDEPS) and Regional Water Master Plans, some of which featured irrigation development (Mascarenhas, A., personal communication).

Despite increased investments, especially between 1975 and 1979, the development of irrigation systems and agricultural production from irrigated farmland continued to fall below expectations. Many of the schemes initiated during that period were not efficient and are now inoperable. In 1982, a government report on agricultural policy noted that "the advantages of irrigation farming have not adequately been tapped" (GOT 1982a). The main problems identified were:

- Absence of a formal irrigation policy;
- Reliance on sophisticated irrigation techniques that demand heavy investments and require foreign exchange and highly trained manpower;
- Poor planning of irrigation projects, particularly smallholder irrigation schemes; and
- Lack of manpower to construct large-scale irrigation schemes.

Six policy proposals were presented, five of which pertain to technical aspects (need for physical infrastructure, land-use plans, soil surveys, etc.). The sixth recommended that village schemes be encouraged to "re-vitalize the spirit of self-help" (GOT 1982a).

The 1982 report resulted in the preparation a National Agricultural Policy in 1983 with broad objectives for irrigation development:

> It is clear that the country has a big potential for the development of both small and large-scale irrigation schemes. The 1974 reconnaissance of areas suitable for irrigation, which was conducted in all regions, will be scrutinised and updated by qualified personnel and existing schemes will then be rehabilitated as a matter of priority. New village schemes will be developed as quickly as this is possible, especially where they can be combined with the construction of mini-hydro power units. Large-scale irrigation schemes will be developed on the basis of their economic viability and the least cost approach. In all cases, steps will be taken to ensure that the irrigation works are properly maintained and managed; the possibilities of having two or more crops a year from irrigated areas will be explored (GOT 1983).

In 1984, the National Food Strategy report focussed attention specifically on the potential role of small, traditional irrigation schemes and stated that their improvement —through government support—should be part of the strategy for increasing food security:

> While the area under smallholder irrigation is slowly expanding, it is unlikely that the smallholder irrigation targets of the National Food Strategy will be met without government support. A first priority will therefore be to rehabilitate existing smallholder irrigation schemes by constructing improved or permanent weirs, off-take structures, conveyance channels and diversion structures (GOT 1984).

The National Food Strategy further proposed that traditional irrigation schemes be promoted by regional authorities with assistance from the central Irrigation Division. The report envisioned that traditional schemes would result in an estimated 255,000 hectares under irrigation by the year 2000, more than double the 125,000 hectares envisioned for both small- and large-scale government schemes.

In response, six Zonal Irrigation Units (ZIU) of the Irrigation Division were established in the regions—coordinated by the National Village Irrigation Development Programme—to assist smallholder irrigation. Yet despite increased assistance from international donor agencies, few objectives of the 1983 policy and 1984 report were achieved. Existing government irrigation schemes continue to degenerate, and little new land has been put under irrigation. Irrigation remains significantly under-utilized in Tanzania.

Recently, the government began revising many of its existing "framework" and sectoral policies and legislation, including its agricultural policy.[14] In September of 1993, the Ministry of Agriculture released the first draft of a revised National Agricultural Policy. On the issue of irrigation, the draft states:

> Emphasis will in future be placed on the development of smallholder irrigation in potential areas and encouraging farmers/operators to form water users associations for better management of their schemes.
>
> Future investment on large-scale irrigation schemes will critically consider the economic viability and cost effectiveness of the projects. The government will encourage private investors to undertake large-scale irrigation, with due consideration to land conservation and environmental aspects.
>
> The Governments role in irrigation development will in future be limited to the construction of the necessary

14 The government is also updating its tenure, forestry, wildlife, and other sectoral policies and is preparing a national environmental policy and act. In addition, some local administrative units are revising their by-laws related to natural resource management and use. Many of these policies and laws have implications for water management and irrigated agriculture.

infrastructure and other support services in irrigated areas, particularly for smallholder irrigation (GOT 1993).

In 1994, a government report on irrigation was prepared which attempts to capture the critical issues regarding irrigation development in Tanzania. This report is currently being internally reviewed and debated. It may lead to the development of a national irrigation policy (Mascarenhas, A., personal communication).

Decentralization in Tanzania

Participation in government and local development, including the improvement of smallholder irrigation systems, can be facilitated by devolving the central government's political authority and directing responsibility for socioeconomic development to appropriate local administrative bodies, including Village Councils.

In 1962, the post-independent government made rural development the cornerstone of its development strategy. Founded on principles of socialism and self-reliance, its goal was to:

> (b)uild a society in which all members have equal opportunities; in which all can live at peace without suffering or imposing; and in which all have a gradually increasing basic level of material welfare before any individual lives in luxury (Nyerere 1962).

A series of public policies, legislation, and actions followed which formed the core of the government's decentralization program. Collectively, these efforts sought to improve the living standards of the rural population by accelerating the pace of local development through community participation in the development process and by allocating more resources to the rural sector.

In February 1967, the Arusha Declaration called for establishing planned communities that would be the focus and purpose of an agrarian system designed to simultaneously achieve political democracy, economic growth, and the egalitarian distribution of income and wealth.[15] In March 1969, Presidential Circular No. 1, "The Development of Ujamaa Villages," introduced the villagization program of bringing all rural people into planned communities. The Decentralization Act of 1972 established a framework for formulating development plans with the village as the principal development unit. Theoretically, communities prepared village development plans that were passed through wards, districts, and regions to the central government for approval. Funding and other resources necessary for implementation were then channeled back to the villages from the central government.

Villagization was set in motion with the 1973 Party Directive "Operation Vijiji" and

15 In 1963, the government created the Village Settlement Agency (VSA) to establish planned communities and village-based agriculture, but its efforts were largely unsuccessful. The VSA was abandoned in 1967.

essentially completed by 1983. By 1980, 90 percent of the rural population (about eight million people) had been regrouped and redistributed into 8,230 nuclear villages, each with 250 to 600 families. Only a small proportion of these villages, however, were formal *ujamaa* cooperatives. The Villages and *Ujamaa* Villages Act of 1975, the Villagization Act of 1977, and the Cooperative Act of 1982 established the legal framework for registering villages as cooperative societies and for constituting a formal village government. In 1982, the Local Government Act further empowered districts and villages to manage their affairs, including authorizing districts to approve some village development plans and Village Councils to establish by-laws and generate government revenue. (*See Chapter II, Msanzi Village: Indigenous Water Management for additional information on villagization and decentralization.*)

Tanzania's decentralization program received considerable world attention. Although the program achieved some successes, most analyses concluded that its results fell far short of the stated objectives (Mushi 1978; von Freyhold 1979; Hyden 1980; Raikes 1980; Fortmann 1982; Chambers 1985; Kauzeni 1988; Collier et al. 1990). The idealistic vision of self-reliant, democratic, egalitarian, and cooperative *ujamaa* villages never materialized. At the community-level, inactive Village Councils, poor development planning, and limited resources hindered the preparation and implementation of village development plans. At the national level, administrative bottlenecks, mismanagement, and financial constraints delayed the approval and funding of village plans.

Equally important, the government's approach to development created local dependence on government and donor agencies, and, in many communities, eroded the local spirit of self-help as well as the capacity for self-reliance (Mushi 1978; von Freyhold 1979; Hyden 1980; Raikes 1980; Fortmann 1982; Chambers 1985; Kauzeni 1988; Collier et al. 1990). In many communities, decentralization programs replaced viable indigenous institutions with ineffective, government-supported Village Councils. Village plans that had been prepared by communities were often significantly altered by higher-level administrative units or put aside in the interests of the region or nation. In most cases, village development targets were not met because the needed (and promised) resources never materialized. As a result, most rural communities remain isolated and most villagers remain poor.

RECOMMENDATIONS

In light of Msanzi's experiences and Tanzania's irrigation efforts and decentralization program, several policy and program recommendations can be proposed for consideration by the Tanzanian government and the development assistance community concerned with improving local water-management for irrigated agriculture.

Developing a National Irrigation Policy

Tanzania needs a comprehensive national irrigation policy. The current national irrigation objectives are still those outlined in the 1983 National Agricultural Policy. This policy recognizes the nation's irrigation potential, acknowledges the slow

implementation rate of new irrigation schemes, and identifies some operational inadequacies of current schemes. It gives priority to the rehabilitation of existing irrigation schemes, the development of new village schemes, and training in system maintenance and management.

Despite the recommendations contained in the 1984 National Food Strategy report regarding traditional irrigation, the government does not adequately recognize the extensiveness of indigenous smallholder irrigation schemes or their contribution to food security, cash crop production, and local and national development. It does not appreciate the considerable pressure that many traditional systems are experiencing —pressures that have caused many to degenerate and some, such as Msanzi's, to collapse. And it does not specifically address the need to improve and rehabilitate traditional irrigation schemes.

If approved, the 1993 draft of the revised National Agricultural Policy will be a significant improvement over the 1983 policy with regard to irrigation development. The policy would give priority to the development and management of smallholder irrigation and recognize the potential environmental impacts of large-scale schemes. In line with Tanzania's ERP, the government's role in irrigation development would be limited to constructing infrastructure and providing other "support services," (particularly for smallholder irrigation), and encouraging private investment in large-scale irrigation. Still the 1993 revision falls far short of a comprehensive national irrigation policy.

The absence of a national irrigation policy has, in part, precluded the formulation of a formal irrigation strategy and action plan, prevented the adoption of irrigation recommendations in a consistent manner, and undermined the performance of the sub-sector. For example, the 1983 National Agricultural Policy states that large-scale schemes will be developed on the basis of their economic viability and the least-cost approach, yet most large-scale public irrigation schemes (and "modern" smallholder irrigation systems) continued to be capital-intensive, ineffective, and unsustainable. Furthermore, the 1983 policy is silent on rehabilitating and improving *traditional* smallholder irrigation systems, and the relevant statements in the draft 1993 policy, if approved, could be interpreted so that the construction of new "modern" smallholder irrigation schemes will take precedence over rehabilitating existing traditional systems.

It is encouraging to note the government's current interest in irrigation, and it is hoped that its 1994 internal report on irrigation will result in a national irrigation policy. Such a policy must fully recognize the importance of traditional irrigation and actively promote its development.

A national irrigation policy, even in the absence of supporting national/regional legislation or a formal strategy/action plan, can provide political support and guidance to help legitimize traditional, small-scale irrigation systems and promote targeted development assistance. In addition, it can encourage local governments to address irrigation and reinforce local leaders' efforts to organize self-help irrigation initiatives and provide the incentives and leverage

they need to resolve other community problems. Last, but not least, it can also shelter traditional smallholder irrigation from conflicting sectoral policy.

Improving Traditional Smallholder Irrigation Systems

Establishing new smallholder irrigation systems, and rehabilitating or improving traditional systems, should be the cornerstones of the government's irrigation development strategy. Most irrigated land in Tanzania is under traditional systems and most traditional systems are stressed, often to the point of collapse. Improving existing smallholder irrigation systems is the most promising approach for improving irrigated agriculture, while establishing new smallholder schemes is the best strategy for expanding irrigated agriculture (Korten 1982; Blackie 1984; Mrema 1984; Mascarenhas, A., et al. 1985; Coward 1987; Adams and Anderson 1988; Carter 1989; Adams 1990; Burra 1990; Vincent 1990). Large-scale "modern" irrigation schemes are expensive to construct, costly to maintain and manage, have a relatively low rate of return on investment, and frequently fail (FAO 1969, 1986; Boeree 1972; JICA 1980; Carruthers 1983).

The Msanzi experience illustrates the ingenuity, creativity, and capacity for self-help development. It also highlights the limitations of indigenous knowledge and traditional systems in responding to the pressures and "shocks" of modern society. Msanzi's farmers have addressed several critical issues that are commonly encountered in irrigation development and that appropriate government support should address. Four of the most prominent and problematic issues are:

1) Smallholder irrigation systems are labor-intensive and have relatively high start-up costs in land, labor, technology, and capital (Carruthers 1983; Blackie 1984; Mascarenhas, A., et al. 1985; Chambers 1988; Adams 1990; Smout 1990). These costs are particularly high when the ecological conditions are less than favorable. In Msanzi, drought, hunger, and persuasion from the district counselor provided the incentives to construct the system—more than three decades after irrigation was first introduced there and in spite of Msanzi's reliable water sources and fertile soils. Capitalizing on irrigation opportunities can be difficult for poor farmers with limited available labor, few resources, and little access to credit.

2) Many traditional systems are not as technically efficient as modern systems (Blackie 1984; Morris and Thom 1985; Carter 1989; Burra 1990; Speelman 1990). An early evaluation of traditional irrigation systems in Tanzania claims that they are only 40 percent effective in utilizing water (Mascarenhas, A., personal communication). Msanzi's traditional system lost water through seepage in unlined canals, its intake weirs had to be rebuilt annually, and the canals and lateral furrows needed rehabilitation and clearing each year. From a technical perspective, traditional systems often cannot support as many water users per furrow or unit of water

as upgraded indigenous schemes or "modern" smallholder schemes.

3) Many smallholder irrigation systems are well managed, often through local water-users' institutions (Korten 1982; Blackie 1984; Fleuret 1984; Bagadion and Korten 1985; Uphoff 1986; Martin and Yoder 1987; Chambers 1988; Burra 1990; Smout 1990; Vincent 1990; Thompson 1991; Vermillion 1991; Tang and Ostrom 1993; Funnell 1994). Yet poor management is a root cause of much inefficiency and failure in smallholder irrigation systems, especially newly established schemes. In some cases, farmers have not organized themselves to manage their irrigation system effectively. In other cases, management has been informal and haphazard, as in Msanzi before the collapse of the main canal. In still others, the water-users' institution has been ineffective, even corrupt.[16]

4) Subsistence demands and limited local resources often force farmers to respond to changing circumstances and increasing pressure on the traditional irrigation system in ways that minimize short-term costs and maximize immediate profits, rather than maximize net long-term benefits. For example, farmers often respond to expansion pressures with a "building block" strategy—adding new irrigation units, sometimes haphazardly, rather than limiting use or making the necessary (usually costly) major structural adjustments. In Msanzi, additional furrows were constructed to bring more land under irrigation in response to population increases and the commercialization of maize. Such an approach is cost effective in the short-term, but will eventually tax the system's capacity and result in the degeneration or collapse of the system. This is exactly what happened in Msanzi.

To address these issues, four government actions are recommended.

1. Focus on Improving Traditional Smallholder Irrigation Schemes

To meet national goals in irrigation and food security, existing schemes will need to be rehabilitated, and new irrigation systems will need to be established. The government priority should be to rehabilitate and improve existing smallholder schemes, especially traditional systems, such as the one in Msanzi. Most irrigated land is under traditional smallholder schemes, many of which are under stress and operate below capacity; some are near collapse. Improving such schemes would be cost effective—a combination of low capital investment and high returns in agricultural productivity and human well-being.

16 Traditional political structures in rural Africa often centralize power within a few individuals, usually patrilineal heads of established families. Various checks and balances help ensure that village leaders use their power for the good of the community. Government-sponsored local institutions, however, often usurp traditional power and undermine these checks and balances. As a result, "modern" leaders often wield unconditional authority, and many have abused their power for personal gain, frequently at the expense of the community at large.

Establishing new "modern" irrigation schemes, whether small or large, is both time consuming and costly. For example, in 1980 it was estimated that the development alone of the proposed Lower Moshi Irrigation Scheme would cost the government T. Sh. 633 million for irrigating 6,320 hectares and would require several years to construct and operationalize (JICA 1980). Considering local inputs for construction, maintenance, and management, the rehabilitation of the Msanzi system will cost the government/donor substantially less per hectare in up-front and recurring costs.

The importance of building on local knowledge, practices, and techniques is well documented (Biggs and Clay 1981; Bunch 1982; Richards 1985, 1989; Chambers et al. 1989; Fujisaka 1989a, 1989b, 1992; McCorkle 1989; Thrupp 1989, 1991; Barrow 1991; Loevinsohn et al. 1991; Warren 1991). Evidence also suggests that improving traditional systems—with communities already committed to irrigated agriculture—is more likely to succeed than introducing new technologies or management systems, including irrigation to non-practicing farmers (Korten 1982; Carruthers 1983; Hogg 1983; Mascarenhas, A., et al. 1985; Morris and Thom 1985; Coward 1987; Adams and Anderson 1988; Carter 1989; Burra 1990; Smout 1990; Speelman 1990; Vincent 1990; Vermillion 1991; Funnell 1994). Farmers are more likely to accept technological improvements that are adaptations of familiar "parent" methods than they are to respond favorably to fundamentally different, new, or foreign practices. Improving existing practices often entails fewer adjustments to the environment and to existing production and management systems. New techniques, especially those unfamiliar to the local people, are often perceived as complex and risky.

When appropriate, government assistance to irrigation should seek to "upgrade" traditional irrigation systems rather than construct new "modern" ones. This applies to technical and organizational aspects of irrigation development. For example, effective irrigation management can often best be achieved through existing and viable local institutions (including traditional groups). Much of RUDEP's support in rehabilitating the Msanzi irrigation system built upon the traditional system, and thereby on indigenous knowledge and social adaptation.

2. Shift to a Participatory Approach to Irrigation Development

A shift of government support from establishing a few large-scale irrigation schemes to improving multiple existing smallholder (usually traditional) systems will require a fundamental shift in the government's approach to irrigation development. The current "technical and bureaucratic" approach to smallholder irrigation typically involves extracting limited information from the water users, processing it outside the community, slapping a technological "fix" on the situation, and bringing the "correct" answer to the community for approval and implementation (Mrema 1984; Mascarenhas, A., et al. 1985; Burra and van den Heuvel 1989; Burra 1990; Lema 1992). Effective government assistance to traditional irrigation will require a flexible, locally-based participatory approach to

planning, construction, maintenance, and management (Korten 1982; Leonard and Marshall 1982; Carruthers 1983; Chambers 1983, 1988; Blackie 1984; Mrema 1984; Bagadion and Korten 1985; Mascarenhas, A., et al. 1985; Morris and Thom 1985; Coward 1987; Adams and Anderson 1988; Carter 1989; Burra 1990; Smout 1990; Speelman 1990; Vermillion 1990; Vincent 1990; Thompson 1991; Lema 1992; Funnell 1994).

All government actions in support of smallholder irrigation systems must recognize the range of individual and community needs, priorities, resources, and constraints, and the importance of incorporating local perspectives in policy and project assistance related to, or impacted by, irrigation development. Efforts must be made to better understand the prevailing ecological and natural resource conditions as well as the local political and socioeconomic circumstances that are fundamental to sustainable irrigation. In addition to data on water flow, availability, and soil characteristics, information is needed on household land holdings, family income, potential markets, labor availability, local institutions, alternative economic opportunities, and other local resources. Considering the potentially significant impacts that irrigation can have on the area and the villages surrounding the involved community, it is also important to assess both up- and down-stream social and economic impacts.

Local perspectives can be communicated to government through the participation and involvement of local people or their legitimate representatives in public decision-making. Participation can take many forms, including participatory project design, conflict-resolution and negotiation, nongovernmental organization (NGO) workshops, regional consultations, and documenting local experiences. Government should find ways to promote and facilitate such participation and incorporate local perspectives in decisions and actions. In many cases, this will require sensitizing civil servants involved in implementation, training staff in facilitating participation and participatory planning, and building skills in the issues most needed by farmers. Community involvement in data analysis/interpretation and irrigation design/implementation will help government avoid situations like Msanzi's, when the technical assessment regarding water availability differed from local knowledge and understanding.

This new approach will require a decentralized government structure in which the most appropriate administrative level and responsible institutions have the mandate and authority to make development decisions, and the capacity to effectively address and manage multiple smallholder irrigation interventions. It will require additional local government staff trained in smallholder irrigation development, including participatory research and development, community management, and information collection and analysis. At present, Tanzania's six Zonal Irrigation Units (ZIUs) are not sufficiently empowered or connected to the local level to effectively perform these functions. Institutional strengthening support to the ZIUs would improve their assistance to smallholder irrigation. Consideration should also be given to empowering and strengthening more local

levels of administration in irrigation development.

3. Strengthen Local Management of Smallholder Irrigation

Community management of irrigation systems is more efficient (i.e., can respond quicker to changing conditions), cost effective, and sustainable than government control. Still, poor irrigation management is a contributing cause of many unsuccessful irrigation interventions—including support to smallholder schemes—by both government and development assistance agencies (Chambers and Morris 1977; Korten 1982; Leonard and Marshall 1982; Carruthers 1983; Mrema 1984; Bagadion and Korten 1985; Coward 1987; FAO 1987a; Martin and Yoder 1987; Carter 1989; Adams 1990; Burra 1990; Speelman 1990; Vincent 1990; Thompson 1991; Vermillion 1991; Tang and Ostrom 1993; Funnell 1994). Irrigation management problems are consistently underestimated by governments and donors and, as a result, not adequately addressed. The government can improve irrigation by helping strengthen irrigation management. The focus should be on helping communities establish effective local water-management systems within viable, existing village-based institutions.

Farmers who are practicing irrigated agriculture often establish a water-users' association to manage system development and maintenance, and water usage and distribution (Korten 1982; Blackie 1984; Fleuret 1984; Bagadion and Korten 1985; Uphoff 1986; Martin and Yoder 1987; Chambers 1988; Burra 1990; Smout 1990; Vincent 1990; Thompson 1991; Vermillion 1991; Tang and Ostrom 1993; Funnell 1994). Most effective associations are characterized by sound leadership and a high degree of active involvement of water users in all aspects of the system's operation and management. Pluralistic management structures promote communication, conflict resolution, and consensus-building. Community-wide participation helps enable all water users to express their individual opinions, and ensures that they contribute their particular knowledge and skills. In so doing, it often fosters a sense of ownership, commitment, and involvement. And successful participatory experiences encourage further involvement in new decisions and actions.

Government technical support to the establishment and improvement of smallholder irrigation systems should be complimented by assistance to system management and organization. Assistance to local water-management can take the form of political support to help legitimize local water-users' associations; training local leaders in negotiating, consensus building, and accounting; advice on critical water-management issues, such as water acquisition, allocation, distribution and drainage; and information on "externalities" such as weather and market dynamics.

4. Improve Information Exchange Between Farmers

Irrigation can be promoted and improved by farmer-to-farmer exchanges of experiences and information on smallholder irrigated agriculture. Farmers are more likely to adopt irrigated agriculture or upgrade their traditional systems when they know and understand new or improved

practices and techniques (Korten 1982; Carruthers 1983; Hogg 1983; Mascarenhas, A., et al. 1985; Morris and Thom 1985; Coward 1987; Adams and Anderson 1988; Carter 1989; Burra 1990; Smout 1990; Speelman 1990; Vincent 1990; Vermillion 1991; Funnell 1994). Government can facilitate the sharing of such information by promoting and supporting farmer-to-farmer exchanges and other "informal" communication channels.

Networking between farmers is as old as farming itself, yet relatively few efforts have been made by the government to better understand and capitalize on traditional and informal "horizontal" communication links. The little information collected by government on traditional practices and experiences has more often been vetted through formal communication channels, such as publications and international workshops, neither of which do not reach many rural people in Africa. Interest by governments in supporting formal and informal farmers' networks and facilitating farmer-to-farmer exchanges is growing, but these less formal communication channels remain substantially underutilized.

Farmer-to-farmer exchanges, farm visits, and farmer networks are particularly useful and cost-effective in sharing information and encouraging the adoption of new practices and techniques (Benor and Harrison 1977; Bunch 1982; Howell 1988; Rahm 1988; Roberts 1989; Haverkort and Millar 1992; Turkahirwa and Veit 1992). Such exchanges allow information sharing among experienced and inexperienced farmers, help build confidence, reduce risks, and avoid the mistakes associated with adopting new techniques and practices (whether through local experimentation and innovation or from outside the community). Farmer-to-farmer exchanges across communities are particularly important for irrigation development because of the up- and down-stream implications of any project and the opportunities that exist for multiple-village systems.

The Msanzi experience shows that local leaders and community innovators, by virtue of the authority and respect they typically command, can act as effective information disseminators and agents of change. The farms and improved practices of local innovators can serve as model sites for other farmers to visit and learn from. Government and agricultural research institutions should collaborate with local innovators and model farmers in developing new farming practices and irrigation techniques, and in disseminating the information and findings to other interested and concerned farmers.

V. Conclusions

The economic hardships, population pressures, and social adjustments prevalent throughout Africa today have put tremendous pressures and demands on traditional systems of resource management and production. At the same time, these conditions make the effective use of natural resources ever more crucial, particularly for the rural poor, who for the most part, depend on agriculture and the resource base for their livelihood and survival. Communities that have successfully adapted their traditional systems to these "modern" pressures (and opportunities) are well worth examining.

The people of Msanzi have been utilizing their local water resources for irrigated agriculture for over 60 years. They have succeeded partly because they have effectively dealt with crises. With each "shock," the villagers have been able to define the problem, identify potential solutions, and initiate appropriate action, including the mobilization of external assistance. For the most part, the relationship between Msanzi and RUDEP is one of partnership—the two parties work together to address a priority need of the community. The RUDEP philosophy of local initiative, self-help, education, and training was instrumental in the success of this complex collaborative effort, one that essentially meshed "modernity" with tradition. The advantages of improving stressed or collapsed traditional irrigation systems over establishing large-scale schemes are clear.

Rukwa is a remote region of Tanzania, but so are Ruvuma, Mtwara, Lindi, Kigoma, and Tabora. While communities can accomplish much on their own, limitations and constraints on indigenous knowledge, labor, capital, and other critical resources restrict self-help ventures. Development assistance is often necessary to jump-start, facilitate, or accelerate community involvement. Working in concert with local leaders and viable village institutions, the government, donor agencies, and PVOs/NGOs can mobilize villagers for local development purposes—in particular, managing common property for improved production. The role of local government and grassroots organizations in collaborating with communities to improve traditional institutions and practices is critical. Tanzania's efforts to reform its agricultural and other sectoral policies and practices, improve its decentralization effort, strengthen its local government, and support its NGOs, as well as other independent groups (including those from the private sector), bode well for the future of both smallholder agriculture and the African nation-state.

Glossary

diwani - district counsellor

intumba - a type of farming system involving the manual construction of mounds on which beans are cultivated the first year, millet the second year, and maize the third year

kipindi cha njaa - the hungry season, i.e., January–March

kualika - traditional labor in which a core of extended family members and neighbors work for reciprocal, usually agricultural, goals on a rotational basis

mashamba ya binafsi - traditional "private" farms located around family homesteads

mbega kwa mbega - block farms

mbugas - wetlands

ntapila - small, dry-season gardens planted near waterways, on stream and river banks, and, when the water is low, or the season exceptionally dry, on moist river beds

ntemele - a form of shifting cultivation in which vegetation over an area many times larger than that which is to be cultivated is cleared and burned so that millet could be grown on the ashbed

shamba la ushirika - cooperative farms

ugali - a main dish of Tanzania consisting of the cooked dough of green maize kernels

ujamaa - numerous interpretations, including family-hood, brotherhood, and friendship

vitongoji - traditional rural settlement patterns consisting of dispersed, extended family homesteads or groups of such homesteads

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