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Social Dimensions of the Participatory Irrigation Management in Africa

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Atsushi Hanatani and Mine Sato

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JICA Research Institute

JICA Research Institute
10-5 Ichigaya Honmura-cho
Shinjuku-ku
Tokyo 162-8433, JAPAN
TEL: +81-3-3269-3374
FAX: +81-3-3269-2054

Assessing Effectiveness and Sustainability of Community-managed Informal Irrigation in Africa – A Comparative Institutional Analysis of "Temporary" Irrigation in Malawi –

Atsushi Hanatani* and Mine Sato†

Abstract

Since early 2000, a type of group-based informal irrigation for irrigating a very small area – less than two hectares on average, has seen widespread adoption among Malawian farmers. The technology, called "temporary" irrigation, uses farmers' own labor and locally available materials for constructing river diversion structures and canals, and these are managed by informal "clubs." This paper attempts to assess the effectiveness and sustainability of this technology from the beneficiaries' point of view, by employing an analytical framework that focuses on property rights and collective action as critical factors affecting technology choice and adoption. A comparative examination of selected informal irrigation cases in the Dowa district reveals that, in spite of the absence of secure tenure over land and water and of strong collective-action incentives among farmers, temporary irrigation has satisfied most of the effectiveness criteria and thus has contributed to technological expansion. This is attributable to the relative resource affluence and temporary nature of irrigation facilities which have existed at least up to the present. But the very "success" of the informal irrigation technology is changing the nature of the resources: where water in the streams has become scarce, river-bank lands have been commoditized and temporary diversion structures have been upgraded to permanent structures. Specific policy measures necessary to ensure sustainability of temporary irrigation should include: 1) provision of agronomic extension services to improve the profitability of irrigation, 2) promotion of basin-wide watershed management including provision of opportunities for stakeholder dialogues for conflict resolution while improving water use efficiency to enable secure and equitable access to productive resources, and 3) a cautious approach in strengthening water users' associations based on deeper understandings of the farmers' incentives (cost and benefit) for taking collective action.

Keywords: Malawi, informal irrigation, property rights, collective action, effectiveness, sustainability

* Senior Research Fellow, JICA Research Institute (Hanatani.Atsushi@jica.go.jp)
† Research Associate, JICA Research Institute (Sato.Mine@jica.go.jp)

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Introduction

While the importance of irrigation in Sub-Saharan Africa (hereinafter simply referred to as Africa) has been widely acknowledged, its performance has failed to live up to expectations. The disappointing results of large-scale irrigation schemes favored by international donors and national governments during much of the 1970s and 1980s has led to a shift of attention to small-scale farmer-managed irrigation (including the promotion of irrigation management transfer –IMT) (e.g., DFID 1998; Vermillion and Sagardoy 1999; FAO 2001).[1]

But small-scale irrigation is not without its flaws. Existing studies have indicated that despite many success stories, not everything about this type of irrigation went well in Africa (e.g., Adams 1990; World Bank 2007). Challenges for small-scale irrigation include the top-down approach in which farmer participation is no more than lip-service, poor project preparation and engineering design under the name of "low-cost technology" (DFID 1998; FAO 2001), bureaucratic control of the management system (Adams 1990), the absence of credit and input/output markets, insecure resource tenure, and smallholders' hedgehog behavior (IWMI 2002).[2]

It is important to note, however, that much of the existing criticism toward irrigation has been directed at "formal" irrigation, which, whether large or small, is initiated, designed and implemented by governments and donors. Success stories can more often be found in "informal" irrigation schemes where farmers themselves make investment decisions, pay,

1. Although categorization of irrigation by size poses difficulties and sometimes proves not useful, small-scale irrigation in this paper will mean those schemes established at village level, practiced on small plots, and farmer-managed. It may serve an individual farm household, but usually a group of farmers, typically comprising between 5 and 50 households (Smout and Shaw 1994).

On the other hand, large-scale irrigation denotes those public systems established by a government body (including parastatal systems) on a larger scale, with variation in size from a few hundred (often 500 ha or more) to thousands hectares in the African context (Brown and Nooter 1992). These schemes were initially planned, developed and managed by the government, but have gradually gone through a transfer of management responsibility to farmers through IMT. However, it is still common that the government retains some role in the operation and management of these schemes.

2. Chambers classified the rural poor into two categories according to their survival strategies: foxes and hedgehogs. While "foxes" intend to diversify their living for survival, "hedgehogs" concentrate on one enterprise or activity, thus tending to remain conservative in taking up new economic activity such as irrigation. See Chambers1983: 140-45.

implement and manage the irrigation systems (Brown et al. 1995; DFID 2001; FAO 1996 2001; IWMI 2006).[3] African farmers have traditionally practiced self-developed and self-managed irrigations in different corners of the continent, adapting to different agro-ecological conditions and water resource availability. These self-help efforts are said to be making substantial contribution to the expansion of irrigated area at the macro level. According to an estimate, the recent growth rate of areal expansion of irrigation in Africa is 2% per annum, most of which has been achieved by farmer-owned systems (Lankford 2009).

So, there appears to be a huge potential for informal irrigation development in Africa. But the question remains as to what kind of informal irrigation is desirable for further expansion. One of the options is "micro" irrigation, where an individual farmer or a single household irrigates small gardens, for example 25-50 square meters of farm plot, using buckets, watering cans or treadle pumps to lift water from a stream or shallow water pans. These privately and individually owned schemes have recently drawn broader attention from donors and scholars (DFID 2001; IWMI 2006; Commission for Africa 2005).

But considering the limited impact of the micro schemes on food provision and poverty reduction at the macro level and in view of the increasing water scarcity caused by population growth and likely by global climate change, more attention should be directed to group-based or community-managed informal irrigation, which can irrigate a few to dozens of hectares from a single abstraction point. For policy makers and practitioners, such irrigation is desirable because it can contribute to expanding irrigated lands. As Lankford insists, one of the future priorities of irrigation development in Africa should be to "put communities of smallholders, not individual smallholders, at the center" (Lankford 2009: 479). Thus, there is a good reason to study this type of community-managed informal irrigation to extract implications for future interventions.

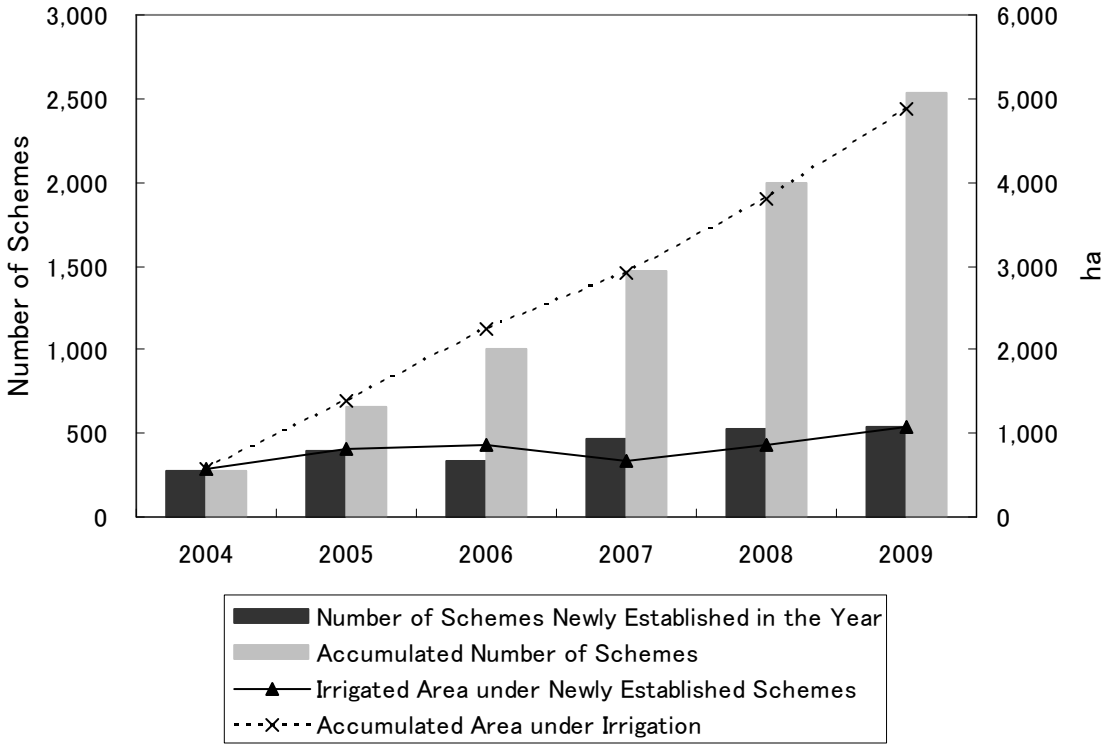
3. Strong farmer involvement in informal schemes, however, does not exclude the possibility of the government and the donor providing a limited amount of facilitation, incentives and financial/material support (FAO 1996).

Malawi is one of the countries in southern Africa where privately owned and practiced "garden" irrigation (dimba) has traditionally been practiced, which uses watering cans and treadle pumps to take water from the valley-bottom (dambo) or small streams (Adams 1990; FAO 2001). More recently, gravity-fed river-diverting irrigation using local materials (wooden poles, bamboos, rocks, grass, mud, etc.), has been widely adopted by farmers throughout the country, owing partly to donors' assistance (Arai et al. 2005; Kanamori 2008; Ieizumi 2009; JICA 2009) (see photograph of an intake inserted below). This irrigation system is hereinafter referred to as a "temporary" irrigation/scheme, following the local terminology, as the structure needs to be removed at the end of every rainy season and re-constructed at the beginning of the next season. In this paper, informal irrigation, counterposed against formal irrigation, is categorized into: 1) individual-based micro irrigation (including *dimba*) and 2) group-based small scale irrigation. The latter is further divided into two sub-categories: a) schemes with a temporary structure (temporary irrigation) and b) schemes with a permanent structure (permanent irrigation).

According to a donor's report, the number of these temporary schemes counts nearly 2,600 at the end of 2009 as compared to 251 sites recorded in 2004 (JICA 2009), irrigating 4,877 ha with the average area under irrigation registering at 1.9 ha. This accounts for nearly 13% of the total irrigated area in Malawi, and 29% of the areas irrigated by the gravity-fed method (MIWD 2010).

An example of temporary irrigation
(an intake structure made of wooden poles and grass)

Figure 1. Numbers of temporary irrigation schemes



Note: Though not all newly established schemes in a year are reconstructed in the following years or thereafter, a monitoring survey conducted in 2009 revealed that 93.1% of all schemes reported in 2008 were found existing in the 2009 season (JICA 2009).
Source: JICA 2009

In the face of the difficulty in sustaining and collectively managing "formal" irrigation systems in Africa, what accounts for the recent spread and sustenance of temporary irrigation systems in Malawi? Is it solely thanks to simple and low cost technology used for infrastructure building or to strong ownership held by participating farmers as the systems are basically self-developed with a minimum amount of external assistance? What are the limitations of this type of irrigation? In order to address such questions, this paper first attempts to evaluate the effectiveness of temporary irrigation schemes and then to explore the prospect of and challenges for sustainability of such schemes from the point of view of beneficiaries – i.e. how farmers perceive the costs, benefits and risks of doing irrigation collectively, and accessing resources – particularly water and land – necessary for agricultural production.

In order to highlight the characteristics of temporary irrigation, a comparison is made with informal irrigation schemes with "permanent" structures (hereinafter referred to as "permanent" irrigation/schemes such as concrete or masonry structures used for river diversion facilities). This comparison is important from a practical point of view, as the government of Malawi, with support from donors (including NGOs), is increasing its efforts to "upgrade" temporary schemes to more permanent ones. This comparison will give some clues to such questions as whether such upgrading can really improve effectiveness and enhance sustainability or whether it may only undermine the strength of temporary schemes. These questions have significant relevance for policy makers and practitioners.

To explore questions regarding effectiveness and sustainability, the present paper begins with a brief review of literature on informal irrigation development in Africa and Malawi to situate the research topic in a theoretical context as well as to ascertain its importance (Section 1). This section is followed by a presentation of our analytical framework which relies on IFPRI/CGIAR's CAPRi (Collective Action and Property Rights), hypothesis and methodology of data collection (Section 2). After offering national and regional background information on Malawi (Section 3), an analysis of three case-study sites in central Malawi, all of which started as informal temporary irrigation at the beginning but are now at different stages of infrastructure improvement, will follow. Section 4 describes the contextual conditions of respective sites according to the analytical framework presented in Section 2. This is followed by deliberation on institutions and processes of property rights and collective action (Section 5). Outcomes of technological choice are discussed in Section 6 from the viewpoint of farm economy, membership transition and competition over resources. Section 7 analyzes case-study findings based on the criteria presented in Section 2 and discusses why temporary irrigation has been so "successful" in the Malawian context (the effectiveness issue) and its future prospects and challenges (the sustainability issue). The paper closes by summarizing the main findings and presenting policy recommendations to policy makers and practitioners as to future interventions in irrigation development (Section 8).

1. Literature review

1-1. Informal irrigation in Africa

Informal irrigation in Africa has been a subject of study for some time. With regard to traditional irrigation, Adams and Anderson (1988), among others, reported that there have been widespread practices of indigenous irrigation in East Africa ever since the pre-colonial era. Underhill (1984) attempted to classify different traditional (as well as modern) technologies based on the method of water abstraction and application. Brown el al. (1995) attempted to link this classification with the extent of farmer control over design, investment decisions, and management. There are also studies on urban irrigated agriculture, which is widely practiced especially in West Africa, where more than 20 million people are said to be engaged in different forms of urban agriculture (DFID 2001; IWMI 2006). This type of urban irrigation is basically run by individual households, and, with manual water fetching, using watering cans is the most commonly used method of irrigation.

In these studies, however, the question of how these informal irrigation schemes are actually managed has not been fully explored. This is despite the fact that it has widely been recognized that the quality of management, rather than the size of the irrigation system and who owns and controls the system, determines the success or failure of the irrigation system (Underhill 1984; Adams 1990; Brown and Nooter 1992; Rosegrant and Perez 1997). Some of the limited efforts in this respect include studies of traditional irrigation in East Africa conducted by Yoshida (1999) and Ikeno (1999), observing the highly open and transient nature of membership in the water users' organizations, where farmers not connected by blood or territorial bonds can join the organization and still leave it after one or a few seasons of cultivation (ibid.). A more recent study conducted by Fu et al. (2010) studied traditional small-scale irrigation systems in Nigeria. The authors report that under the leadership of village-level "landlords," farmers manage to mobilize local resources to develop and maintain irrigation facilities and resolve conflicts among themselves.

The outputs of these studies are useful in exploring factors behind the success and limitations of temporary irrigations in Malawi. However, further investigations are necessary to understand how much these irrigation systems meet farmers' needs and interests.

1-2. Informal irrigation in Malawi

Apart from the literature written on the process and impact of the transfer of formerly government-managed schemes (Mulwafu and Nkhoma 2002; Ferguson and Mulwafu 2004; Nkhoma and Mulwafu 2004), studies on informal irrigation in Malawi are limited, let alone those on community-managed irrigation (Peters 2004; Arai et al. 2005; Kanamori 2008; Ieizumi, 2009).

Peters studied traditional (individual) irrigation in Malawi using *dambo* and river banks, and highlights the impact of the recent expansion of private irrigation on land and water resource management: the expansion of irrigation is bringing about fierce competition among various stakeholders over suitable land for traditional irrigation as well as water resources, and resource accumulation by local elites. Works by Arai, Ieizumi and Kanamori deal with temporary schemes more directly. They highlight farmers' livelihood constraints as the main reasons for the recent spread of informal irrigation, farmers' livelihood constraints including frequent drought, adoption of simple and low-cost technology by donors, and farmers' full cost-recovery approach in facility construction.

These works are helpful to understand the social background of land and water use in Malawi as well as their implications for irrigation development, and technical and contextual factors related to the recent expansion of temporary irrigation schemes. However, they are written mainly from the viewpoint of policy makers and donors, and there is a need to reassess informal irrigation schemes from the beneficiaries' point of view.

2. Analytical framework, hypothesis and methodology

2-1. Criteria of Effectiveness and Sustainability

In order to explore why community-managed temporary irrigation has been widely accepted by Malawian farmers and what limitations it faces, it is important to assess the technology's effectiveness and sustainability from the viewpoint of beneficiary farmers. "Effectiveness" here addresses to what extent this technology satisfies farmers subjectively. "Sustainability" examines whether such benefits are going to be recognized by farmers continuously.

Assessing effectiveness from farmers' viewpoints is justifiable as those who implement and benefit from community-based informal irrigation are farmers themselves. When seen from such a perspective, "successful" irrigation schemes can be defined in three different but mutually related terms: technological, economic and institutional (Brown and Nooter 1992). Technologically, such schemes are those that can secure a sufficient amount of water at a convenient time for the farmers. Economically, it has to be cheap, with low levels of capital investment, maintenance, and replacement costs, and profitable enough to offer farmers sufficient, if not maximum, returns. Institutionally, successful irrigation organizations are those that realize the above objectives for the farmers with minimum (direct and indirect) cost and interference with their livelihood.

As for sustainability, it will be useful to look at how sustainability is defined in the rural water supply sector since this sector shares many characteristics with irrigation. Rural water supply is defined as sustainable "if the water sources are not over-exploited but naturally replenished, facilities are maintained in a condition which ensures a reliable and adequate water supply, [and] the benefits of the supply continue to be realized by all users indefinitely" (Harvey and Reed 2004: 7).[4] For irrigation, it is imperative that farmers have secure access to and use of land resources in addition to water. Accordingly, our definition of sustainability

4. According to Harvey and Reed, there is another dimension of sustainability known as "replicability." This has been omitted from our definition as it is more of a concern to external actors, such as government and donors, than that of beneficiary farmers.

highlights whether farmers' access to and tenure of water and land resources is secured, whether continuous investment is made in facility maintenance, and whether benefits are distributed equitably among resource users.

2-2. Analytical framework and hypothesis

The definitions of effectiveness and sustainability presented above lead us to focus on property rights over land and water and the collective action problem as important contextual factors shaping farmers' perceptions and behavior regarding their choice and use of technology. Property rights can be defined as "rules governing the use of resources" (Ensminger 1992) and collective action as "action taken by a group (either directly or on its behalf through an organization) in pursuit of members' perceived interests" (Marshall 1998).

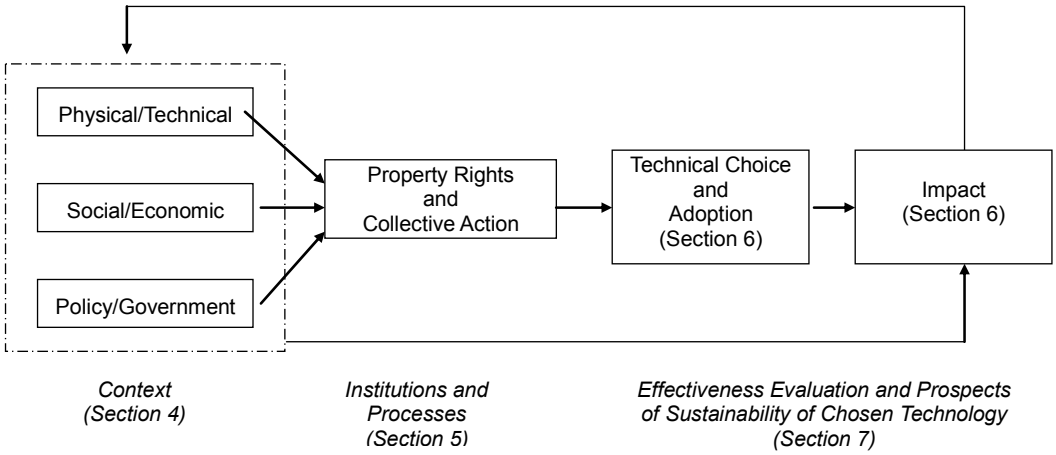
In terms of property rights, continued practice of irrigation requires a high level of tenure security over land in order to provide sufficient incentives to farmers. Likewise, the right to abstract water from a stream also needs to be secured for a prolonged period of time to enable continued practice of irrigation. As to collective action, since community-managed informal irrigation by definition involves more than one farmer, it naturally requires coordinated action among participating farmers for facility construction, water allocation, and maintenance activities.

Property rights and collective action are interdependent. For example, acquisition of a water right requires collective action among irrigation farmers, and concerted efforts taken for securing a water right may lead to the reinforcement of collective action among farmers (Meinzen-Dick and Gregorio 2004). In short, property rights and collective action present two vital focal points for assessing the effectiveness and sustainability of irrigation systems.

Based on this understanding, this paper intends to employ an analytical framework proposed by a group of IFPRI/CGIAR researchers, called CAPRi (McCulloch et al. 1998; Knox et al. 2002; Meinzen-Dick and Gregorio 2004). It is a framework focusing on institutions

(property rights) and processes (collective action) in assessing patterns of natural resources management and its outcome. The schematic diagram of the analytical framework is presented in Figure 2 below.

Figure 2. Schematic diagram of analytical framework based on CAPRi



Source: Knox et al. 2002: 38 with a partial modification by the authors.

According to Knox et al. (2002), four kinds of explanatory variables are assumed to explain the dependent variable - technical choice for irrigation. They are physical/technical factors (e.g., climatic conditions, infrastructure), social/economic factors (e.g., wealth, human resources, economic risk, and social network), policy and government factors (e.g., price policy, resource governing legislation), and property rights and collective action. Out of these four categories, the first three are of a contextual nature, providing direct and indirect constraints and opportunities for technical choice and adoption. The fourth factor, property rights and collective action, is concerned with institutions and processes around which interactions among players take place and directly affect resource management technology.[5] Finally, the technical choice has an impact on efficiency in resource use (productivity),

5. The two-way relationship among explanatory factors and dependent variables presented in the original figure has been omitted for the sake of ease of understanding. Moreover, the reverse relationship among factors was not clearly observed in the case materials treated here due to the limited timeframe which came under analysis.

distribution of benefits within the society (equity), and environmental sustainability, which subsequently feeds back to the contextual factors.

Our hypothesis is that the temporary irrigation technology has widely been adopted by Malawian farmers, because it has satisfied most of the effectiveness and sustainability criteria at least up to the present. The future prospect of sustainability of the technology, however, is not fully warranted due to changes in the contextual factors, especially physical/technical conditions, which are consequences of the very success of the technology itself.

2.3 Methodology

In the subsequent sections, this paper examines three cases of informal irrigation through the lens of this analytical framework. It will use the information and data from existing literature and from our field survey. The objective is to assess to what extent community-managed informal irrigation in Malawi – particularly temporary schemes – are satisfying the criteria of effectiveness and sustainability defined in Section 2-1. This will be better answered by a comparative analysis of an irrigation scheme with a temporary structure, one with a permanent structure and one with a half-temporary and half-permanent structure.

Since the main purpose is to look at impacts of property right and collective action, care has been taken to keep the contextual factors similar. The three irrigation sites surveyed – *Tipindule, Mtetelezi and Chimwansongwe* – are all located in the same administrative area called TA (Traditional Authority)[6] *Chiwere of the Dowa* district in Central Region. The reason for the location choice is that temporary irrigation is most popular in this region as shown by the fact that the largest number of temporary irrigation sites are found in this region (1,226 out of 2,535 or 48 % of the total) as of December 2009 (JICA 2009). Furthermore, these sites are

6. Traditional Authority denotes the area of indigenous geo-political and socio-economic jurisdiction as well as a symbol of kinship unity; an indigenous state sometimes of a single lineage descent group. The land under TA is held by the community but administered by TA on behalf of the members of the community. The responsibilities of TA are devolved upon TA's representatives, Group Village Headman (GVH(s)) and Village Headman (VH(s)) (GoM 2002).

all served by the same agricultural extension office called EPA (Extension Planning Area) *Mvera*, and accessible within 30 minutes' drive on laterite roads from a nearby tarmacked highway.

Assistance was sought from the Malawian Ministry of Irrigation and Water Development to prepare a short-list of candidate sites which were then visited by the research team before the determination of the actual research sites.

The field survey, which took two weeks per site, was conducted in September-October 2010. It was a dry season in which irrigated cultivation is practiced. The survey was administered by the authors themselves with assistance from an irrigation engineer who was responsible for conducting topographic survey and measuring water flows and facility dimensions and from two research assistant-cum-translators. The survey included interviews with villagers and traditional chiefs, focus group discussions with irrigation club committee members (such as the chairperson, treasurer, secretary, etc.) and participant observation of cultivation practices, water management and club management activities such as meetings and facility maintenance activities. Wherever available, irrigation club records were analyzed after being translated from *Chi-Chewa* into English.

Interviews with farmers cover issues such as household composition, land holdings,[7] sources of livelihood, agricultural production and disposal, and irrigation-related matters. The interviews were conducted with ten club-member households and ten non-club member households. Samples were selected randomly from the list of member households and from the list of non-member households belonging to the same villages. The number of interviewees belonging to irrigation clubs is ten for Tipindule and Mtetelezi and seven for Chimwansongwe. The number for Chimwansongwe is smaller because there were only seven members in the 2009 crop season.

7. The size of the irrigation plot and total irrigated area were actually measured using convex, but the land size of upland field was not measured due to the time limitation, and relied on farmers' accounts.

Information on the farm economy was collected for the 2008/2009 season on upland cultivation and for 2009 on irrigated cultivation. The information is based on the interviewees' memory, as no written record is kept by the farmers. This might affect the quality of collected data, but efforts were made as much as possible to confirm outlier data by double-checking with the interviewees.

After quickly glancing at the national and district backgrounds in the next section, findings from the field survey will be presented in accordance with the analytical framework shown in Figure 2.

3. Background

3-1. Agriculture sector in Malawi

Malawi is a landlocked country in southern Africa with a high population density (139 persons per sq. km). Some 13 million people inhabit the land with 94,200 sq. km (NSO 2009). Agriculture is the most important economic sector for the country, which employs about 80% of the total work force, contributes over 80% of foreign exchange earnings, and accounts for 39% of GDP (MoAFS 2010). Most of those who live in rural areas are smallholder farmers, who are engaged in subsistence farming and contribute some 70-75% of the agricultural production (GoM 2006; WB 2007). While the estate sub-sector produces most of the export-oriented high value cash crops such as tobacco, tea and sugar, the main staple foods for Malawians, such as maize, cassava and sweet potatoes, are produced by the smallholders, mostly under rain-fed conditions.[8] Among these staples, maize has the primary importance in the Malawian diet and in the smallholder farming.

Smallholder production in Malawi is characterized by its low productivity. The average yield of maize production still stands at less than 1.5 tons per hectare (MoAFS 2010).

8. The main cash crops available to farmers include burley tobacco, of which production was liberalized to smallholders after 1990, and groundnuts. The former, however, is not a readily available option to ordinary smallholders due to the high input requirement and frequent price fluctuation.

The low productivity of maize has chronically induced food deficits both at the national and household levels. At the national level, according to government statistics, before introduction of the Food Subsidy Input Program in 2005/6, Malawi had continuously experienced a domestic food gap (MoAFS 2010). Being a food-deficit country, Malawi needs costly food imports from the international market, which reduces already scarce foreign currency reserves. At the household level, a large proportion of farmers are chronically food insecure and most farmers are *not* maize self-sufficient. A majority of farmers have experienced a lean period which lasts, on average, for six to seven months from the end of the dry season until the harvest season (MoAFS 2010).

Oft-cited causes of this low productivity include, among others, excessive dependence on rain-fed cultivation, limited landholding size and low uptake of improved farm inputs (GoM 2006, 2010; World Bank 2007). First, staple crops including maize are cultivated under rain-fed conditions during the single rainy season lasting 4-5 months between November/December to March, followed by a 7-8 month long dry season. Out of 3 million hectares of cultivable land in Malawi, 98% is reported to be under rain-fed cultivation (MoAFS 2010). The biggest challenge for the rain-fed maize production is the highly erratic and unreliable rainfall. In the past two decades, Malawi experienced at least five droughts (1992, 1994, 1997, 2001-2, 2005), which constrained national and household food security as much as national economic development.

Second, due partly to the high population pressure and partly to the past policy of the alienation of customary lands[9] to the estate sector (Ellis et al. 2003), lands available to smallholders are highly limited. The Malawi government notes that the average landholding size per household is 1.2 hectares while the average land per capita stands at mere 0.33 hectares (GoM 2006). Despite this land shortage, smallholder farmers find it difficult to invest

9. Most of the lands cultivated by smallholders are under a customary tenure arrangement. They cover nearly 80% of the total land areas (NSO 2009), where farmers enjoy usufructuary rights conferred by traditional chiefs.

their labor in the productivity improvement of agriculture. They are forced to allocate their time and labor to short-term wage earning activities (*ganyu*), out of their need for quick cash, which causes labor shortages and further reduces already low productivity (Alwang and Siegel 1999).

Third, there is a low uptake level of inputs such as hybrid maize variety seeds, fertilizers and chemicals. Inadequate access to credit, output and input markets, and agricultural services are main reasons for this deficiency (MoAFS 2010). The situation is further exacerbated by poor infrastructure, high transport costs, weak farmer organizations and inadequate market information. High inflation, high interest rates and continued depreciation of exchange rates have also made the prices of inputs unaffordable to many of the subsistence farmers (World Bank 2007).

Under such fragile and unstable conditions, Malawian smallholders' livelihood structure is highly diversified (Peters 2004; Orr and Mwale 2001; Ellis et al. 2003). In the context of rural Africa, it is widely acknowledged that income diversification is the norm; few people rely on a single source of income. Ellis et al. confirms this discourse for Malawi by stating that diversity of livelihoods (50:50 split between own-farm income and non-farm income) is an important feature of rural households (2003). Farmers diversify their livelihood portfolio out of a necessity to minimize their risk for survival as well as high profitability of off-farm activities (Ellis et al. 2003: 1505).[10]

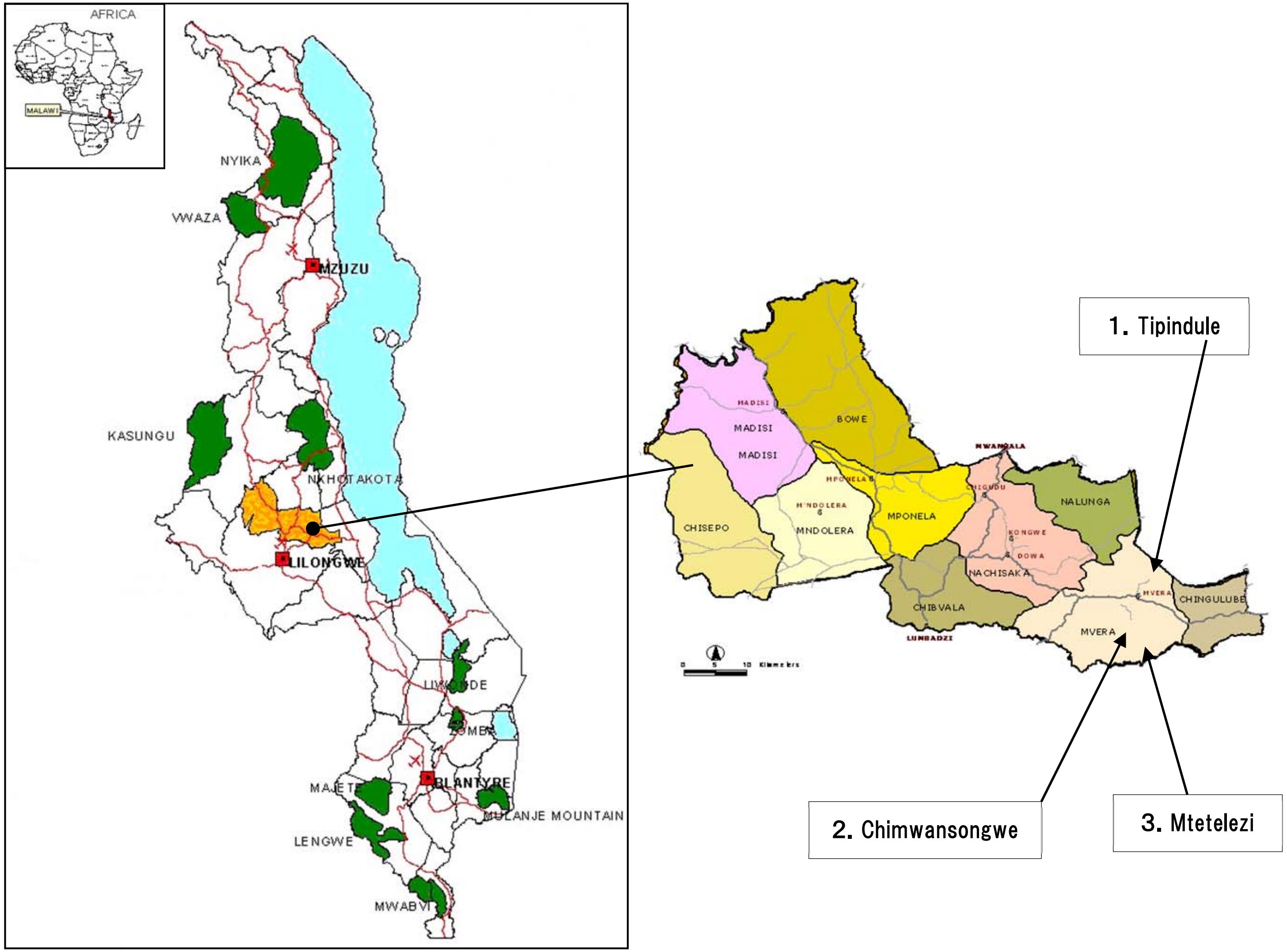
3-2. Dowa district

Dowa district lies between 33°22' east and 34°10' east and between 13°20' south and 13°40' south in the central part of Malawi. It is located at just 52 km away from the capital city

10. Takane (2009) also asserts that the livelihood of Malawian farming households is highly diversified. Farmers attempt to minimize the risk posed mainly by the unreliable rainfall pattern, which induces them to seek alternative sources of income in non-farm economic activities but with limited success (ibid.). The need to respond to daily cash needs, as noted above, further prompts smallholders to adopt a diversified livelihood strategy.

Lilongwe. The total land area of the district is roughly 3,041 sq. km (see Figure 3). Topographically, it is divided into two parts: the eastern part (where TA Chiwere is located) is predominantly hilly while the western part is low. The hilly eastern part is well drained by small streams which flow into Lake Malawi, and is suitable for *dimba* cultivation. The average annual rainfall ranges from 750 to 1,000 mm. The rainy season is from mid November to mid March, with the highest average rainfall seen in February. The temperature is within the range of 15°- 35°. The coldest months are May-July.

Figure 3. Location map



As of 2008, some 556,678 people in 121,884 households (4.57 persons per household) live in this district, which is about 4.3% of the national population (NSO 2009). The district is divided into seven TAs, which are administrative units below districts. TA Chiwere is one of them, where some 82,000 people live in 213 registered villages. This area is predominantly inhabited by *Chewa* people, who are known to have kept the matrimonial and matrilocal tradition, although it is rapidly changing. The other major ethnic group found in the district is *Ngoni*, who are under a patrimonial and patrilocal system.

Most of the lands in the district, especially those cultivated by smallholders, are under the customary land tenure system, and the average land holding size per household stands at 1.39 hectares as of 2006/7 (GOM 2008b). The main food crops grown include maize, cassava, sweet potatoes, Irish potatoes, groundnuts and beans, while the main cash crops are tobacco, paprika and legumes. According to the 2005 household survey, the average annual household income for Dowa stands at MK67, 626.30 (US$446),[11] which is 33% higher than the national average of MK50, 904.40 (US$336), and the poverty headcount ratio for Dowa is 36.6% in comparison with the national average of 52.4% (GoM 2008a).

11,482 hectares are reportedly under some kind of irrigation, out of which 94% use the residual moisture technology (*dimba*) in 1,355 sites, followed by 4.6% using river diversion technology (including temporary irrigation) which is found in 89 sites (GoM 2008a). Different statistics indicate that there are 313 temporary schemes irrigating some 654 hectares at the end of 2009 This figure is the largest among the districts of the nation (JICA 2009).

11. As of September 2010, the official conversion rate of Malawi Kwacha (MK) stands at MK 151 to 1 US dollar, or 0.0066 US dollar to MK 1.00.

4. Contextual conditions

4-1. Policy and government context: agriculture sector policy and government institutions

(a) Agriculture sector policy

Historically, there have been three major policy approaches to address the food security issue in Malawi (Devereux 1997). First, the national food security approach, promoted in the immediately post-independence period, emphasizes raising food production through hybrid-maize promotion and increased fertilizer use. This policy was characterized by strong state interventions in production, marketing and consumption, and by a bias toward the estate sector. Second, the market liberalization approach, promoted after the 1980s under the influence of structural adjustment programmes (SAPs), aims at increasing smallholder incomes through diversification of smallholder agriculture into production of high-value crops by providing price incentives under the liberalized market. The ban on the production of cash crops by smallholders was lifted, the role of ADMARC (Agricultural Development and Marketing Corporation) in the marketing of agricultural produce was reduced, and existing maize fertilizer subsidies were removed.

The current government follows the third approach which places more emphasis on household food security. This approach emphasizes targeted resource transfers to the poor through provision of agricultural inputs. The Farm Input Subsidy Programme introduced in the 2005/6 season is one of the main policy measures adopted under this philosophy. The policy aims to address the low productivity of food production by providing subsidized inputs to smallholder households. Owing to the sound macro-economic management and favorable weather conditions, the current program has made a substantial impact on macro-level agricultural production and the national economy. Due to this success, during 2006-2009, agriculture recorded positive growth at a rate of 9.23% while the GDP growth rate for the same

period registered 7.28% (MoAFS 2010).[12] This program is primarily directed to boost rainy season production.

The other policy measure meant to improve smallholder productivity is irrigation development. Despite its importance and policy level emphasis, irrigation development is still limited in Malawi: the land under irrigation covers slightly over 38,000 hectares (including those in the estate sector), which accounts for 8.6% of the total potentially irrigable area (400,000 ha) (MIWD 2010). Most of this was developed during 1970s and 1980s under strong government initiative and control. After reorientation of irrigation development policy in the 1990s, more emphasis has been placed on small-scale irrigation development and management transfer of formerly state-run schemes. More recently, the government has been eager to promote low cost small-scale irrigation based on the use of treadle pumps and temporary diversion weir with support from various development partners. The government further intends to consolidate this growth momentum by promoting the Green Belt Initiative (GBI). This new program launched only recently, aims at intensifying irrigation farming by using available water resources through rehabilitation and expansion of existing irrigation schemes as well as new development throughout the country (GoM 2009).

(b) Government institutional set-up

The Department of Irrigation (DOI) under the Ministry of Irrigation and Water Development is the organ responsible for irrigation development at the central government level. Under the current policy which places emphasis on farmer participation and ownership of irrigation schemes, the department is to assume a facilitator role to support farmers' initiatives. The department is represented at the field level by Irrigation Services Divisions

12. The country poverty ratio has seen some remarkable reduction in recent years, though it still registers high figures especially for rural areas. The proportion of people below the poverty line declined from 52.4% in 2005 to 40% in 2008; and the figure for rural areas declined from 53% to 44% for the same period (NSO 2006; NSO 2009; MoAFS 2010). Part of this remarkable progress is attributed to the low and stable food prices effected by the Farm Input Subsidy Programme (MoAFS 2010).

(ISDs) and 30 Rural Development Projects (RDPs) nationwide.

Dowa district is one of the three districts under the jurisdiction of Kasungu ISD, which is staffed with only three engineer-level irrigation officers. This means that there is only one fully qualified irrigation engineer for each district. Irrigation officers are expected to assist field extension officers (Agricultural Extension Development Coordinator: AEDC and Agricultural Extension and Development Officer: AEDO) posted at the EPA level for matters relating to irrigation development and operation. There are nine EPAs in Dowa, of which EPA Mvera is one.

Due to the lack of a sufficient number of qualified staff in irrigation at the field level, technology dissemination of temporary irrigation including the method of site selection, design, construction, group management and crop husbandry, was done mainly by the field extension staff, whose number was larger than that of irrigation staff, and through farmer-to-farmer dissemination channels. During the 2006-2009 period, extensive training was conducted, with support from a Japanese aid agency, to these personnel including nearly 500 field extension staff in 120 EPAs and 4,600 interested farmers (JICA 2009).

4-2. Physical and technical context: basic features of the three schemes

Informal irrigation in Malawi is basically a dry season activity. Farmers practice irrigation between July/August and November/December. It starts sometime after the end of the rainy season harvest in June and ends before the rainy season cultivation starts in mid-end November. This is particularly so for temporary schemes (Tipindule, Mtetelezi), as the diversion structure is flushed away during the rainy season, and needs to be reconstructed before the next irrigation season. For those who are under permanent schemes (Chimwansongwe), multiple (double to even triple) cropping is possible, but even here, irrigation does not start until the end of the rainy season, as farmers concentrate on upland cultivation during the rainy season. The irrigable area under these schemes is indeed very small

– 0.97 ha, 5.6 ha and 0.24 ha, respectively, using land which had had limited value before irrigation was introduced, and even now is only partially used during the rainy season.

All of the schemes surveyed started with a temporary weir using locally available materials. The initiative came from an individual, but was soon joined by fellow farmers as the construction work requires collective effort. The initiator(s) often narrate that they had experience doing *dimba* before, but had suffered from the hard labor required for fetching water. For some, the technology used to put up the weir was indigenous based on their traditional way to trap fish in the river. Other farmers were inspired by their fellows' practice. The canal, which is mostly earthen, is usually leveled in accordance with water flow as they dig the ground.

Having started as self-help schemes, some received external assistance for facility upgrading from an NGO (at Mtetelezi) or the government (at Chimwansongwe). With the external assistance, the intake structure was relocated and turned into a half-cemented and half-temporary weir in Mtetelezi. In Chimwansongwe, the intake was improved to be a fully cemented structure together with a part of the main canal lined with cement. In Tipindule, farmers have received material support from various NGOs in the form of plastic sacs and plastic sheets. A brief description of the physical features of these three schemes is as follows (Figure 4 & Table 1).[13]

The Tipindule scheme was started in 2004 by an individual farmer along a peninsular-shaped land surrounded by the meandering Lufe River. The scheme is located adjacent to a feeder road which connects small towns where a periodical market is located (called "*trading centers"*). The area under irrigation covers 0.97 ha as of 2010, serving 21 registered farmers cultivating 18 plots.

The temporary weir made of fascines, rocks and sand, measures 18m in width and

13. Conditions of site selection such as all needing to be informal schemes with different types of structures in the same geographical area limited the scope of choice available for the authors; thus culminating in picking up extremely small scale irrigation schemes; most of the permanent irrigation schemes are formal.

0.20-0.35m in height. Water is conveyed to the field along a 130m long earthen conduit (partially supported by sandbags) and a 20m long hand-made temporary aqueduct made of wooden poles, bamboo basket and plastic sheets. The canal in the field is also fully hand-dug with no diversion or control structure and stretches for about 300m until it flows back into the river. Three plots can be found on the right bank before crossing the aqueduct and the remaining 15 plots on the left bank which is on the peninsula.

The topography is generally flat with a gentle slope climbing up toward the center of the peninsular, allowing farmers to follow the basin irrigation method. All three plots on the right bank and four top-end plots on the left bank are located above the canal level, which compels farmers to use watering cans and treadle pumps to irrigate. The amount of water abstracted measured at 15.2 l/s and 10.2 l/s at the end of September and the beginning of October 2010, which declined to 1.1 l/s at the tail-end point.

(b) Mtetelezi scheme

The Mtetelezi scheme was established in 2005 on the gentle slope and terrace found on the left bank of the Lowe River. Though remote from the trading center, the scheme lies close to the railway station. The scheme was initiated by a farmer who decided to put up a temporary weir to irrigate his own land with six other farmers. When upgrading and expansion of irrigation were realized in 2006, the scheme came to cover 7.0 ha of land, but by 2010, the area under irrigation contracted due to water shortage. It now covers 5.6 ha of land consisting of three blocks divided by gullies, serving 47 farmers.

The right-hand side of the diversion structure is of temporary nature, and constructed with a single layer vertical weir, made of wooden poles, thatches and plastic sheets (11.8m wide and 0.8m high). The remaining part of the structure on the left hand side, which was upgraded with assistance from an NGO, is made of a concrete wet masonry structure (12m wide and 1.2m high). The total length of the canal reaches 1,512m including 20m long PVC

pipes which convey water around rock ledges. The canal is basically earthen, except for this water conveyance structure and a 140m long lined part directly below intake. The canal serves three irrigation blocks, the first one consisting of 5 plots, the second 4 and the last one 38. Most of the plots divert water directly from this main canal, except for those located in the last block where secondary canals are used.

All of the irrigated fields are located on the steep river bank slope, especially those located in the head-end two blocks, which requires farmers to follow the furrow irrigation method. The amount of water abstracted ranged from 48.9 l/s to 37.0 l/s measured at the end of September 2010, which reduced to 6.0 l/s at the tail-end point.

(c) Chimwansongwe scheme

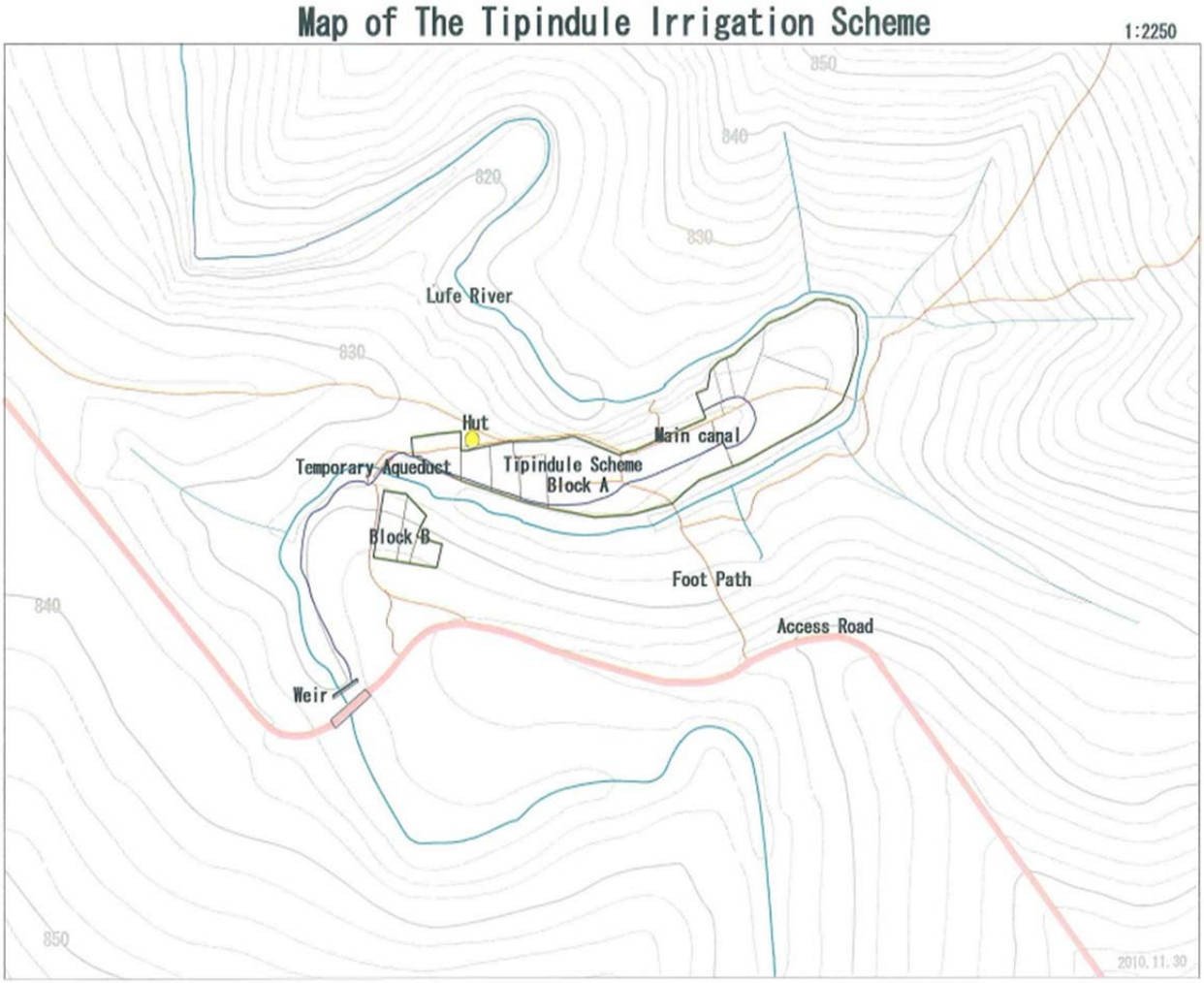
The Chimwansongwe scheme was established by three farmers in 2000 on the hilly slope located on the left bank of the Chimwansongwe River. The scheme is isolated from the nearest trading centre and access to the nearby feeder road takes 30 minutes to walk. Due to topographical constraints, the irrigated area is limited and covers only 0.24 ha, stretching in a 40m wide and 150m long area. The scheme is now serving 11 farmers.

The initial weir was of a temporary type constructed on a foundation rock, which was later upgraded to a concrete wet masonry structure erected at the same location. The diversion structure consists of two parts, one being a weir with an intake notch (5.9m wide and 0.7m high) and the other being a training dike (7.5m wide and 1.5m high). The total canal length is 245m, of which the initial 47m is lined with concrete and rubble, followed by a non-lined earthen canal. There are 11 plots as of 2010, all of which draw water directly from the main canal.

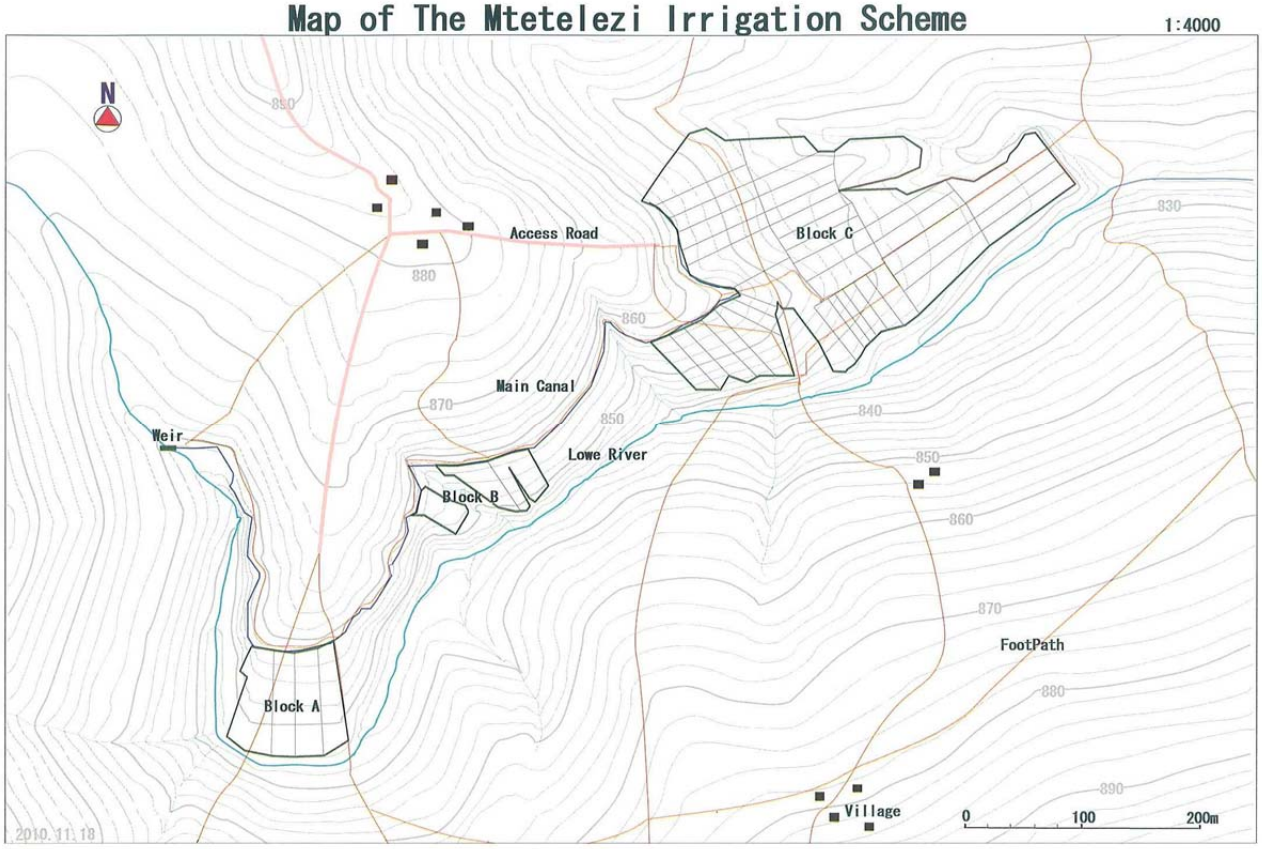
Depending on the topography of the area where each plot is located, farmers use both the furrow and basin irrigation methods. The amount of water abstracted ranged from 5.5 l/s to 2.4 l/s measured at the end of September 2010, which reduced to 0.9 l/s at the tail-end point.[14]

14. Liberal usage of water by farmers on the field and significant water loss due to seepage and leakage in the mostly earthen canal could be some of the reasons for this head and tail-end difference in water availability.

Figure 4. Maps of the three irrigation schemes



Map of The Mtetelezi Irrigation Scheme



Map of The Chimwansongwe Irrigation Scheme

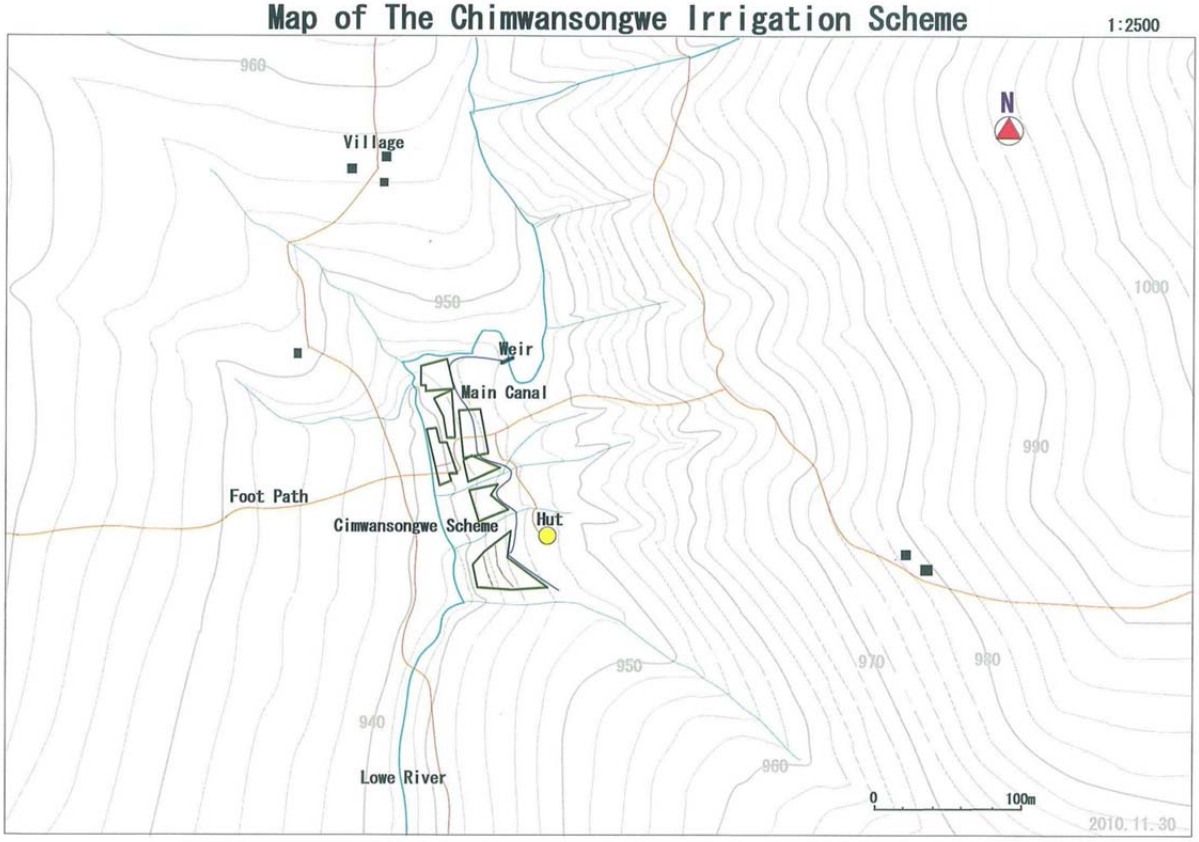


Table 1. Outline of the three schemes under study

	Tipindule	Mtetelezi	Chimwansongwe
Topographic Location of the Scheme	S13°39' 38" E34°07' 37"	S13°47' 51" E34°07' 33"	S13°46' 10" E34°07' 54"
Source of Water	Lufe River	Lowe River	Chimwansongwe River
Physical Structure of Weir	River diversion with temporary weir (natural diversion with rock band)	River diversion with half concrete masonry weir + half temporary weir	River diversion with full concrete masonry weir
Dimensions of Weir	H: 0.35 m, W: 10.8 m	(cemented part) H: 0.8m, W: 10m (temporary part) H: 1.2m, W: 12 m	H: 0.7 m W: 13.4 m (wing: 5.9m, spillway: 7.5m)
Amount of Water Abstruction in September 2010	15.2 l/s	48.9 l/s	5.5 l/s
Canal Length and Ancillary Structure	435 m (earthen, including a canal bridge)	1,512 m (earthen, including 20 m piped canal)	245 m (earthen, with initial 20m lined with cement)
Area under Irrigation in 2009	0.97 ha	5.6 ha	0.24 ha
Main Cropping Season(s)	July/August - November/December	July/August-November/December	(April-June) June-August September-December
Year of Establishment	2004	2005	2003
Mode of Establishment	Self-help (one farmer inspired by an already developed scheme observed in an exposure trip, asked his uncle for permission to use his land for irrigation)	Self-help (one farmer inspired by an already developed scheme observed in his wife's village induced other farmers to start irrigation on his land)	Self-help (one farmer inspired by observing irrigation in an estate farm induced other farmers to start irrigation on their land)
Year of Upgrading	N.A. (material support obtained from NGOs used for canal embankment and lining)	2006 (area expansion and facility upgrading with support from an NGO)	2005 (facility upgrading with support from MASAF)
Number of Beneficiary Farmers in 2009	21 (M:48%, F:52%)	47 (M:62%, F:38%)	7 (M:45%, F:55%)

Source: Field survey conducted by the authors in September-October, 2010.

4-3. Social and economic context: Farming households in three sites

The average family size of household interviewed (n=27) stands at 5.37, which is slightly larger than the district average 4.57. The figure is smaller for Chimwansongwe as there are several single-headed households among the club members (Table 2 & 3).

All of these irrigation farmers owned upland plots for cultivating food and cash crops under rain-fed conditions. These plots are held under customary land tenure arrangements, whether inherited, allocated or even purchased. The average area of landholding and actually farmed areas was 1.73 ha and 1.35 ha. These figures are slightly higher than the district average (1.39 ha) and the national average (1.2 ha). 67.5% of the upland plots were owned by husbands and 32.5% by wives. In terms of mode of obtainment, the majority of the plots

(57.5%) were inherited from mothers, followed by allocation by Village heads (30%). There were three cases and two cases where the land was inherited from fathers (to females) and purchased (from VH), respectively. These figures suggest that while traditional land allocation and inheritance customs are mostly followed, transformation of the traditional inheritance system and commoditization of land are also taking place (notably in Tipindule).

All farmers grow maize for rainy season cultivation, either a local variety or hybrid variety[15] or both. Nearly all irrigation farmers use fertilizers in their maize production. 55% of the farmers are benefiting from the Input Subsidy Program in one way or another.[16] Groundnut is cropped in rotation with maize for both own consumption and market sales. Only a small number of farmers cultivate tobacco, as the access to inputs necessary for tobacco cultivation is not easy. From the upland cultivation, farmers make net earnings of MK46, 035 (US$305), which is equivalent to almost 60% of the total income of the farmers. The harvest from the rainy season cultivation finishes before the year end or by the beginning of the following year even among irrigation farmers. In the off season, practices of *ganyu*, basket weaving, and self-employed small businesses are undertaken.

The average size of plots allocated to each farmer in each scheme is quite limited (0.08 ha, or something like 28 x 28 square meters). Behind this limitation lies a small irrigation capacity. Facilities were initially developed on farmers' own initiatives to satisfy the interests of an individual or a small group of individuals. They were not designed from the technical viewpoint to satisfy certain criteria of economic feasibility. The plot size is relatively large for Mtetelezi compared to the other two schemes as the field was designed to have a unit parcel of 15m x 75m at the time of upgrading.

15. According to farmers' accounts, the same terminology "hybrid" is used for hybrid variety and OPV (Open Pollinated Variety) without discriminating these two. The description in this paper follows farmers' recognition.
16. There are basically three ways (practiced in the villages) to get access to fertilizer coupons under this program: first, receive coupons directly from VH, which is the official way; second, share coupons with other villagers; third, buy them from the unofficial coupon market. The above figures showing the number of beneficiaries include all of these different methods.

Table 2. Basic features of irrigation club member households

Tipindule Irrigation Club (0.97 ha)	Average	Minimum	Maximum	S.D.
Irrigation Club Members (n=10)				
Size of Household	6.00	3.00	8.00	1.94
Upland Landholding Size (ha)	1.56	0.60	3.20	0.76
Upland Area Actually Farmed in 2009 (ha)	1.50	0.60	3.20	0.75
Average Size of Plot/HH Allocated for Irrigation (ha)	0.10	0.04	0.20	0.06
Net Profit from Upland Cultivation in 2009 (MK)*	45,947	6,500	140,500	44,941
Total Net Income in 2009 (MK)*	76,501	18,990	203,700	62,014
Month When the Rainy Season Harvest Finishes	Early February			
Mtetelezi Irrigation Club (5.60 ha)	Average	Minimum	Maximum	S.D.
Irrigation Club Members (n=10)				
Size of Household	5.80	2.00	9.00	2.44
Upland Landholding Size (ha)	1.65	1.08	2.80	0.53
Upland Area Actually Farmed in 2009 (ha)	1.45	0.90	2.80	0.54
Average Size of Plot/HH allocated for Irrigation (ha)	0.11	0.08	0.14	0.02
Net Profit from Upland Cultivation in 2009 (MK)	58,248	7,740	250,550	71,702
Total Net Income in 2009 (MK)	93,383	21,400	290,800	85,913
Month When the Rainy Season Harvest Finishes	Mid January			
Chimwansongwe Irrigation Club (0.24 ha)	Average	Minimum	Maximum	S.D.
Irrigation Club Members (n=7)				
Size of Household	3.86	1.00	6.00	1.86
Upland Landholding Size (ha)	2.10	1.40	4.00	0.89
Upland Area Actually Farmed in 2009 (ha)	1.00	0.20	1.50	0.45
Average Size of Plot/HH allocated for Irrigation (ha)	0.02	0.02	0.04	0.01
Net Profit from Upland Cultivation in 2009 (MK)	28,715	4,000	56,529	19,013
Total Net Income in 2009 (MK)	50,584	12,720	125,985	38,310
Month When the Rainy Season Harvest Finishes	Mid September			
Total	Average	Minimum	Maximum	S.D.
Irrigation Club Members (n=27)				
Size of Household	5.37	1.00	9.00	2.12
Upland Landholding Size (ha)	1.73	0.60	4.00	0.72
Upland Area Actually Farmed in 2009 (ha)	1.35	0.20	3.20	0.61
Average Size of Plot/HH allocated for Irrigation (ha)	0.08	0.02	0.20	0.04
Net Profit from Upland Cultivation in 2009 (MK)	46,035	4,000	250,500	52,401
Total Net Income in 2009 (MK)	76,034	12,720	290,800	67,369
Month When the Rainy Season Harvest Finishes	Mid December			

* All agricultural outputs produced were converted into cash amount by multiplying the prevailing farm gate price at the time of harvest. Production costs include purchased inputs, hired implements, hired labor both in cash and in kind and rent; but own family labor and amortization of farm implements are not counted.

Source: Field survey conducted by the authors in September-October, 2010.

Table 3. Owners and mode of acquisition of upland plots for irrigation farmers

	Inherited from Maternal Line	Inherited from Paternal Line	Allocated by Village Head	Purchased	Total
Tipindule (no. of plots = 15)					
Land belonging to Husband	53.3%	6.7%	0.0%	13.3%	73.3%
Land belonging to Wife	13.3%	13.3%	0.0%	0.0%	26.6%
Sub-Total	66.6%	20.0%	0.0%	13.3%	99.9%
Mtetelezi (no. of plots = 14)					
Land belonging to Husband	21.4%	0.0%	42.9%	0.0%	64.3%
Land belonging to Wife	7.1%	0.0%	28.6%	0.0%	35.7%
Sub-Total	28.5%	0.0%	71.5%	0.0%	100.0%
Chimwansongwe (no. of plots = 11)					
Land belonging to Husband	54.5%	0.0%	9.1%	0.0%	63.6%
Land belonging to Wife	27.3%	0.0%	9.1%	0.0%	36.4%
Sub-Total	81.8%	0.0%	18.2%	0.0%	100.0%
Grand Total (no. of plots = 40)					
Land belonging to Husband	42.5%	2.5%	17.5%	5.0%	67.5%
Land belonging to Wife	15.0%	5.0%	12.5%	0.0%	32.5%
Total	57.5%	7.5%	30.0%	5.0%	100.0%

Source: Field survey conducted by the authors in September-October, 2010.

In sum, the promotion of temporary irrigation by the government of Malawi can be contextualized in the current government's strong initiative to address the food security problem, which has chronically plagued the national economic development and farmers' livelihood. Faced with the limited number of irrigation staff in the field, temporary irrigation technology was promoted by field extension staff and through farmer-to-farmer dissemination channels. In fact, all of the schemes were initiated by farmers inspired by other farmers' antecedent practice of irrigation. Since these irrigation schemes were designed to serve a small group of initiator farmers, the total land put under irrigation and the size of each plot allocated to participating farmers are not necessarily large. Irrigation farmers cultivate upland plots along with practicing irrigation, from which they raise more than half of their total net income, but they continue to experience food shortages.

5. Property rights and collective action

5-1. Property rights: access to and tenure of productive resources

(a) Land

In terms of land ownership, irrigated lands in the surveyed sites belong to the farmers who initiated irrigation. Such was the case with Mtetelezi and Chimwansongwe, where the schemes were initiated by farmer groups which demand water for their own fields. In Tipindule, the scheme was started by an initiator farmer who managed to borrow a piece of land from his uncle (his mother's senior brother), who plays a guardian role (*nkhoswe*) in the Chewa society (Mtika and Doctor 2002). In terms of land use, all three schemes were developed on a piece of land which had limited value during the dry season before irrigation was introduced: in Tipindule and Chimwansongwe the land had been used only partially for *dimba*; and in Mtetelezi the land had been mostly "bush," used occasionally as grazing land for animals. Thus, the access to these lands by initiators, even when borrowed from somebody, was easy at the start of irrigation.

In temporary irrigation, initiator farmers need to work collectively with other like-minded farmers to construct temporary diversion weirs and canals. Once the work is complete and irrigation starts, participating farmers need to borrow a piece of land from title holder farmers, who are normally called "landowners." Though the landowner's title to the irrigated land is usufructuary in legal terms, the landowners can charge rent from farmers which is payable in cash (Table 4.). The amount is fixed per plot per season, based on the agreement made personally between the landowner and each of the farmers. For the surveyed cases, however, the rent seems to be an afterthought for the landowners whose recognition of the value of land was influenced by the success of irrigation. For Tipindule and Mtetelezi, the rent was not charged in the first season but was introduced in the second season. In Chimwansongwe, rent is going to be charged from the 2011 season, 10 years after its inception.

In general, landowners prefer to maintain individual agreements with participating farmers. A collective agreement with the irrigation club is avoided, as landowners suspect that such arrangement would lead to the perpetuation of irrigation, strengthening of the position of tenant, and further to the loss of their title to the land. There are a plethora of past cases where the land under customary tenure was appropriated by the government under a leasehold contract for estates and other formal irrigation development, and the title to the land was eventually lost. On the other hand, it is also reasonable for the joining farmers to keep the agreement as it is now, since the number of participating farmers changes from one year to another (as will be discussed later), and an decrease of members in the future means an increase of costs to be borne by the remaining members. The current practice of having an individual agreement with landowners is therefore reasonable and attractive both for the landowners and farmers at least for the short run, but it leaves land tenure fragile and unstable for most of the irrigators.

Table 4. Amount of rent charged in each scheme

	Tipindule	**Mtetelezi**	**Chimwansongwe**
Land Tenure Arrangement for Landowners	Customary	Customary	Customary
Number of Landowners	2	3	3
2004	0		0
2005	(scheme closed)	0	0
2006	(scheme closed)	MK800/plot/season (MK600 for Rainy Season)	0
2007	0～MK3,600 /household/season*	same as above	0
2008	same as above	MK1,000/plot/season (MK600 for Rainy Season)	0
2009	same as above	same as above	0
2010	same as above	MK1,200/plot/season (MK600 for Rainy Season)	0**

* The amount of rent varies among members according to the number of plots used and the relationship with the landowner. Wife of the landowner is waived from paying rent and his children pay only a neglegible amount.

** MK500/plot/season is to be charged from 2011 season.

Source: Field survey conducted by the authors in September-October, 2010.

(b) Water

Like in many other African communities, water in the streams in Malawi has been regarded as god-given, and access to it is often regarded as free and unlimited. According to farmers' understandings, water in the streams is not under the conventional jurisdiction of traditional chiefs such as VHs and TAs. Chiefs may be consulted and looked up for mediation in case farmers come across any conflict with other users, but there is usually no role to be played by these chiefs in allocating water in the streams.

Furthermore, in all of the surveyed schemes, the streams have traditionally been used by farmers for domestic use as well, and this has been done without obtaining any permission from anyone or any authority. Such having been the case, no permission, prior or ex post, is obtained from the government or anyone for additional water abstraction for irrigation. The level of awareness of "water right" stipulated under the Water Resources Act of 1969 is still quite limited among farmers.[17] Farmers usually take full advantage of the water available and attempt to divert all of the amounts to their fields, by building up a closing dam type structure at intake.

As a result, relatively abundant water vis-à-vis the area under irrigation is abstracted from the streams. The ratio of the abstracted amount of water (measured at the upper end of the fields) calculated against the total crop water requirement (on the assumption that all plots are cultivated with maize) stands at 6.04, 2.09 and 9.60 for Tipindule, Mtetelezi and Chimwansongwe, respectively.[18] This clearly indicates that in all schemes, at least at the head-end of the scheme, more than enough water is made available for cultivation. This has to be seen with care, however, as the water abstracted reduces to about one-tenth at the tail-end of

17. Currently, the number of approved water right permits is 35 in Dowa district, out of which 23 are accorded to irrigation schemes and 3 to informal irrigation clubs (information from the Ministry of Irrigation and Water Development as of December 2010).
18. The calculation is based on the canal flow volume data measured at the head-end of the irrigated field during field survey, which is compared with the standard crop water requirement for maize set by GoM, which is 9.0mm/day in September/October (under the assumption that the whole area is put under maize cultivation). Excessive water abstraction at the intake, however, is wasted by a large amount of seepage and leakage in the earthen canal.

the canal due to seepage and leakage; and there is usually a decrease of water flow towards the end of the dry season.

5-2. Collective action: institutions and processes

(a) Institutional arrangements

Informal irrigation schemes are usually managed by an organization called a "club," an informal non-registered group composed of interested farmers. Clubs are a familiar mode of organization to Malawian farmers as they were used as a window to receive external support for food, credit and inputs (Table 5). There is usually no gender discrimination for club membership. Payment of a membership fee is required for new members (MK2,000 [US$13] for Tipindule and MK4,500 [US$30] for Mtetelezi), though this payment is often waived for original members as they are thought to have made substantial investment for the initial installation of the schemes.

A club is usually run by an executive committee, composed of a chair-person, vice-chair, secretary, vice-secretary and treasurer. For most of the smaller schemes (like Tipindule and Chimwansongwe), an executive committee is the sole organ of management (single-tier structure); while in larger schemes (like Mtetelezi), the executive committee is supported by a lower tier of organizations such as hydraulic blocks and joint-work groups (double-tier structure). Selection of the committee members is done by consensus among club members or by voting for candidates who are self-nominated or recommended by peers. The committee is renewable after two to three years tenure. Rules and regulations of club management are stipulated as by-laws, either written or verbal. By-laws usually include rules and regulations on membership qualification, executive committee membership and tenure, kinds and frequency of meetings, farmers' obligations including the amount of water fees, fines/sanctions for offenses of the rules and conditions of removal from the club.

For temporary schemes, reconstruction of intake structure, and dredging and weeding

of canals constitute the largest portion of farmer contribution, which is payable by members' labor force.[19] Schemes with a permanent structure do not have cash contribution regulations for the sake of facility maintenance per se. Mtetelezi does not collect cash from members at all, and the amount collected in Chimwansongwe remains nominal at best. During the cultivation period, canal cleaning is the major work to which farmers are expected to make contribution with their own labor for both types of schemes.

Fines are more elaborately stipulated, especially for Tipindule and Mtetelezi. Different amounts of fines are set for absence from maintenance work, meetings and group work for income generation,[20] coming late for these activities, and sometimes special fines are set for breach of the water rotation schedule/water theft. The Chimwansongwe club does not have clearly articulated clauses on fines as it has operated with a limited number of farmers; they rather prefer to rely on persuasion to curve disobedient behavior.

Members are supposed to meet in a "General Assembly" held twice a month (Tipindule, Mtetelezi) and every week (Chimwansongwe). Important matters such as the planting schedule, water rotation schedule, and distribution of inputs provided by donors are among the most commonly discussed topics. In Mtetelezi, confirmation of absentees/late-comers in recent club activities and pleading by offenders are also discussed in such meetings.

19. Even for these schemes, cash contribution is necessary to purchase consumables, such as plastic sacs and plastic sheets used for canal embankment and lining, but their roles are minor.
20. Club member farmers are supposed to work in other farmers' fields for the purpose of generating operational income for the clubs; similar to *ganyu* practiced by individual farmers.

Table 5. Institutional arrangements of the irrigators' organization

	Tipindule	Mtetelezi	Chimwansongwe
Type of Irrigators' Organization	Club (informal)	Club (informal)	Club (informal)
Structure of the Clubs	Single tier	Double tier (lower tier - sub clubs - functions as unit of group work)	Single tier
Structure of Executive Committee	Chairperson, Vice-chair, Secretary, Vice-secretary, Treasurer	Chairperson, Vice-chair, Secretary, Vice-sec., Treasurer, Committee members	Chairperson, Vice-chair, Secretary, Vice-secretary, Treasurer, Committee members
Membership Fee	MK2,000/person	MK3,000/person (up to 2008) MK4,500/person (since 2009)	0
Contributions Required from Members	- Irrigation Fee: MK100/month - Participation in Facility Construction/Removal/Manitenance & Income Generation Work	- Irrigation Fee: 0 - Participation in Facility Construction/removal/Maintenance & Income Generation Work	- Irrigation Fee: MK50/month (MK50/week since Aug.2010) - Participation in Canal Maintenance & Income Generation Work
Sanctions	- MK250 for absence from maintenance work and basket weaving (150 for late-coming) - MK200 for absence from group work (100 for late-coming) - MK500 for refusal to pay fines - MK50 for absence from meeting (25 for late-coming)	- MK100 for absence from group work - MK50 for late-coming - MK200 for breaking water rotation schedule - Removal from the club when committed more than three offences in a season - Removal from the club when one has done damage to the club	- Not specified (rely on persuasion)

Source: Field survey conducted by the authors in September-October, 2010.

(b) Construction and maintenance activities

For temporary schemes, namely Tipindule and Mtetelezi, weir reconstruction work takes place after the end of the rainy season. It is usually implemented in June-July in Tipindule (after harvest) and in April in Mtetelezi (after main cultivation activities). The same applies to canal maintenance – de-silting work. To complete these tasks, it takes eight days in total spread over four weeks in Tipindule and two days in Mtetelezi.[21] All of the members are supposed to participate in such works. Since most of the work is carried out with human labor, the biggest challenge is whether sufficient labor can be mobilized. However, the record of attendance is not necessarily satisfactory (Table 6).

In Tipindule, according to the record kept by the executive committee, the attendance rate for the 2009 season for different group activities including weir reconstruction and canal maintenance works remained at less than 70%. Farmers also mentioned that for the 2010

21. The difference in necessary working days between these two schemes can be attributed to the need to weave bamboo baskets used for the water conveyance structure in Tipindule.

season, it took almost two months to complete the reconstruction work, one month longer than in normal years, as members found it difficult to assemble due to other commitments (such as selling of the rainy season harvest, engaging in own business, attending social activities, etc.). In addition, these absentees are rarely sanctioned. Only 26% of recorded fines were actually collected. For Mtetelezi, the attendance rate to maintenance work for the 2009 season was relatively high, registering 84%, which probably reflects the scarce water resource condition facing the scheme (as will be discussed later). But even there, the number of farmers who were actually sanctioned exceeded 50 cases for three consecutive years after 2008. Furthermore, the experience from direct observation conducted by the authors in September 2010 shows that there was a little over 40% attendance to the canal maintenance work.[22]

On the other hand, farmers have different notions and attitudes towards maintenance of concrete structures under the permanent scheme. As noted earlier, there is no cash contribution collected from farmers in Mtetelezi and only a nominal amount (MK50/month) is collected in Chimwansongwe. In both schemes, farmers disclose that they are not feeling the acute need to prepare for future maintenance requirement: "we will seek appropriate measures when the problem actually happens" is the typical attitude held by farmers. Farmers' differentiated attitudes toward maintenance of different types of weirs can most clearly be seen in Mtetelezi, where farmers cooperate rather strongly for maintenance of the temporary part of the weir while there is no such cooperation for the permanent part. This phenomenon can also be confirmed by how they expend the collected money: the expenditure records of both schemes do not include any savings for facility maintenance: main items of expenditure respond to immediate operational needs including purchase of inputs, cost for transport and communication (mobile phone talk time), and food and refreshment served for visitors.

22. As a result, a second round of canal maintenance work was announced by the executive committee because the work was not completed with low attendance on the first day.

Table 6. Level of cooperation for group activities

	Attendance Rate to Facility Construction and Maintenance Work in 2009	No. of Offences Committed in 2009 (incl. attendance to meetings)	Rate of Fine Collection
Tipindule	62.5%	33	26.8%*
Mtetelezi	84.0%	61	63.5%*
Chimwansongwe	100%**	N.A.***	N.A.***

* Figure for Tipindule is for 2009 and the one for Mtetelezi is for 2008, due to availability of reliable information.

** In Chimwansongwe, the figure represents attendance rate for maintenance work only.

*** In Chimwansongwe, fines are not stipulated in their by-laws.

Source: Field survey conducted by the authors in September-October, 2010.

(c) Water distribution

The irrigated fields of all schemes studied are divided into several water distribution blocks and a water rotation schedule is established to allow for equitable distribution of irrigation water. The Tipindule field is divided into four blocks, each comprising two to three plots, and farmers are supposed to irrigate their own plots for up to 24 hours every four days. Mtetelezi is divided into five blocks, each of which is further divided into two sub-blocks, each comprising eight to ten plots. The interval to irrigate one's plot is five days and 24 hours are given for each block. Within a block, two sub-blocks share 24 hours equally and rotate every time by assigning morning and evening shift. Adherence to the water rotation schedule is monitored by the members of executive committee. In each water rotation block/sub-block, "first come, first served" is the rule of water distribution in Tipindule and Mtetelezi. Under this arrangement, whoever comes first to the field is allowed to irrigate his/her field until his/her satisfaction. Chimwansongwe has only two blocks composed of seven and four plots respectively,[23] and here too, a water rotation schedule is applied between the two blocks. Within each block, "tail-ender first" is the rule of water distribution. In all schemes, turn-taking is done by face-to-face communication between farmers.

Thus, all schemes have a reasonably designed water rotation arrangement

23. In Chimwansongwe, upstream plots are smaller, so the total area covered in each block is nearly equal between the upstream and downstream. The smallness of upstream plots does not necessarily imply farmers' equity concerns, but rather due to the availability of idle land in the upper end.

corresponding to the level of water availability; but a close look at its actual application reveals flexibility rather than fixed rules. For example in September 2010, farmers in Tipindule were at different stages of crop production, indicating that they were following different cropping calendars, and they were not following the agreed-upon rotation schedule. Interviews with farmers revealed that the cropping season varies from one farmer to another, ranging from July-October to September-December, and they come to their field to irrigate whenever they feel it necessary. Up to present, the potential negative impact of this flexible application of water rotation schedule – conflict over water – is probably avoided thanks to abundant water resources in the case of Tipindule as no one complains about this arrangement. This can be confirmed indirectly by the insignificant difference in productivity between upstream farmers and downstream farmers. A similar situation applies to Chimwansongwe where farmers practice multiple cropping under a permanent structure (Table 7).

On the other hand, farmers in Mtetelezi are not endowed with such luxury in water usage: according to farmers' accounts, there used to be frequent quarrels over water distribution between head-enders and tail-enders. Water shortage experienced shortly after a scheme expansion made farmers follow the rule more strictly. Although there are still some offenders of the water rotation schedule, we observed during the field survey that most of the farmers are now following the same cropping calendar and water rotation schedule, resulting in nearly the same level of productivity of maize.

Table 7. Difference in irrigated maize yield between head-end and tail-end farmers

	Yield of Maize for Head-end Farmers	Yield of Maize for Taile-end Farmers	Average for All
Tipindule	2.67t/ha	2.37t/ha	2.50t/ha
Mtetelezi	1.72t/ha	1.69t/ha	1.82t/ha

Source: Field survey conducted by the authors in September-October, 2010.

(d) Conflict management

Conflict management as manifestation of collective action can be observed in two

different aspects: one external to the club and the other internal. The most notable case of external conflict management is found in Mtetelezi, where farmers experienced severe water shortage in the stream in 2006-07. Faced with a lower water level, farmers in the club decided to form an expedition team and walked upstream along the river to search for any water abstraction point built by somebody else, and destroyed it. After repeating this exercise several times, farmers in Mtetelezi and those upstream finally came to an agreement in 2007, through mediation by an NGO, as to sharing of the limited water resources. The situation has been stabilized with this arrangement, but farmers vowed that they were prepared to resort to physical action whenever such need arises. The recent move to apply for water right can be regarded as another expression of farmers' collective action works.

Chimwansongwe farmers, after experiencing a decline of stream water in recent years, have also established a water sharing arrangement with immediately upstream irrigation farmers. The arrangement is that whenever upstream users want to irrigate their fields, they can inform Chimwansongwe farmers, so that the latter can refrain from irrigation on that day; or vice versa. In Tipindule, where water is not yet scarce, such collective action has not been taken.

An example of internal conflict management can be observed in Mtetelezi where farmers experienced disputes over water distribution due to non-obedience to the water rotation schedule and adoption of an arbitrary cropping pattern. In this scheme, the experience of external conflict management mentioned above was applied to internal problem solving. After experiencing fighting with upstream farmers, the executive committee tried to persuade the violators – mostly head-enders – to follow the water rotation schedule and cropping calendar by saying that one has to walk in others' shoes, as those at the tail-end are in the same position as the Mtetelezi scheme itself which is fighting for the water with upstream farmers.

In Mtetelezi, there was an instance of firing a club president. In 2008, the then president who was a village head of a nearby village allegedly stole fertilizers provided by an

NGO and distributed them to his friends and relatives from the same village. Once this news was known to other farmers in the club, they demanded to convene an extraordinary general assembly to discuss the matter. The assembly agreed to evict the president and farmers involved in the case from the club. Farmers subsequently organized an election to select a new president and an executive committee. These instances demonstrate that farmers can take collective action when faced with critical problems.

6. Results of technological choice

6-1. Agricultural production under irrigation

(a) Farm Economy under irrigation

The crops cultivated under irrigation are maize (hybrid variety), tomato, onion and other vegetables (Table 8). Among these, a majority of farmers (71% of farmers and 66% of plots) are engaged in cultivating maize, either for self consumption or for sale, followed by tomato and onion. Since the majority of farmers in the surveyed area experience a lean period of main staple food for several months, it makes sense that farmers' priority is placed on maize, and more than half of the harvest (55%) is directed to self consumption. The harvesting period of irrigation maize, which falls in November-December, coincides with the finishing period of the rainy season grain stock. In this sense, the practice of irrigation during the dry season should be providing an attractive option to secure staple food for the farmers. One of the most commonly heard remarks of the farmers as to benefits of irrigation is: "we find irrigation very attractive because we are now maize self-sufficient throughout the year."[24]

The average yield of maize (hybrid variety) from an irrigated field is certainly higher than the average yield under rain-fed conditions, but its net profitability is limited due to the

24. The own consumption rate is especially higher for Mtetelezi where 78% of the harvested maize was used for own consumption, while the figure was about 40% for other schemes. The reason why different crop disposal strategies are taken requires further examination, but accessibility to market (high in Tipindule due to its closeness to a feeder road where bus service is available) and availability of other cash generating options (high in Mtetelezi due to wide practice of tobacco cultivation, which is less in Chimwansongwe) may provide part of the reason.

small size of the plot (Table 9). The average net profit from irrigated maize stands at only MK5,700 (US$38).[25] When profits from other cash crops are added, the total average net profit from irrigation registers MK10,007 (US$66) (after deduction of rent). Important to note, however, is that there is a high degree of variance in farmers' profits. Some farmers make a relatively large profit by engaging in cash-crop cultivation in the expanded lands under irrigation. Less profitable farmers just concentrate on maize production to supplement the food shortage.

While irrigation certainly plays an important role for farmers' survival, its significance in the overall livelihood structure needs to be assessed carefully. When the share of net profits from irrigation is compared with other income sources, including ones from rainy season cultivation, farm wage labor and off-farm activities, it is revealed that irrigated cultivation accounts for only 13.2% of total net income, while the majority (60%) of income is still derived from rain-fed cultivation and 20% and 5% are generated from off-farm activities and farm wage labor, respectively. Furthermore, about two-thirds of the irrigation farmers still continue to practice casual wage labor and off-farm income generating activities (excluding sale of livestock).

These suggest that informal irrigation in Malawi has contributed to the expansion of farmers' livelihood options, but still remains as one of the supplementary sources of food and cash income. Farmers' livelihood is dominated by rainy season crops. Only in Chimwansongwe, where multiple cropping is possible under permanent weir, the contribution of income from rainy season crops is reduced and partially replaced by income from irrigation. But even there, farmers retain the common tendency to maintain a diverse livelihood. Five out of seven farmers continue to engage in *ganyu* and other off-farm income generating activities.

25. Note that average cropping intensity is 2.7 in Chimwansongwe.

Table 8. Cropping pattern and disposal of maize harvest in 2009

	Number of Plots Cultivated	Share against Total Number of Plots	Total Area Cultivated in ha	Share against Total Area	Percentage of Sold Maize in Quantity
Tipindule (n=10)		(Total Number of Plots = 18)		(Total Area Cultivated = 0.97 ha)	
Maize	12	67%	0.607	63%	59%
Tomato	8	44%	0.306	32%	
Onion	2	11%	0.029	3%	
Beans	1	6%	0.005	0%	
Cabbage	1	6%	0.021	2%	
Mtetelezi (n=10)		(Total Number of Plots = 10)		(Total Area Cultivated = 1.07 ha)	
Maize	10	100%	0.926	87%	22%
Paprika	2	20%	0.095	9%	
Tomato	2	20%	0.033	3%	
Mustard	1	10%	0.003	0%	
Chimwansongwe (n=7)		(Total Number of Plots = 10)		(Total Area Cultivated = 0.64 ha)	
Maize	6	60%	0.240	38%	58%
Tomato	7	70%	0.231	36%	
Onion	4	40%	0.125	20%	
Beans	4	40%	0.042	7%	
Rape	1	10%	0.001	0%	
Total		(Total Number of Plots = 38)		(Total Area Cultivated = 2.68 ha)	
Maize	27	71%	1.773	66%	45%
Tomato	17	45%	0.571	21%	
Onion	6	16%	0.153	6%	
Beans	5	13%	0.047	2%	
Cabbage	1	3%	0.021	1%	
Paprika	2	5%	0.095	4%	
Mustard	1	3%	0.003	0%	
Rape	1	3%	0.001	0%	

Source: Field survey conducted by the authors in September-October, 2010.

Table 9. Profitability of irrigation

	Tipindule (n=10)	Mtetelezi (n=10)	Chimwansogwe (n=7)	Average(weighted) (n=27)
Yield of Maize under Irrigation	2.50t/ha	1.82t/ha	2.04t/ha	2.11t/ha
Net Profit from Irrigated Maize*	MK7,047	MK3,597	MK6,934	MK5,740
Net Profit from Irrigated Vegetables	MK10,915	MK235	MK4,464	MK5,287
Net Profit from Irrigation Total (after deduction of rent)**	MK16,108 (21.1%)***	MK2,933 (3.1%)	MK11,398 (22.5%)	MK10,007 (13.2%)
Net Profit from Upland Cultivation	MK45,947 (60.1%)	MK58,248 (62.4%)	MK28,715 (56.8%)	MK46,035 (60.5%)
Net Profit from Agricultural Wage Labor	MK5,346 (7.0%)	MK1,566 (1.7%)	MK2,900 (5.7%)	MK3,312 (4.4%)
Net Profit from Non-agricultural Activities	MK9,101 (11.9%)	MK30,636 (32.8%)	MK7,571 (15.0%)	MK16,680 (21.9%)

* All agricultural outputs produced were converted into cash amount by multiplying the prevailing farm gate price at the time of harvest. Production costs include purchased inputs, hired implements, hired labor both in cash and in kind and rent; but own family labor and amortization of farm implements are not counted.

** Net profit from irrigation total in Tipindule, Mtetelezi does not match sum of net profit from maize and vegetable production as rent is deducted from the gross sum. In Chimwansognwe, there was no rent charged at the time of survey.

*** Figures in balkets indicates share in total net income.

Source: Field survey conducted by the authors in September-October, 2010.

(b) Comparison with non-member farmers

In order to understand the meaning of outcomes of irrigation in the broader context of rural community, we attempted to compare irrigation club members with non-members. Such comparison should shed some light not only on the issue of profitability of irrigation, but also on the equity aspect of irrigation (or who are eligible to practice irrigation).

In terms of land size, there is a substantial difference between club members and non-members (1.73 ha vs. 1.16 ha) (Table 10). Club members have 50% larger upland land area than non-members. The difference is most outstanding in Mtetelezi, where member farmers own twice as large land as that of non-members. In terms of upland agricultural production, the average difference of maize productivity is minimum between members and non-members (1.63 t/ha vs. 1.43 t/ha), though the difference is rather large in Mtetelezi (1.62 ton/ha vs. 1.23 t/ha). Furthermore, in Mtetelezi, the number of tobacco farmers shows a remarkable difference between members and non-members. While 50% of member farmers cultivate this high-input high-return crop, only one farmer plants the same crop among non-member farmers.

In terms of total net income, irrigation club members are earning nearly twice as much as non-members (Figure 5-left). There is however a large disparity among locations. The margin of income between members and non-members stands at 36% and 54% for Tipindule and Chimwansongwe respectively; but in Mtetelezi, club members are earning nearly three times more than non-members. Considering the fact that the profitability of irrigation is extremely low in Mtetelezi, this income difference should be attributed more to the difference in income from upland cultivation where member farmers surpass non-members in landholding size and tobacco cultivation.

Finally, the income structure represented by the share of contributions from different income sources is compared (Figure 5-right). This analysis reveals that the share of contribution from rainy season cultivation remains almost unchanged, which registers approximately 60% for both types of farmers. The difference of income share between members and non-members derives mainly from other economic activities: wage labor, non-farm activities and newly added irrigation. Where ordinary non-member farmers rely on *ganyu* and other non-farm activities for additional income, member farmers rely more on irrigation. But as mentioned earlier, irrigation farmers have not abandoned other non-agricultural income sources altogether.

This comparison seems to suggest that while irrigation club members are definitely earning more than non-members in absolute terms, it is hard to conclude at this point that this is attributable wholly to irrigation, as there are cases in which the difference can be explained more comfortably by the different asset holding and wealth status. Those who are wealthier have a better chance to do irrigation. In any instance, the share of irrigation in the overall income portfolio is still very much limited.

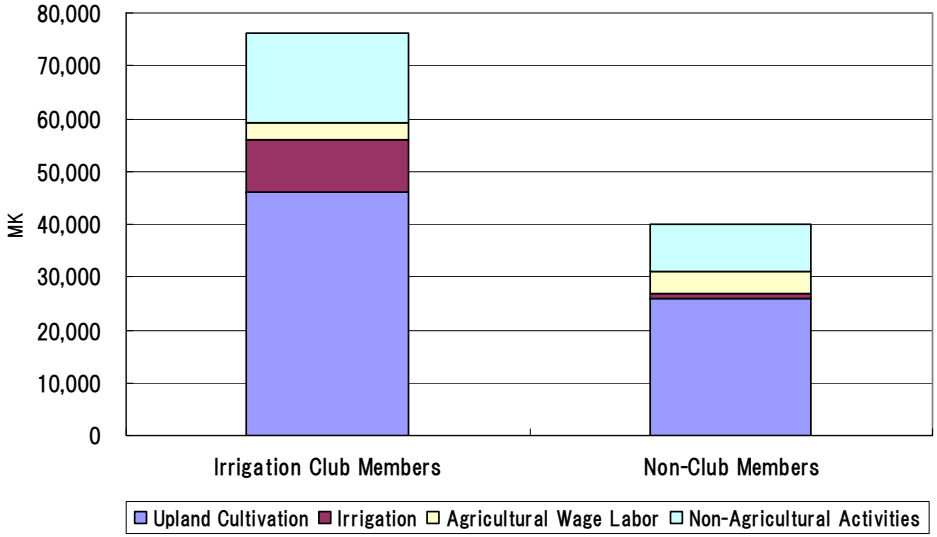
Table 10. Comparison of farm economy between irrigation club and non-member farmers

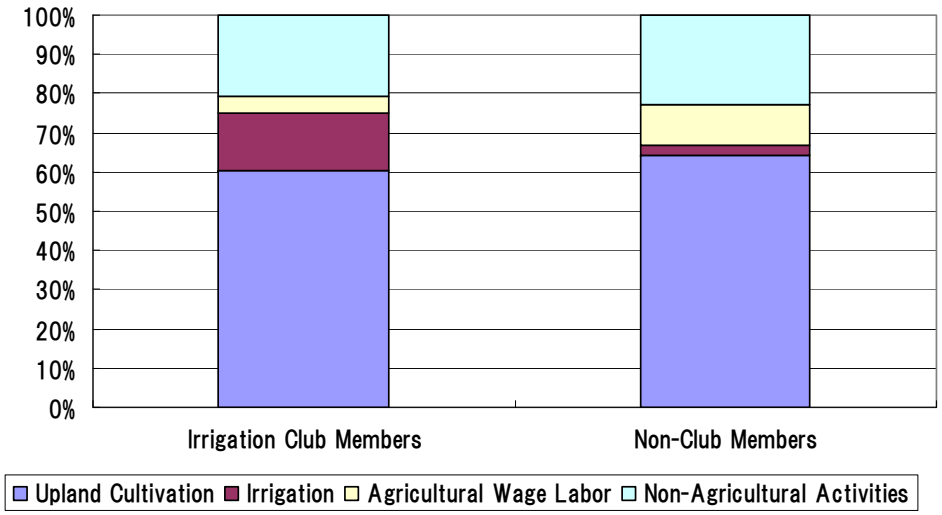
	Tipindule		Mtetelezi		Chimwansongwe		Irrigation Club Members Average (n=27)	Non-Club Members Average (n=30)
	Irrigation Club Members (n=10)	Non-Club Members (n=10)	Irrigation Club Members (n=10)	Non-Club Members (n=10)	Irrigation Club Members (n=7)	Non-Club Members (n=10)		
Size of Household	6.00	5.10	5.80	5.80	3.85	5.00	5.37	5.30
Upland Landholding Size	1.56 ha	1.22 ha	1.65 ha	0.82 ha	2.1 ha	1.44 ha	1.73 ha	1.16 ha
Yield of Upland Maize (Hybrid)	1.67t/ha	1.59t/ha	1.62t/ha	1.23t/ha	1.61t/ha	1.44t/ha	1.63t/ha	1.43t/ha
Number of Farmers Cultivated Tobacco in 2009	3	2	5	1	0	1	2.7	1.3
Total Net Income in 2009*	MK76,501	MK56,347	MK93,383	MK31,808	MK50,584	MK32,325	MK76,034	MK40,160

* All agricultural outputs produced were converted into cash amount by multiplying the prevailing farm gate price at the time of harvest. Production costs include purchased inputs, hired implements, hired labor both in cash and in kind and rent; but own family labor and amortization of farm implements are not counted.

Source : Sample survey conducted by the authors in each site in September-October 2010.

Figure 5. Comparison of income structure (in MK – left and share – right) between irrigation club members and non-members





6-2. Transition of irrigation club membership

Despite the benefits that farmers can expect from irrigation, either in terms of food crops or of cash income, farmers often leave the clubs (Table 11). Constantly changing membership is one of the unique features of informal irrigation clubs in Malawi. The most outstanding example can be seen in Mtetelezi, where more than ten percent of the members leave at the end of a season, and then an equivalent number joins at the beginning of the following season. Some farmers opt not to go for irrigation after registration. In Tipindule as well, some farmers left the club soon after its inception, but later saw a steady increase. In Chimwansongwe, the number of memberships increased from 3 in the beginning to more than 22 in mid-2000, but thereafter decreased to seven.[26]

The reason for departure varies from one case to another. Some stated that after practicing irrigation for some seasons, they preferred to rest in the following season. Cultivation under irrigation requires more labor and time to attend their field for irrigation and animal/bird chasing than that required under rain-fed cultivation. Others mentioned that he decided to take up another trade, e.g., charcoal production, as he thought it appeared more profitable. The most frequently cited reasons for leaving clubs are inability to pay rent and un-affordability of inputs. As discussed earlier, low profitability of irrigation due to the narrow extension of lands and heavy reliance on maize production often makes it difficult to raise sufficient profit to cover rent payment and input purchase, especially at Mtetelezi.[27]

Another factor influencing club membership change is interference by landowners. In Tipindule, for example, the introduction of rent in 2005 caused disagreement between the landowner and some of the farmers, which prompted these farmers to leave the club.

26. Here the situation was slightly different. According to farmers' accounts, the sudden increase of members in 2004 was related to government intervention for scheme upgrading. Farmers joined the irrigation club in expectation of getting access to temporary job opportunities created for the scheme upgrading work and the subsequent farm input handout. But once the work is completed and input distributed, these farmers left the club.

27. There is another factor at play in Mtetelezi: reduction of available water due to an increasing number of upstream water users. Due to the reduced amount of water available, part of the tail-end plots were abandoned after the 2007 season.

Furthermore, this conflict made the landowner deny land use for irrigation for two consecutive seasons in 2006-07. In Mtetelezi as well, repeated revision of rent in recent years is behind the high turnover rate of club members. As rent payment is becoming prevalent, landowners' influence on club management is increasing as well. For all of the schemes, new applications for membership must be accompanied by approval from the landowners: those who are considered "*persona non-grata*" by the landowners are not admitted into the club.

As a result, irrigation is increasingly becoming an enterprise enjoyed by a limited number of farmers within the community. The most notable example of this phenomenon can be seen in Tipindule, where 21 members of the club are all related by blood or by marriage, and consist of 11 nuclear families, most of them cultivating two plots registered in the names of husband and wife (Figure 6). Non-member farmers claim that a high rate of rent and high registration fees are posing barriers to new entrance. There, the benefit is enjoyed most comfortably by landowners, and those who have access to land through a personal relationship to the landowner.

Table 11. Transition of membership in each club

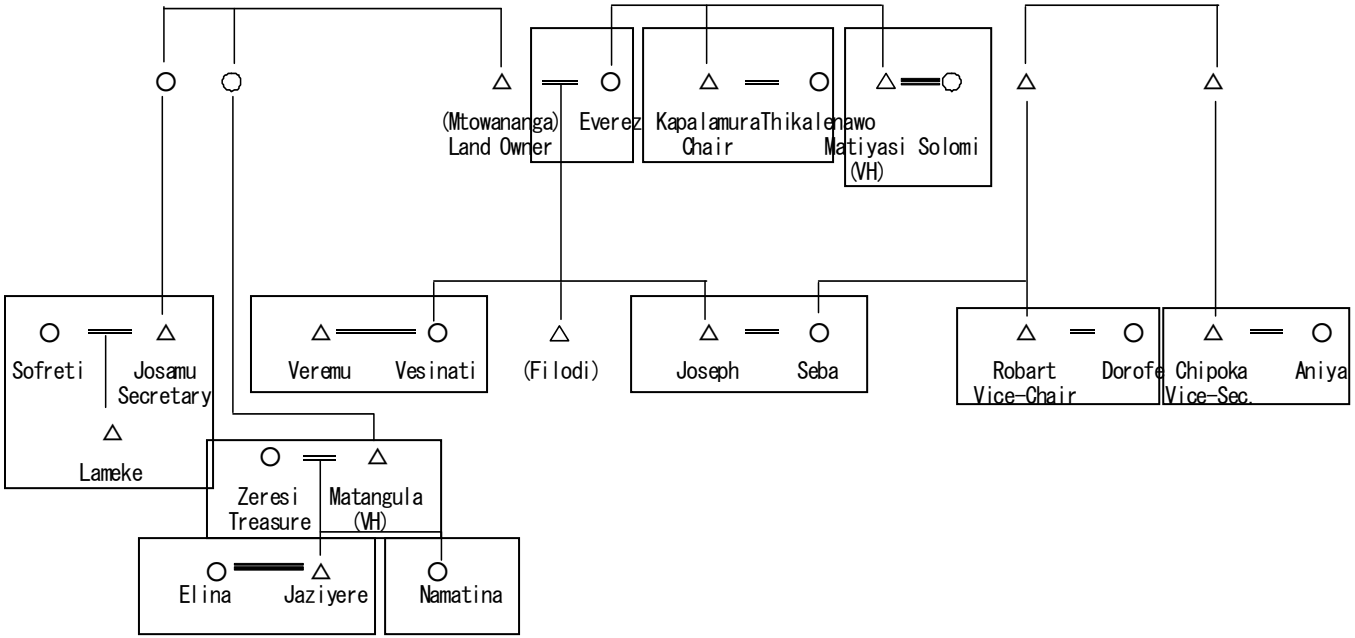
Tipindule	2004	2005	2006	2007	2008	2009	2010
Number of Farmers Newly Joined in the Club	14	4	0	0	5	4	0
Total Number of Farmers Registered at the Beginning of the Season	14	14	0	0	17	21	21
Total Number of Farmers Actually Practiced Irrigation	14	14	0	0	17	21	21
Number of Farmers Who Left the Club at the End of the Season	4	2	0	0	0	0	N.A.

Mtetelezi		2005	2006	2007	2008	2009	2010
Number of Farmers Newly Joined in the Club		7	62	Unknown	58	22	6
Total Number of Farmers Registered at the Beginning of the Season		7	69	66	58	58	47
Total Number of Farmers Actually Practiced Irrigation		7	Unknown	Unknown	48	51	47
Number of Farmers Who Left the Club at the End of the Season		0	Unknown	Unknown	12	10	N.A.

Chimwansongwe	2000	2001-2005	2006	2007	2008	2009	2010
Number of Farmers Newly Joined in the Club	3	0	19	Unknown	Unknown	0	4
Total Number of Farmers Registered at the Beginning of the Season	3	3	22	22	15	7	11
Total Number of Farmers Actually Practiced Irrigation	3	3	9	9	9	7	11
Number of Farmers Who Left the Club at the End of the Season	0	0	Unknown	Unknown	2	0	N.A.

Source: Field survey conducted by the authors in September-October, 2010.

Figure 6. Genealogical relationship among club members (Tipindule)



Note: The box indicates the unit of a nuclear family who jointly cultivates plots in the scheme.
△ indicates a male and ○ indicates a female.
Source: Field survey conducted by the authors in September-October, 2010.

6-3. Competition over water resources

In addition to land used for irrigation, water in the streams is also becoming a scarce resource with increasing value. As temporary irrigation becomes popular among Malawian farmers, an increasing number of new schemes are being initiated wherever perennial water is available, sometimes along the same stream. Tipindule farmers are already aware of four new schemes recently established in the upstream portion of their scheme. In Mtetelezi, there are already seven new upstream irrigation schemes which are already causing conflict with Mtetelezi club members. Chimwansongwe, where there are six upstream schemes, is also experiencing a decreasing amount of water.

Some of these new schemes are receiving support from donors and government. When support for scheme development and upgrading is provided, it is common for planners and engineers to try building a water abstraction point as far upstream as possible to increase irrigable areas and to reduce the impact from existing schemes. These considerations drive the accelerated search for and creation of new schemes further upstream on the river.

Under these new circumstances, some farmers including those in Mtetelezi and Chimwansongwe have begun to consider applying for water right. Donors and NGOs are also encouraging farmers to obtain such right. But so far, the complex procedures for application, and the lack of resources on the side of government as well as that of farmers, are hindering farmers' effort to obtain such right.[28] As we saw above, only three informal schemes have obtained water right in this District.

7. Analysis of findings

In the foregoing sections, we have examined how informal irrigation schemes have

28. Farmers' need to pay MK3,000 (US$19.8) at the time of filing an application accompanied by a 1/50,000 scale topographic map showing the exact location of their scheme. The application can be accepted only at the central office of the Water Resource Board located in the capital of Lilongwe, and the frequency of meetings in which the granting/refusal of permits is decided is held only once or twice a year. The registration fee payable yearly is set at MK1,000 (US$6.6).

been constructed and managed and what outcome they have produced. We now turn to explore why this type of technology has been so widely adopted by Malawian farmers, followed by discussions on the prospect of future sustainability of this technology, according to the criteria set forth in section 2-1.

7-1. Assessment of effectiveness

(a) Technological aspect

In a situation where there was little limitation on access to and use of water in the natural streams, irrigation farmers were able to avail the advantage of forerunners by abstracting as much water as they wanted. Water in the streams was regarded as a pure public good, which is beyond the authority of local chiefs. Farmers rightly chose the streams where water was available even in the dry season, as they knew the condition of water availability through their customary use of the streams for domestic purposes. Compared to the amount of water abstracted, the land opened up for irrigation was small. All schemes were started as an individual's or a group of individuals' private investment and occupied only a small tract of land.

Under such conditions of resource affluence, despite significant loss of water in the canal, farmers have been able to use a sufficient amount of water during much of the cultivation period (except for the end of the dry season), especially in Tipindule and Chimwansongwe. These schemes have water distribution schedules, established to ensure equitable access to water for member farmers, but they are not always strictly followed with minimum detrimental effect to tail-end farmers.

A different scenario can be observed in Mtetelezi, where the area has been expanded with an external support to maximize the number of beneficiaries vis-à-vis the amount of water available in the stream. With external support for upgrading and expansion, the canal was extended to serve three separate blocks, thus resulting in more water loss toward the tail-end

blocks. Emergence of other water users upstream further worsened the water availability. Under this situation, farmers were forced to abandon tail-end plots and consequently the irrigated area was contracted after 2007 season. However, after 2008, helped by the natural adjustment mechanism of informal irrigation and by an elaborate and disciplined water distribution schedule, Mtetelezi farmers (though reduced in number) were again able to access a sufficient amount of water for irrigation.

(b) Economic aspect

In terms of capital investment needed to construct/maintain/replace irrigation facilities, temporary irrigation is a cheap option for farmers. Apart from the limited materials, such as plastic sheets and sacs, most of the materials are locally available and put up with farmers' own labor. The time required for such work is also limited; for example, two days in the case of Mtetelezi.

Irrigation is primarily oriented to filling the food shortage gap. Maize is a natural selection for many of the farmers who experience a constant scarcity lasting for several months. Maize harvest from irrigated lands is a timely solution to fill, at least partly, this food shortage. Maize can also be used as a cash crop to sell green to the market at the end of the dry season. In this sense, informal irrigation provides an economically convenient option for Malawian farmers. But for some, the three-month period required to reap the harvest from irrigation may seem a bit too lengthy, especially for those farmers who need to raise quick cash to purchase daily necessities and to cater for the expenditure needs of social occasions.

On the other hand, the small plot size is limiting the profitability of irrigation, which is further squeezed by the increasing amount of rent. Those with an entrepreneurial mindset choose to venture into production of market-oriented crops, but such venture is usually constrained by accessibility to the input/output market, the initial availability of capital and credit, and market information. Risk is higher for perishable commercial crops.

These considerations cause farmers to retain, along with irrigation agriculture, other income generating activities, such as *ganyu* and basket weaving. They even abandon irrigation temporarily to engage in other activities. Farmers choose the most suitable mix of activities according to their subjective assessment of profitability and the household needs. For these farmers, the flexible and elastic nature of clubs is highly suitable to their livelihood strategy as they are allowed to rejoin the clubs whenever they so wish.

(c) Institutional aspect

In this subsection, the institutional cost necessary to practice irrigation under informal schemes is examined in two respects: one being the direct monetary cost necessary to access natural resources – land and water; and the other being the cost incurred by taking collective actions for the management of the club.

First, the cost of accessing water has been kept minimal for participating farmers. Farmers have not obtained water right and have not paid annual registration fees to the government office. Up to now, water has been a truly free good for them. The land was also accessible with no cost incurred at the beginning, though it became more and more costly for those renting plots from landowners. In all cases we studied, rent was not charged in the initial years, but was introduced at a later date. For landowners, informal irrigation is an attractive enterprise as well, as it does not pose any risk of losing claim to the land, and they can as well expect to collect rent from the club members. Landowners can also reap benefits from practicing irrigation by joining irrigation clubs, themselves.

Secondly, the cost of organizing collective action is low as informal schemes require only a loose form of collective action. They can be built by a small number of dedicated farmers who accept free riders in part because informal schemes can be constructed with only some additional days of their own labor and in part because they have little leverage to enforce collective action. This latter reason is explained by the frequent membership changes of the

irrigation clubs and social costs associated with applying sanctions (such as the fear of curses). As a result, Malawian informal irrigation is run by "loosely-knit organizations" with a low level of cooperation.

Our observation actually indicates that limited cooperation among a small number of farmers in putting up temporary weirs is compensated by the allocation of additional days of labor. For example in Tipindule, the low level of attendance in facility reconstruction work was absorbed by the extension of working days, which was made possible by the long leisure time available during the dry season. In Mtetelezi as well, low attendance in canal cleaning work is compensated by additional days for canal cleaning work.

Under this arrangement, fairness is sometimes compromised against those who are diligent and committed. But they have no other options because they know that without somebody contributing to the construction of the facilities, water would not become available for the season's irrigation, which would be a disaster for themselves. For those who decide to free-ride, the cost of cooperation can be kept minimal as long as they can expect others to volunteer to work for the benefit of all. This situation can be understood as a situation under "chicken game" explained in the collective action theory (e.g., Taylor 1987; Bardhan 1993), where collective goods are supplied by the unilateral cooperation of a part of the players.

7-2. Prospect of sustainability of technology

(a) Resource access and tenure

As seen already, access to water in the stream has been becoming more difficult in recent years. The very "success" of temporary irrigation in Malawi is intensifying competition over limited water resources. More and more new schemes are built along the same streams. Donors and NGOs are giving support for area expansion and upgrading of the existing systems, which naturally entails an increased amount of water abstraction.

Water in the stream stretches beyond the boundary of villages and the traditional

allocative authority of chiefs. While the traditional coordinating mechanism is absent, government authority and control over stream water is hardly acknowledged by farmers. The stream waters have changed in nature from public goods, which are neither excludable nor subtractable,[29] to common pool resources (CPRs), which are not excludable but are subtractable; new arrangements are now required to rationalize the usage of water in an efficient and equitable manner.

As the demand for irrigated lands increases, "commoditization and individualization" (Woodhouse 2003) of customary lands accelerates. When they have no legal title to their land, the last thing landowners want to do is to put the land under a leasehold arrangement since this risks the loss of their land title. A long-term lease arrangement will also limit landowners' freedom of disposal. As they may want to give the land to their descendants or turn the land to another use, an individual agreement with tenant farmers for the current season only is probably the best option for them.

For other farmers, the commoditization and individualization of lands simply means increasing difficulty in accessing irrigation lands. In addition, the status of land tenure remains fragile and unstable in the absence of any formal arrangement over the use of land. Those who are squeezed out of the club due to inability to pay rent or an impaired relationship with the landowners, may wish to create their own irrigation scheme (and become landowners themselves); but this will further intensify competition over limited water resources.

(b) Investment in facility maintenance

Under temporary schemes, farmers invest their labor and time mostly in rebuilding diversion weirs and canals every year. It may not necessarily be done with full participation of the farmers, but the limited cooperation is compensated by the extension of working days.

29. The notion of excludability means the easiness for a user of a resource to exclude other potential users from consuming the same resource; while the notion of subtractability means the degree of reduction in the amount of a resource effected by one person's use from that available to be used by others (see for example, Ostrom et al. 1994).

The cost of annual reconstruction and removal of irrigation canals is high and frequently becomes unbearable to farmers. Since the initial construction is usually borne by the government or donors in the case of permanent schemes, farmers begin to regard maintaining and reconstructing temporary schemes as rather costly. Moreover, a permanent weir enables multiple cropping and promises more profits. It is therefore quite reasonable for farmers to endeavor for upgrading irrigation systems from temporary weirs to permanent concrete weirs.[30]

The question is whether farmers can continue to invest their resources to maintain the upgraded facilities. Without such resources, the sustainability will be lost, as often happened in the formal irrigation systems. Donors and NGOs who are supporting upgrading seem to believe that social capital used to run temporary schemes can be also utilized to maintain permanent schemes.

However, as we examined above, in neither of the Mtetelezi and Chimwansongwe schemes with permanent weirs are farmers spending and saving money for maintenance of concrete weirs. They simply seem to be unaware of the need to prepare for future maintenance needs because concrete weirs do not appear to require regular maintenance. Lack of knowledge could be one of the reasons for this attitude, but a more fundamental reason may be sought in the type of benefit farmers can expect from maintaining different types of weirs. Unlike temporary weirs, where cooperation results in immediate accrual of benefit, cooperation for permanent weirs will generate benefits only in the distant future, which reduces the present value of cooperative benefit. As Wade once noted, people usually find it difficult to recognize benefits that they do not already enjoy (Wade 1988). Moreover, due to the transient nature of membership, farmers are uncertain if they will stay in the club and if they can receive benefits from maintenance works in the future.

30. A preliminary comparison of the necessary cost of maintenance between temporary weirs and permanent weirs was attempted for the presently temporary section of weir in the Mtetelezi scheme. Assuming a ten year life period for a permanent weir (hypothetical case of upgrading) and using the prevailing cost of unskilled labor for farmers' own labor, the accumulated maintenance cost of existing temporary weirs exceeds that for (hypothetical) permanent weirs only after three years.

So, sustainable maintenance of permanent weirs cannot be guaranteed, no matter how successful the same scheme has been under the temporary system. One cannot take it for granted that farmers will continue to invest in the maintenance of permanent weirs after their upgrading.

(c) Distribution of benefits

From the examination of membership, it has become clear that the central figures in the community-based informal irrigation are landowners. It is they who have the authority to decide who can join irrigation clubs. It is they who decide whether or not rent is to be collected and how much. Furthermore, at times, it is they who dictate how the irrigation club is to be run by whom. Hence, there is a tendency that the primary benefits of irrigation are enjoyed by landowners themselves, followed by those who have a close relationship with them (at Tipindule). In this respect, informal irrigation in Malawi has an element of being a private enterprise run by landowners. Where the scheme is larger and can accommodate a larger number of people, benefits of irrigation can be enjoyed by those who can afford to pay membership fees, rent and inputs (at Mtetelezi).

But these do not necessarily mean that informal irrigation is directly leading to the accumulation of wealth by local elites and the creation of disparity within the community. It is important to remind ourselves that these landowners are not landowners as a class and not always traditional chiefs in the community. Their plots happen to be located on the river bank to which stream water is easily channeled.[31] Even those who have difficulty in paying expensive membership fees or the increasing amounts of rent can organize a new club with friends and relatives by shifting to another location and establish a new scheme, and irrigate either their own land or land belonging to somebody close to them. If they are lucky enough,

31. However, there is a possibility that "original settlers and relatives of the village head's lineage are more likely to have stream-bank and wetland than others" as noted by Peters and Kambewa (2007); but it was not confirmed in the present study.

they can become landowners and collect rent. They can at least be waived from paying membership fees by becoming initiators. For latecomers, this is probably a better strategy than seeking membership in existing clubs. This may be a reason why farmers are scrambling to implement new schemes.

8. Conclusions

8-1. Summary of findings

The above examination based on the CAPRi framework revealed that informal irrigation, especially under temporary systems, is satisfying most of the criteria for the assessment of effectiveness of the chosen technology. Under relatively resource affluent conditions, farmers have been able to access water in a sufficient and convenient manner with minimum cost incurred. Temporary irrigation certainly has been a cheap technological option if own labor cost is excluded, as construction, maintenance and replacement require little materials purchase. Irrigation has been economically convenient in further expanding farmers' diversified livelihood portfolios while partially filling the staple food gap during the lean period, though its profitability is limited and its contribution to overall livelihood remains marginal. Under elastic and loosely-knit organizations, the institutional cost of taking collective action has not been very high. Free riders are hardly punished, but the nature of the facilities has allowed continued practice of irrigation with modest cooperation.

But as irrigation continues, the land, which is basically held communally, has increased its value and has begun to be commoditized by landowners. As the increasing rent further reduces the already modest profitability of irrigation, and the membership fee is posing barriers to latecomers, more and more farmers, who have access to potentially irrigable areas, build new schemes for their own use with an intention to become landowners themselves. The resultant scramble for irrigation is already causing water scarcity in some places while the notion of watershed management is hardly understood by farmers. These emerging situations

are threatening farmers' access to productive resources. Furthermore, external intervention for facility upgrading is not likely to guarantee sustainable facility maintenance due to farmers' difficulty in perceiving benefits in maintenance works of permanent structures.

In sum, temporary irrigation has become popular among Malawian farmers under relatively resource affluent conditions and has proved reasonably resilient in coping with changing land and catchment conditions at least up to the present. However, the very success of temporary irrigation is changing the nature of resources, reaching a point where the hitherto effective self-adjusting mechanism cannot cope. In order to realize sustenance of irrigation facilities and to enhance their benefits, a new approach needs to be explored now.

8-2. Policy recommendations

Based on the above analysis, some practical suggestions can be made for future interventions in irrigation development in Malawi. These suggestions are arranged into the following three categories: (a) profitability of irrigation, (b) property rights and (c) collective action.

(a) Improve profitability of irrigation

First, in order to improve the profitability from irrigation practice in a very limited land area, and to make irrigation more attractive to farmers, better crop husbandry techniques can be extended through existing agricultural extension service networks. Under the Farm Input Subsidy Programme, more and more farmers are exposed to the production enhancing effect of purchased inputs, but farmers' accessibility to purchased inputs is still limited. In addition to the dissemination of the effective and efficient application methods of these purchased inputs, the use of self-produced fertilizer such as manure should also be included in the technology package. Furthermore, where market conditions allow, diversification of crops including market oriented cash crops should also be promoted.

(b) Secure property rights

Second, measures needs to be taken to ensure secure and equitable access to land and water resources. Informal irrigation is largely a private enterprise, but exploitation of water in the streams has reached a point where new arrangements are necessary to ensure equitable resource allocation and sustainable management. Watershed management is certainly an important approach, and allocation of water right to present and planned water users should merit further promotion, but with the limited administration capacity of the government and the relatively high cost and lengthy process for acquiring water right, the immediate chance of regulating water use is small. Rather, measures to maintain/increase the amount of resource in the streams may prove more useful in the short-term. Practical measures in this respect include, among others, improvement of water distribution efficiency through the lining of canals and better on-farm water management technology, enforcement of river bank protection to avoid sedimentation, and invention of means to bring back excess water and drained water into streams. Provision of opportunities to hold dialogues and conflict resolutions among different water users should be another area where the government can make meaningful contribution.

Land will continue to pose a difficult problem for future irrigation development as well as continuation of existing schemes. The challenge here is how to avoid excessive accumulation of benefits by landowners and local elites as land suitable for irrigation becomes more and more scarce. External interventions either by the government or by donors in institutionalizing land use should be made with maximum care since such act may incite landowners' fear of losing the title to the land and inhibit irrigation development itself. A close examination of who is benefitting from irrigation plot allocation under what kind of renting arrangement will prove useful to realize equitable distribution of irrigation within the community, so that the needs and interests of the poor and the vulnerable are not neglected.

(c) Embrace collective action risks

Third, in terms of collective action, the elastic nature of irrigation clubs, closely linked with the diversified livelihood strategies of farmers, needs to be taken into account when one approaches capacity building and strengthening of water users organizations like WUAs (Water Users Associations) or cooperatives. One should refrain from assuming that farmers are always fully committed and ready to contribute their dues to realize organizational goals. How to incorporate this elastic nature of irrigation clubs into formally structured WUAs remains a challenge; but it has been confirmed that farmers are willing to remain in the organization and cooperate only when they can feel sufficient incentives and overcome the accompanying cost of participation, as Meinzen-Dick once noted (1997).

Finally, in a similar vein, the present analysis has revealed that one cannot take it for granted that continued practice of irrigation under temporary schemes guarantees proper maintenance of irrigation under permanent schemes. To achieve the latter objective, farmers need to be sensitized on the future need and benefit of facility maintenance, but farmers' notion of the return period and present value of benefit from such investment may discourage them from making necessary investment. Farmers' notions may also be restrained by the limited role played by irrigation in the overall livelihood portfolio of farmers and by the volatile socio-economic conditions surrounding farmers' daily lives. External intervention for upgrading, no matter how it is based on goodwill, needs to be wary of these risks.

Apart from the profitability aspect, future interventions in informal irrigation development in Malawi can benefit from paying more attention to property rights and collective action which reflect the changing nature of the resources involved in irrigation (water, land and facility). Such approach, which can neatly be captured by the CAPRi framework adopted in this paper, should prove useful to improve the long-term sustainability of the informal irrigation technology whether under a temporary or permanent system.

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Abstract (in Japanese)

要約

マラウイでは、2000 年代前半より、農民グループによる「テンポラリー灌漑（簡易堰を伴った小規模灌漑、以下、「灌漑」）」が全土に普及しており、堰の建設には、地場資源と労働力を利用した簡易技術が適用されている。本論文では、「灌漑」がなぜ普及したのか（有効性）と、そうした「灌漑」技術は持続可能か（持続性）という 2 点について、所有権と集合行為に留意しつつ、受益者農民の視点から分析する。３つの堰の比較考察によると、不安定な土地と水の保有状況や農民間の緩い集合行為にも関わらず、「灌漑」の普及に必要で、技術的（簡易な技術）・経済的（地場資源活用）・制度的（「灌漑」に必要な水・土地などの資源へのアクセス、緩い集合行為での運営）に有効な成立条件をほぼ満たしていることが分かった。しかし同時に、「灌漑」の普及により、水や土地の希少化や恒久堰への移行など、資源量や資源運用の性質が変化していることも明らかになった。将来的な「灌漑」の持続性確保には、１）灌漑自体の利益効率を上げる、２）流域保全策の推進、３）農民の集合行為への動機づけを理解した上での水利組合の強化などの政策が必要となろう。