Supporting Policy Research to Inform Agricultural Policy in Sub-Saharan Africa and South Asia

Irrigation and Water Use Efficiency in Sub-Saharan Africa

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Abstract

Food production in Sub-Saharan Africa (SSA) is almost entirely rain-fed with irrigation playing a minor role. This is unfortunate because wider use of the region's ample water resources would give a substantial boost to production of food staples and high value export crops. Recognizing this, governments in SSA and donor agents have placed various levels of emphasis on irrigation development since the 1960s. Yet, there are many challenges that are already confronting irrigation development and that will become steadily more acute as population growth and climate change place added stresses on the available freshwater resources. These challenges include: the allocation of water across competing users and uses; the appropriate pricing of water resources; the efficient harvesting and utilization of water; along with a whole range of other management issues. To address these hurdles, some SSA governments have gone relatively far in decentralizing irrigation management, and encouraging the participation of private sector in new development and maintenance of irrigation systems. Other governments have continued to operate large and centrally managed command-and-control systems for water allocation. What has worked, what has not worked and why remains an important question to be answered, as it will help inform strategies for sustainable future management and utilization of water resources in SSA's agricultural sector. This paper attempts to address this need by surveying past irrigation policy in the sub-continent, identifying the major challenges and hurdles encountered, and highlighting both successes and failures. An argument is made on the need to adopt more flexible and holistic approaches to governance of irrigation water, support farmer and private sector involvement in a move towards commercial agriculture, target irrigation investments where pay-offs are substantial and realistic, and contextualize irrigation as part of a larger policy package to improve agricultural productivity.

1. Introduction

Today, 60 percent of people in SSA are employed by or depend directly on the agricultural sector. They cultivate a total of 197 189 000 ha of land and represent the largest industry of many countries in the region (You *et al.*, 2010). The area under irrigation, which extends over 6 million hectares, makes up just 4 percent of the total cultivated area, compared to 37 percent in Asia and 14 percent in Latin America (You *et al.*, 2010). Two thirds of that area is in three countries: Madagascar, South Africa, and Sudan (*ibid*).[1] Therefore, food production in the region is almost entirely rain-fed with irrigation playing a minor role. Meanwhile, although the sizes of the productivity gains from irrigation over rainfed agriculture remain contested[2], irrigation is an important tool in helping farmers insure against droughts and also plays an integral role in transitions from subsistence to commercial farming. Furthermore, the region is blessed with water resources, although admittedly, more so in some parts of the sub-continent than others and is far from achieving its irrigation potential, which is estimated at 42.5 million ha (FAO, 2005). Even where irrigation is practiced, it is practiced inefficiently, entailing unnecessary water losses and thus, potentially endangering future availability and sustainability of water resources.

In recent decades, there have been various levels of emphasis on irrigation development by governments and donors around the world. South and East Asian countries saw massive investments into irrigation during the green revolution, while Sub-Saharan Africa seemingly failed to jump on the bandwagon. Recently, however, in the face of a growing population, increasing climate variability and a global commitment to eradicating hunger and poverty, food security has landed on the forefront of national agendas around the globe, and the question of how the planet will feed 9 billion people by 2050 (UN, 2009) seems to find a partial answer in more and better irrigation. Yet, there are many challenges that are still confronting water use in agriculture – and that will become steadily more acute as population growth and climate change place added stresses on freshwater resources. These challenges include: the allocation of water across competing users (and uses); the appropriate pricing of water resources; the efficient harvesting and storage of water; along with a whole range of other management issues.

Historically, the irrigation development in the region has been managed largely by governments and it is likely to continue to be heavily influenced by government policies. In this paper, we thus trace the trends in development of irrigation in the SSA region for the past half century using a policy lens and identify what has worked, what has not worked and why. We hope that the findings presented in this paper will serve to inform the incumbent and future governments of the SSA region in setting up adaptive and sustainable irrigation strategies and policies to achieve not only efficient, but sustainable water management in irrigation systems.

The paper has benefited enormously from literature reviews and on-ground case studies and consultations with policy makers and other stakeholders in Tanzania and Ethiopia. The main aim was to combine the scientific research findings from the field with the concerns of those actually

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[1]Most international organizations include Sudan as part of Sub-Saharan Africa (SSA). Geographically however, SSA constitutes the area of the continent of Africa that lies south of the Sahara. A political definition of SSA covers all African countries which are fully or partially located south of the Sahara. Six African countries are not geographically a part of SSA: Algeria, Egypt, Libya, Morocco, Tunisia, and Western Sahara (claimed by Morocco). Together with Sudan they form the UN sub-region of Northern Africa.

[2] Different authors provide different figures of relative productivity of irrigated and rainfed agriculture for SSA region. FAO (2003), for example, indicates that irrigated agriculture contributes about 25 percent of agricultural outputs in the region. Considering that the proportion of land irrigated in SSA is only 4 percent, this implies a productivity ratio of six to one which seems astonishingly high. Rosegrant *et al*. (2008) review some additional micro evidence and conclude that irrigated agriculture is more likely about 1.5 to 3 times as productive as rainfed farming.

involved with and affected by the formulation and implementation of the policies in question in order to identify a way forward that is both realistic and effective.

The remainder of this paper is divided into three main sections. The first section provides some highlights of the current state of resources for irrigation in the SSA region. The second section presents an overview of past and current irrigation development in SSA and a discussion of challenges and opportunities. This section covers issues of Irrigation Management Transfer (IMT); ground water exploration; efficiency-improving technologies; extension services and research; private sector involvement; and the role of rainfed agriculture in SSA. Other issues are returns to irrigation investments; pricing and water markets; and obstacles to private-public irrigation development in the region. Some case studies of both successful and failure irrigation developments are also presented. Finally, a conclusion section is provided along with some implications for policy making. Specifically, an argument is made on the need to adopt more flexible and holistic approaches to governance of the irrigation water resources and the need for water governance regimes in SSA to overcome the existing institutional and political drawbacks. These include, among others the fragmented and overlapping jurisdictions and responsibilities, competing priorities, traditional approaches to irrigation development, rights and water pricing systems and diverging opinions.

2. Current State of Resources for Irrigation in SSA

Sub-Saharan Africa boasts renewable water resources of approximately 3880 km^3, of which almost half is found in Central Africa and another 25 percent in the Gulf of Guinea area (FAO, 2005). Only three countries fall below the cut-off point for extreme water stress of 500 m^3, namely Niger, Mauretania and Djibouti, and Niger and Mauretania benefit from water supplied by international rivers from upstream countries, pushing them well above this water stress threshold (FAO, 2005). SSA is therefore rather water-abundant. However, dam capacity as a share of total surface water available is a mere 11.2 percent and only 17.5 percent of total renewable groundwater resources are pumped every year (You *et al*., 2010).

The extent to which irrigation is practiced in Sub-Saharan Africa is generally low but varies significantly between countries. Table 1 presents a summary of selected descriptive features for Sub-Saharan Africa versus that of the world as a whole.

Table 1: Basic descriptive features of Sub-Saharan Africa and the world

Variable	**Unit**	**World**	**Sub-Saharan Africa**
Cultivated area (2003)	‘000 ha	1 541 488	197 189
Share of total are	%	11	8
Per inhabitant	Ha	0.24	0.27
Per person engaged in agriculture	Ha	1.16	1.02
Total population (2005)	‘000	6 464 452	732 836
Population density	Inhabitants/km^2	47	81
Rural population as % of total	%	51	62
Precipitation	mm/year	1 169	1 136
Internally renewable water resources	km^2/year	43 744	5 463
Per inhabitant	m^2/year	6 859	7 455
Total water withdrawals	km^2/year	3 818	120
Per inhabitant	m^2/year	599	163

Irrigation (total area equipped)	'000	277 285	7 117
% of cultivated area	%	18	4

Source: Extracted from You *et al*. (2010)

Only 4 percent of area cultivated in SSA is equipped for irrigation. More than one third of countries irrigate less than 1 percent of their cultivated area, another third irrigate less than 10 percent, and the rest fall below 20 or 30 percent with the exception of Djibouti, where 100 percent of cultivated area is under irrigation. Northern Africa has almost exhausted its irrigation potential with 88 percent share of irrigation potential being realized. The share of cultivated area equipped for irrigation in Northern Africa is estimated at 28 percent (You, 2010). Much of the irrigation development in the north has been implemented through the unsustainable withdrawal of groundwater resources (in Libya, for example) or the use of water resources which were sourced from elsewhere (e.g. Egypt's use of Nile water for irrigation). Whereas agricultural withdrawals as a share of total renewable water resources reach as high as 219 per cent in northern Africa, that share is only 1 percent in SSA (*ibid*). Among the regions of SSA, southern Africa, led by South Africa, withdraws the most water at 6 percent of total renewable water resources for agriculture (*ibid*).

Overall, Sudan, South Africa, Madagascar and Nigeria are the main countries for irrigated agriculture. Other countries with more than 100 000 ha of full water control irrigation are: Ethiopia, Kenya, Tanzania, Zimbabwe, Mozambique, and Senegal. Total withdrawals for agriculture in SSA amount to 105 billion m^3, less than 2 percent of the total renewable water resource. Most countries in the region have low levels of water storage infrastructure, averaging 543 m^3 per capita, compared to 2 428 m^3 in South America and well below the world average of 963 m^3 per capita. In Kenya, for example, total storage capacity per capita is only 126 m^3 per capita, less than 4 percent of the level in Brazil (World Bank, 2005). However, in several countries, including Somalia, Malawi, Mali and Zambia, equipped partial control irrigation (spate and lowlands) predominates, and in Nigeria, Angola, Sierra Leone, Chad and Zambia, non-equipped flood recession and wetland cropping systems are important.

Where formal irrigation is practiced in SSA, it is to a large extent controlled by governments, although there has been a strong push for irrigation management transfer (IMT) to farmers over the past two decades (Svendsen *et al*., 2009). About 90 percent of irrigation schemes are supplied by surface water, which means that groundwater exploitation is still in its infancy in most countries (FAO, 2005). There are, of course, exceptions, especially where groundwater is a vital source of water for domestic consumption and livestock herding as is the case in Botswana (Chenje and Johnson, 1996 - cited in Masiyandima and Giordano 2007), and in drier countries such as Eritrea, which sources the majority of its irrigation water from groundwater (FAO, 2005). As a result, some areas have already begun to exhibit signs of overexploitation of groundwater (Masiyandima *et al*., 2001; Ulf and Manfred, 2002; Kgathi, 1999 - cited in Masiyandima and Giordano, 2007).

A significant number of schemes initiated in the past have fallen into decay. It is estimated that out of the total area equipped for irrigation in SSA, on average, only 75 percent is actually irrigated. This figure includes eight countries with use rates below 50 percent, namely Angola, Benin, Congo, Djibouti, Lesotho, Mozambique, Somalia, and Sudan (FAO, 2005). Similarly, in an examination of irrigation investment needs in 24 SSA's most economically and demographically significant countries[3], You (2008) estimates that out of the 6 million hectares currently equipped for irrigation in the area, 1 million are in need of rehabilitation.

The potential expansion in irrigated area for the whole of Africa is estimated to be between 5.9 million and 30.1 million hectares (You *et al.* 2010). Nigeria was identified as having the largest potential for small-scale irrigation followed by Uganda, Mali, Tanzania, Cameroon, Chad, and Sudan, for which Internal Rates of Return (IRRs) are all estimated to be above 28 percent (and therefore highly profitable. Although their expansion potential is lower, Kenya, Niger, Somalia, and Mauritania also have very high IRRs (above 30 percent) for small scale irrigation. On the other hand, IRRs are close to zero for Burundi, Sierra Leone, Gabon, and Swaziland (*ibid*). Meanwhile, the African average IRR for large-scale, dam-based irrigation is 7 percent (*ibid*). The majority of profitable expansion is projected to occur around existing dams (9.4 million versus 6.9 million ha) and countries with the greatest potential for large-scale irrigation are Botswana, Eritrea, Sudan, and Mali, who all have a high IRR at above 10 percent, and Nigeria, Benin, Guinea, Mozambique, Sudan, Ethiopia, and Tanzania, who each hold a large expansion potential, geographically, with 0.7 million hectares or more (*ibid*).

Thus, the potential for irrigation development in Sub-Saharan Africa is large; however, there are a number of significant challenges that need to be overcome if this potential is to be realized. These will be explored in further detail throughout this paper.

3. Irrigation Development in SSA

3.1. Overview

Historically, Sub-Saharan governments have played a central role in irrigation development. Like their Asian counterparts, African countries received significant donor support from the World Bank and its partner lenders starting around the mid-1960s, when the Green Revolution was in full swing in Asia and irrigation was seen as a major strategic tool in the combat against poverty and food insecurity. The irrigation schemes established during this time were largely centralized, government-controlled systems that were designed without farmer input and without robust plans regarding their operation and maintenance. Unfortunately, returns from many of the projects implemented during this time failed to meet expectations and both donor and government interest in irrigation development waned in the face of increasing construction costs (as the most favourable areas had already been developed), decreasing food prices and absence of tangible results from previous investments (Inocencio *et al*., 2005).

Assessments of early centrally managed irrigation developments in SSA indicate high per hectare capital investment costs of irrigation in the region relative to North Africa and the rest of the world with only a few exceptions. Obviously, costly investments are unlikely to deliver positive economic returns – particularly if they are to be used for the production of food crops.

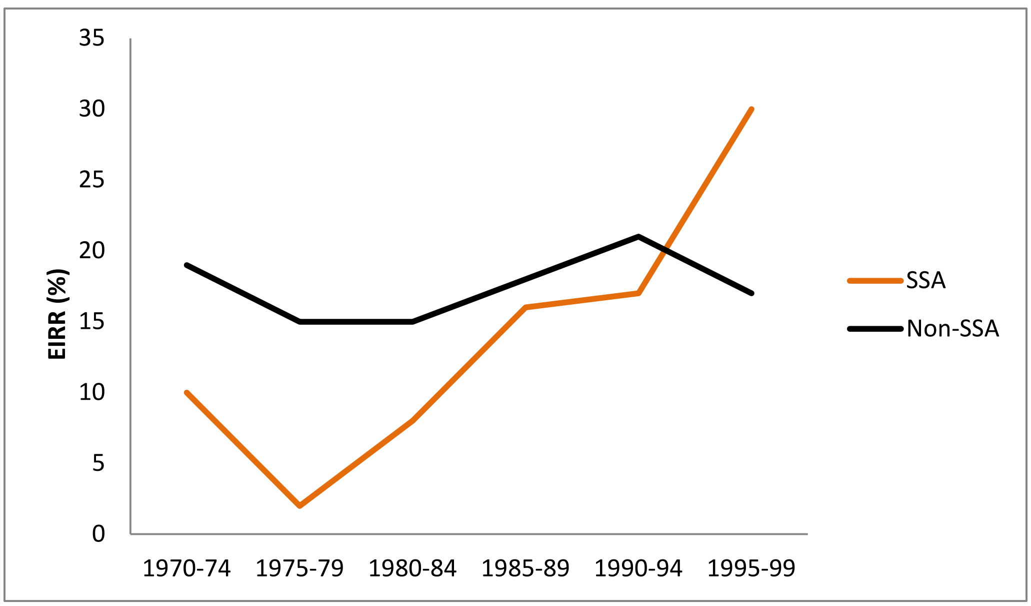
[3] These 24 countries together account for 85 percent of the gross domestic product, population, and infrastructure aid flows of Sub-Saharan Africa and are: Benin, Burkina Faso, Cape Verde, Cameroon, Chad, Congo (Democratic Republic of Congo), Côte d'Ivoire, Ethiopia, Ghana, Kenya, Madagascar, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, South Africa, Sudan, Tanzania, Uganda, and Zambia.

Since the mid 1980s to early 1990s a number of reforms have been implemented in order to address the key bottlenecks in the earlier irrigation development efforts, including the reforms that aimed at reducing government involvement while encouraging greater private sector participation in various phases of the irrigation project cycles, irrigation management transfer (IMT), partial to full cost recovery, and shifts from large-scale, resettlement irrigation projects to small-scale, simple irrigation schemes.

3.2. Returns to Past Irrigation Investments in SSA

The large scale and centrally managed irrigation projects in SSA, which were initiated in the 1960s and 80s are widely perceived as failures, largely because they involved higher costs and lower benefits than expected (Rosegrant and Perez, 1997). They have also deteriorated quickly as maintenance was poor, often operating on a much smaller scale than expected at their initial design. The trends of performance between SSA and other regions as measured in terms of Economic Internal Rate of Return (EIRR) are compared in Figure **1**. The figure was plotted using data from Inocencio *et al*. (2005) who conducted a survey of 314 irrigation projects that were implemented in 50 countries worldwide between 1967 and 2003. Of these irrigation projects, 45 were from 19 SSA countries.

Figure 1: Trends in the Economic Internal Rate of Return (EIRR) of irrigation projects



Data source: Inocencio *et al*. (2005)

As depicted in Figure 1, the EIRRs of irrigation projects in SSA region lagged behind that of other regions until the mid-1990s but since surpassed them. In fact, the average EIRRs presented here suggest that these past projects had positive (and lately, substantially positive) returns. However, it is important to note here that the EIRR is calculated at project completion meaning that the "benefits" used for the calculation are often just estimates/future projections which may not materialize due to many reasons. It may thus be an overly optimistic measure of actual returns to investment. Furthermore, a positive EIRR does not necessarily imply that the project was a good investment decision, as it must be measured relative to pay-offs from other potential investments. Thus, for example, Inocencio *et al*. (2005) define projects with an EIRR below 10 percent as failures; according to this criterion, the irrigation projects in SSA they surveyed were on average 'failures' until the mid-1980s.

We further acknowledge that there were many policies that worked against agriculture in the region during the 1960s and 1970s (e.g. overvalued exchange rates, exploitative marketing boards for cash crops, and price ceilings for food), which may have contributed to keeping returns low. For now, however, we delve deeper into the question of what kept costs of irrigation projects higher and benefits lower than expected.

In the past, costs of irrigation development in Africa have been exceptionally high. Inocencio *et al*. (2005) found that the SSA projects in their sample had average unit total costs of USD 11 828 per hectare versus USD 3 882 per hectare in the rest of the world. Small-scale irrigation schemes tend to have lower unit costs, but they can also go as high as USD 8 000 per ha, depending on the type of technology used (Table 2).

Table 2: Unit costs of small-scale irrigation

Typology	Examples	Average cost per ha (USD)
Traditional community based	Water harvesting; flood recession; swamp irrigation	600 – 1 000
Individual	Pumps and other small lift systems (e.g. treadle, motorized, with and without sprinklers)	1 500 – 3 000
Inter-community	River diversions; small dams; deep tubewells	3 000 – 8 000

Sources: Kay (2001) and You (2010)

A number of explanations have been advanced for these extravagantly high costs of irrigation development. Many of these articulate the relative quality of appraisal and feasibility studies, implementation capacity, use of inappropriate technologies and cost ineffective design, which were caused in some cases by political willingness to develop irrigation at any cost. Other factors include the possibly more limited competition among contractors, more focus on construction of new schemes rather than rehabilitation of existing infrastructure, and failure to realize the potential of alternatives to conventional irrigation in water management. Even other explanations include: a) higher proportion of investments allocated to appurtenant infrastructure; b) higher mobilization costs due to more remote projects; and c) higher construction input prices (including higher costs of labour, materials, and equipment; and lack of qualified local contractors) among others (You, 2010).

One of these explanations, namely poor planning, deserves a more detailed treatment. A good body of literature documents the exceptionally poor record of technical planning for irrigation in SSA. The role played by the associated unrealistic expectations of the costs (which usually ended up being higher than expected) and benefits (which were often lower than expected) is believed to be significant, and is often specified as the major reason for the failure of many of the irrigation schemes in SSA. The actual expansion for most of the irrigation systems in the region has been slow and has usually fallen way short of projections by planners; leave alone the reality that, for most schemes, developed capacity has not been used fully. For example, in Nigeria, feasibility studies of irrigation development on the Kanu River began in 1969 but tenders were not called until 1976. By 1984, about 11 500 ha of the projected 42 000 ha had been developed; of which, only 7 238 ha were cultivated during the 1985/86 dry season. Despite these less than satisfactory results, the feasibility studies, which were completed in 1981, suggested a development of a further 40 000 ha. Again, there were delays in the construction and release of funds so that by 1990 the entire Kanu River Project's area under irrigation amounted to about 12 000 ha of the initially planned 82 000 ha (Adams, 1991).

The Kanu River irrigation project demonstrates not only poor planning, but also the wastage resulting from the decay of initial structures, that remained idle, and were gradually eroded due to execution delays. It further exemplifies the dramatic difference between the promises of feasibility studies and the reality of irrigation construction and the serious underutilization of developed irrigation infrastructure.

Another example is that of the Bura Irrigation Scheme in Kenya, a fascinating case in which the costs of development ended up being higher even as the irrigated area shrank. The Bura Irrigation Scheme was built between 1977 and 1984 with initial investment costs estimated at USD 98 million and a projected command area of 6 000 ha (Rosegrant and Perez, 1997). It was, however, later on discovered that most of the land contained soils with high salinity and low (sub-soil) permeability. The actual area that could be irrigated was only 3 900 ha and the investment costs shot up to USD 128 million (equivalent to a unit cost of USD 32 000 per hectare) (*ibid*). Over time, the scheme deteriorated further because of lack of adequate irrigation water, which likely resulted from either frequent breakdowns of the Nanighi Pumping Station and/or lack of adequate funds to operate the pumping units. The canal network became heavily silted up and as a result, the scheme finally irrigated only 1 000 ha and serving a mere 2 245 tenants (National Irrigation Board of Kenya, 2007)[4].

It is thus clear that careful planning makes a big difference. To improve planning it is in turn crucial to learn from past experiences on how to keep unit costs lower and the EIRR higher. In this regard, Inocencio *et al*. (2005) identify a useful number of characteristics of past SSA projects that were correlated with lower unit costs and higher EIRRs.

Specifically, they found that the projects that performed better tended to be overall larger but contained smaller individual irrigation schemes and fewer project components. In addition, these projects had longer gestation periods (i.e. the time between project identification and approval) and achieved smaller sizing errors (i.e. realized irrigated area comes closer to planned area). The projects which performed better had also higher shares of hardware in total investment, as opposed to software. They mostly produced vegetables, and were part of sector-wide or multi-sectoral projects. This suggests that economies of scale matter but project complexity is also harmful.

[4] Accessed on May 10, 2012 at:
http://www.nib.or.ke/index.php?option=com_content&task=view&id=32&Itemid=45

The finding regarding marketability of output is frequently repeated in the literature and suggests the dire need for complementary investments in transport and storage facilities, market information dissemination, and other market infrastructure (Minot and Ngigi, 2003).

The survey by Inocencio *et al*. (2005) also found that rehabilitation projects had higher rates of return than the newly constructed projects, which is actually not surprising since building new reservoirs involves significantly higher initial costs. Elsewhere in the literature, however, it is noted that if the cost of the reservoir is covered by another benefiting sector (such as hydropower), then new construction may actually be less costly than rehabilitation (You, 2008).

You (2008) also points out that although large-scale irrigation developments tend to be more lucrative, the vast majority of potential area for viable irrigation expansion in SSA (estimated at 96 percent according to her calculations) is contributed by small scale rather than large scale schemes. Moreover, You (2008) argues that viable small-scale schemes may be as far as 5 hours away from a major city whereas larger schemes are much more geographically concentrated. These points are important, especially when deciding where to direct irrigation investments: Governments not only desire to maximize efficiency, but must also deal with concerns of equity and poverty alleviation.

Inocencio *et al*. (2005) identified two more characteristics of irrigation projects that significantly affected performance in the full world-wide sample but were not significant in the SSA sub-sample, namely; the contribution of farmers to construction and management, as well as, the conjunctive use of water (surface water and groundwater). It should however be noted here that, the lack of significance in the SSA sample may be due to the small sample size combined with the low number of observations of farmer-managed projects and projects with conjunctive water uses (i.e. there were only 2 observations out of 45 for both categories). Either way, these observations are still in line with other research findings which showed that farmer involvement in project planning and implementation as well as the conjunctive uses of ground- and surface water increase the project success[5] and returns to irrigation projects, and may as such be relevant for SSA (Bruns, 1997; Shah, 2007).

These findings are especially important as they lead to the popular discussion regarding the role of management in determining the returns to irrigation projects of the past. The management of irrigation schemes in the 1960s to 1980s was extremely bureaucratic, characterized by slow and inefficient responses to the field-level problems and carrying high administration expenses. In many cases, the bureaucrats in charge of irrigation management were poorly trained and, in some cases, reported to be engaged in rent-seeking (Rosegrant and Perez, 1997). Poor management leads to poor operation and thus poor performance of irrigation systems. These, combined with low-cost recovery by governments from farmers, have caused decay and abandonment of many irrigation schemes. The efforts since made to improve irrigation management are discussed at length in Section 3.9.

[5] See Merrey *et al*. (2001). It should however, be noted that the authors of these reports do not denounce participatory management but argue that it is not being implemented properly.

We have presented a comprehensive list of reasons why irrigation in SSA has been more expensive than it needs to be. Some of these explanations may also account for why yields were lower than expected. Micro-evidence from specific irrigation schemes indicates that yields from large-scale irrigation projects were often disappointing. Adams (1991) for example, writes that yields on the Nigerian large scale irrigation schemes have been substantially below that which were predicted in the appraisal reports. He also cites evidence that found actual yields of irrigated cotton to be only 17 percent of the predicted value. Suspected factors for low yields in irrigation include; the lack of access to complementary inputs (e.g. fertilizer), unreliable water supply, and lack of reliable and lucrative markets for crops. Further blame is often laid on the unrealistic nature of the irrigation project appraisals, based on intensively managed small pilot projects. Cropping patterns are often not as predicted, as farmers produce subsistence-oriented grains rather than high-value vegetables and other cash crops due to uncertainty about market opportunities. The type of crop grown and marketing opportunities matter.

One may further expect the type of irrigation technology used to impact on costs and returns. However, this is a difficult question to address for a region as diverse as SSA since the appropriate technology greatly depends on the topography, as well as a host of social and economic factors. In identifying which technologies work best for which area, locality-specific studies are therefore, indispensable. Further discussion of technologies for irrigation is provided in Section 3.4.

While the shortfall in irrigation development in SSA is widely seen a natural response to low returns to investments in irrigation, numerous studies have also documented the positive socio-economic effects that irrigation has had at the community level in helping to alleviate chronic and extreme poverty (see for example in Peacock *et al*., 2007; Haile, 2008). One might also argue that in a region that is for the most part food insecure and where the majority of poor people live in rural areas like SSA, any positive rate of return to investment that benefits the poor would justify the investment.

Luckily, the evidence is not all negative and, in fact, the general tendency of current policy discussion is to endorse rehabilitation of existing or "failed" schemes through a mixture of physical rehabilitation and managerial, as well as, institutional reforms. One example, which is very often cited in the literature as a demonstration that such reforms can be successful, is that of the Office du Niger irrigation scheme in Mali. The project's story is familiar, except perhaps that it is a very old scheme: it was started in 1932 and the planners foresaw a development of 1 million hectares over 50 years. By 1982, only 60 000 ha had been developed, of which about 10 000 ha were abandoned due to poor maintenance and operation. Average paddy yields were as low as 1.6 tons per hectare. Then, the government of Mali managed to turn around the scheme by investing in both physical rehabilitation and institutional reforms. As part of these reforms, the maintenance work was contracted out to the private sector and the marketing of paddy was liberalized. In addition, the management agency was reduced in size and some land reforms were made to achieve more secure land tenure. The reforms had also entailed the improvement of the supply chains for supplementary inputs, specifically high-yielding crop varieties and fertilizers. Furthermore, improved agricultural practices were introduced and farmers were effectively involved in decision making. As a result, the average paddy yields increased from the previous 1.6 tons per hectare to 6 tons per hectare and the O&M cost recovery shot up to 97 percent. The

10 000 ha, which were previously abandoned were put back under irrigation (ADB *et al.*, 2007). The success of the Office du Niger revival is largely attributed to a combination of infrastructural and institutional reforms.

As per the conclusion by ADB *et al.* (2007), many projects that focused only on physical rehabilitation turned out to be economic failures. Examples include the Sudan Gezira Rehabilitation Project (1985), Madagascar Lac Alaotra Rice Intensification Project (1984), and the Sudan Blue Nile Pump Scheme Rehabilitation Project (1982), just to mention few. Yet the review of literature on irrigation development in SSA, especially of the "successful" or highly performing irrigation systems also suggests that there are some bits and pieces of the initial investments which have worked well and that future irrigation projects may work better *where conditions are right*. Meanwhile hardware must not be underrated!

3.3. Irrigation Management Transfer (IMT)

Starting in the 1980s, the focus in irrigation policy circles turned towards irrigation management transfer (IMT) and the involvement of farmers at the grassroots level, starting from project design and initial investment right up to the maintenance schedule. IMT was regarded as a solution both to low productivity of irrigation systems and low project cost recovery on the part of the government. The past three decades have thus seen the proliferation of Water User Associations (WUAs) and other farmer organizations such as Irrigation Boards and Cooperatives throughout SSA, which are supposed to take an active role in the maintenance, operation and management of irrigation schemes. Although in theory, WUAs sound great, in practice, experience has been mixed in SSA as in other parts of the world.

Different reasons are provided for the failure of WUAs in SSA with most of them underpinning the absence of an appropriate structure, poor leadership, lack of effective participation and clarity in the roles of WUAs, as well as the lack of autonomy and accountability (see Narain, 2003; Albinson and Perry, 2002; Howarth 2002; Pradhan, 2002). The structure of most newly established WUAs is more intricate than that of the conventional systems and is intended to make the WUAs more democratic. They are mainly designed by outsiders, with little involvement by the users themselves and are not often as representative as desired and even the formal democratic procedures are rarely acted on. As a result there has been little awareness amongst users of the reasons for setting up WUAs - often leading to a lack of understanding of the function of WUAs.

More widely, IMT attempts in SSA are thwarted by a number of factors. First is the scale of farming: experience in South Africa indicates that IMT is successful when it involves large, commercial farmers but unsuccessful with smallholders (Tren and Schurr, 2000). Most African farms are quite small, which means that transactions costs of irrigation management may be disproportionate to benefits. Furthermore, many households do not rely solely on agricultural production but supplement income with off-farm activities, reducing their stake in and time available to dedicate to irrigation management and improvement of agricultural productivity (Merrey *et al.*, 2001).

Another inhibitive feature of rural SSA is that property rights are often insecure and more importantly, unclear, leading to sub-optimal use of land resource. Farmers for example, tend to hesitate lending out their land as they are unsure about their legal rights. Lack of formal land titles also means farmers have no collateral to enable them to access credit. This in turn prevents them from purchasing the inputs they need to obtain high yields and income and pay for the purchase and maintenance of irrigation equipment (Samad 1996, Wester *et al*., 1995, Kabutha and Mutero 2001).

Even when credit is available, farmers are unable to shoulder the high costs of investments in larger machinery for system maintenance. They are further not equipped to handle such activities as seed research to ensure long-term viability of schemes (Kabutha and Mutero, 2001).[6] Due to low competition between engineers in rural areas, farmers also face high prices and unreliable quality of maintenances services for irrigation equipment. This case was demonstrated in Senegal, where farmers stopped cropping during the dry season primarily as a result of the frequent breakdowns and high cost of pumps (Wester *et al*., 1995). Perhaps most importantly, marketing opportunities are scarce and uncertain, eroding private incentives to invest in irrigation. The imperfection of *both* input and output markets is stressed in the literature as the major obstacle to IMT in developing countries and means that state disengagement from irrigation must be accompanied by farmer capacity building, public investments in market infrastructure and encouragement of the private sector in taking over functions previously fulfilled by the government.

To improve IMT outcomes, farmers must also be shaken out of their dependence mentality. There have been instances in which farmers, following IMT, did not save for larger purchases such as the replacement of irrigation pumps and explicitly stated that they were expecting the government to step in to aid them with these purchases in the future (Samad, 1996; Wester *et al*., 1995). Moreover, it is vital to ensure that the irrigation schemes are actually profitable before handing them over to farmers as this is not always the case: where farmers are truly dependent on state subsidies, they can hardly take over all the costs of managing irrigation schemes. This is exemplified by the case in the Sudan's White Nile region, where the empirical evidence indicates that net income from agriculture was negative when family labour was valued and added to the cost of irrigation, even when farmers were not paying for diesel to operate irrigation pumps or contributing to any other maintenance costs (Samad, 1996). The study concluded that IMT was premature in Sudan and that farmers could certainly not shoulder the additional costs of operation and maintenance, as alone the costs for diesel were much too high and farm cash incomes were already negative. Once irrigation is profitable, however, the case for IMT may be quite strong. In Mexico and Colombia the implementation of IMT was encouraging, especially in terms of shifting the financial burden of irrigation from the government to farmers, which is likely due to the relatively higher incomes of farmers in these countries (Samad, 2001).

In sum, IMT is a sound concept and probably inevitable as irrigation schemes mature and farmers' incomes increase; however, its successful implementation depends on a great number of

[6] In some countries of Africa, the cost of pumps and other maintenance costs are reported to total up to 25percent of total earnings, which makes irrigation unattractive (Merry *et al*., 2001). Successful schemes only cost about 5percent of total output value (*ibid*).

factors, all of which need to be aligned. In a review of both African and international experiences with IMT, Merry *et al*. (2001) identify three pre-conditions whose absence in SSA they argue to be responsible for the overwhelming number of failures of management transfer in the region: a) the scheme in question must be central to bringing about a significant improvement in the living standard of most of the local management team, b) the cost of management (including maintenance and operation) must be a sufficiently small fraction of farmers' incomes, and c) transaction costs, especially those related to management must be low. For IMT to work, the focus must thus be on raising overall productivity of African smallholders by making complimentary investments in facilitating access to input and output markets, improving access to credit and secure land tenure rights, and finally giving farmers the skills they need to form effective management teams.

3.4. Groundwater Exploration

Most of the discussion around IMT pertains to surface irrigation as river diversions are the major type of irrigation investments under government control. By contrast, groundwater irrigation is mostly small-scale and privately managed. The initial investment needed for a tube well is small compared to what is needed to construct a dam and the number of beneficiaries are also much fewer and therefore easier to manage. Construction of tube wells has been both undertaken by private individuals and subsidized by governments and NGOs across Sub-Saharan Africa, often on quite a scattered basis, and many wells in rural areas serve mainly for domestic use with irrigation as a secondary goal. High energy costs have posed a significant obstacle in the development of the groundwater sources throughout Africa as most smallholders have not benefitted from generous energy subsidies as have farmers in India and other South Asian countries. Drilling costs are also high in the region compared to other countries, estimated to be on average USD 100 per metre and thereby more than ten times the cost in India (Wurzel, 2001- cited in Masiyandima and Georganio, 2007). Combined with an often challenging hydrogeology typified by low-yielding aquifers and high average depth of groundwater occurrence, which leads to a low drilling success rate, groundwater exploration in SSA is less than inviting for both private individuals and governments (*ibid*). This is true even for countries like South Africa which are relatively quickly adopting high tech irrigation systems (Bakker *et al*., 2008).

Groundwater abstraction in SSA is estimated to average at 17.5 percent of total renewable groundwater resources (Svendsen *et al*., 2009), of which the majority is assumed to be used for domestic purposes. In contrast, many Asian countries, especially India, are facing depletion of their groundwater resources due to the boom of groundwater for irrigation experienced in the region over the past few decades.

It has long been suspected that SSA has vast groundwater resources, although not always easily accessible and often concentrated outside of population centres. In fact, detailed knowledge on water resources below the surface has long been elusive and many researchers have called for more work to be done on this. While the struggle continues, recent work by MacDonald *et al*. (2012) has found that groundwater volumes are about 100 times that of renewable surface water but that the hydrology in SSA is suited mostly for low-yielding boreholes that can be operated by hand-pumps. The authors conclude that medium- and high-yielding boreholes are only appropriate in the sedimentary basins of remote Northern Africa and potentially a few other areas which would first need to be studied in detail.

Although some details are missing, the general consensus is that small-scale farmers in much of SSA could benefit from groundwater irrigation via hand-operated pumps. This might mean that a groundwater boom would look quite different from what has so far been experienced in India and other Asian countries, where pumps were powered by electricity and subsidization of energy for pumping operation was crucial to facilitating groundwater expansion. If wells will be hand-operated, then the price of diesel or fuel for pumping the water becomes less important, although it will still matter for the costs of drilling. The question then becomes: what are the pay-offs from using such small-scale irrigation, and assuming pay-offs are large enough, what factors, if not high energy costs, are holding farmers back from investing in groundwater irrigation?

Research on the returns to groundwater irrigation in SSA is scant. However, a recent study by Namara *et al*. (2011) has investigated the returns to small-scale irrigation using shallow groundwater in the White Volta basin in eastern Ghana. The study found that the returns were indeed positive, especially when the opportunity cost of labour was assumed to be zero. Specifically, Namara *et al*. (2011) estimated the value-added in shallow groundwater irrigation for 35 communities to amount to about USD 1.1 million or USD 455 per groundwater irrigating compound per annum. The major crops irrigated were tomatoes and green peppers and irrigation mainly took place during the dry season, reducing the high unemployment common during that time and contributing to food security of the communities.

Only 17.4 percent of those surveyed employed motorized pumps and these users were restricted to riverine shallow wells (as opposed to in-field and permanent shallow wells) as yields were high enough to justify use of electric pumps. This means that the vast majority of wells were manually-operated. Construction of boreholes also was quite labour-intensive, with other drilling costs reported to range from USD 1.4 to 2.4 per metre and the costs for cement lining of wells and purchase of electric pumps were reported to be significant, leading to a limited number of lined wells or wells that were operated by electric pumps.

The authors conclude that shallow groundwater irrigation has contributed significantly to reducing poverty and food insecurity in the region and suggest that this low-tech model can be expanded as long as shallow groundwater is available. Combined with recent findings regarding the widespread availability of groundwater suitable to exploitation for small-scale agriculture, this is thus encouraging evidence. However, the study highlights key issues that constrain the expansion or improvement of groundwater use for agriculture among smallholders, namely: poor knowledge of water availability which discourages farmers from investing in wells; insecure land rights which discourages farmers from investing in permanent wells; poor market linkages and post-harvest storage which often force farmers to sell their produce from the farm and reduces the share of the final market price that goes to the farmers; high cost of essential inputs to production (e.g. fertilizer, improved seeds, pesticides) as well as modern drilling and water-lifting technology plus fuel prices; low technical know-how of maintenance; lack of accessible credit; poor extension services leading to low knowledge among farmers of crop water requirements or improved land management; and risk of crop destruction by livestock, birds and crop pests. Most of these “limiting factors” to irrigation are issues of overall agricultural productivity, suggesting that irrigation would indeed be very lucrative if other constraints to small-scale agriculture were lifted.

Another lesson from this case study is that a groundwater revolution in the style of South Asia may not be realistic for SSA as groundwater aquifers are not high-yielding enough to justify use of motor pumps. Instead, a spread of manual extraction of shallow groundwater resources may be more in line with hydrogeological realities.

On another encouraging note, Shah (2010) argues that SSA can explore groundwater and still mostly avoid the high depletion rates of South Asia due to its much lower population densities of smallholder farmers. He estimates that Ethiopia probably needs only 3 - 5 km^2 of groundwater development to drought-proof its agriculture but alludes to the lack of "economies of scope" that distinguish the groundwater economy in SSA from South Asia. According to Shah (2010), groundwater development in South Asia was spurred on by the "growing density of tube wells" that created a highly competitive market for drilling and maintenance services and equipment. He also suggests that higher population pressures on land resources may have encouraged groundwater development and, although not mentioned in the presentation, the subsidization of fuel for pump operation must also have contributed significantly to kick-start the groundwater boom. Shah (2010) then calls for a sound business model to propagate tube wells across SSA and proposes his own plan which involves training and assisting women in becoming "irrigation service providers", in other words, setting them up with a borehole and other equipment on a lease-basis to sell irrigation to farmers in their communities.

Whatever the specific way in which governments choose to further groundwater irrigation, water resources below the surface will certainly play an important role in future irrigation development in SSA.

3.5. Efficiency-improving Irrigation Technologies

A number of promising technologies and strategies for raising water use efficiency have been tested and adopted in SSA. To begin with, these include land-water management practices such as improvement of soil fertility to remove nutrient constraints on crop production; efficient recycling of agricultural wastewater; soil-water conservation measures through crop residue incorporation, adequate land preparation for crop establishment and rainwater harvesting; and conservation tillage to increase water infiltration, reduce run-off and improve soil moisture storage.

Small-scale informal systems are found throughout the region using water from low-lying wetlands, rivers and small boreholes. Slowly, more and more novel irrigation technologies that help conserve water and stabilize output are also being adopted, including supplementary irrigation to supplement inadequate rainfall); deficit irrigation (eliminating irrigation at times that have little impact on yield); and pressurized irrigation systems such as sprinkler and drip irrigation (targeting irrigation water to plant rooting zones). Examples of drip and sprinkler irrigation[7] are found in South African and Swaziland citrus and sugar industries as well as in

[7] Trickle or drip irrigation comprises a system of pipes and emitters that can deliver small frequent irrigations to individual plants.

Tanzania, Kenya and Ethiopia, irrigating export flower and vegetable crops. Micro irrigation (the use of low technology header tanks and pipes as well as treadle pumps) is popular across SSA.

In South Africa, an interesting development has been underway since 1981 using large mobile irrigation machines as part of the Taung project. Centre pivots and linear move machines were installed with the aim of providing income and livelihoods for smallholders on farms varying in size up to 10 ha, cropping wheat, barley, corn, peanuts and cotton (Kay, 2001). The project outsourced the provision of operation and maintenance services to an independent contractor (*ibid*). Government supports the farmers through a full range of extension services. Whereas information regarding the success and sustainability of this kind of development is lacking, there are concerns that the approach may be too 'top-down (*ibid*).

Zimbabwe is another country in SSA which has recorded a significant use of pressurized irrigation equipment. The country has a history of large commercial farming (200 ha and more) on which a sprinkle and trickle irrigation manufacturing, distributing and support network has grown (Kay, 2001).

These new technologies have the potential to increase the productivity of water and labour significantly but they are really only accessible to those farmers who can afford to buy them and who are growing cash crops such as vegetables, fruits and flowers (*ibid*). They are unlikely to be taken up by poor farmers as they are more expensive than the traditional methods and depend very much on external specialist support from suppliers and distributors (*ibid*). Evidence from India also indicates that the increased use of trickle methods in the country is not so much a result of market demand but rather due to the low-cost of the systems which are heavily subsidized by the Indian Government (Kay, 2001). Even with subsidies, the systems are too expensive for most small farmers (*ibid*). Trickle systems are also thought to be too complicated to operate and maintain and not easily divisible to fit small plots (Polak and Sivanappan, 1998).

Recognizing this, technology developers have, of recent, made efforts to bring down the costs of efficiency-raising technologies. "An excellent example is the treadle pump, which was developed specially as a low-cost pump for smallholders and continues to be adapted for particular local needs and markets in the region" (Kay, 2001). Treadle pumps help smallholder farmers avoid the tedious task of lifting and carrying water and can help them move from subsistence farming into growing cash crops. The use of treadle pumps is growing, especially in West, East and southern Africa where it was introduced in 1997 with most being used for vegetable production. Attempts are also made to combine the use of treadle pumps with low-cost water distribution systems such as trickle kits and hosepipes in Zimbabwe, Kenya and in West African countries that see high usage of treadle pumps. In addition, the 'wagon wheel' systems found in Western Cape, South Africa, are another type of low-cost irrigation technologies. They comprise a central water tank with laterals radiating as spokes to a length of about 5 metres with each wheel irrigating a circle of about 8 m^2 (Kay, 2001).

Various technologies and systems have been used in SSA irrigation, ranging from small-scale traditional to large scale commercial irrigation. Of the whole, small- and medium-scale schemes that are locally managed and employ traditional methods have tended to fare best in terms of both economic efficiency, that is, economic internal rate of return (EIRR), and water use efficiency (Kadigi *et al.*, 2008; Kadigi *et al.*, 2004). In their comparative studies of productivity of water (PW)[8] for different irrigation schemes and other water uses in the Great Ruaha River Catchment (GRRC) in Tanzania, Kadigi *et al.* (2008) indicate that small-scale irrigation schemes involving smallholder farmers may perform well when the farmers are supported with necessary research and extension services. Their research findings show that the PW in smallholder irrigation schemes was higher than that of large scale irrigation schemes. In irrigated paddy, the PW for different irrigation systems were, however, very low, ranging from 0.059 to 0.250 kg per m^3 or USD 0.047 to 0.20 per m^3 for abstracted water.

The PW for rice production in Sub-Saharan Africa is generally low, ranging from 0.10 to 0.25 kg per m^3 (using the current price of rice of USD 0.8 per kg, this PW range is equivalent to USD 0.08 to 0.20 per m^3), with an average yield of 1.4 tonnes per ha and water consumption close to 9,500 m^3 per ha (Rosegrant *et al*, 2002). Among developing countries, China and some Southeast Asian countries have recorded higher PW figures for rice, ranging from 0.4 to 0.6 kg per m^3 (equivalent to USD 0.32 to 0.48 per m^3). In addition, researchers working with the International Water Management Institute (IWMI) have shown that the PW for water consumed in agriculture ranges from USD 0.05 to 0.90 per m^3, with the majority of observations in the range of USD 0.10 to 0.20 per m^3 (Perry, 2001).

There are numerous explanations for the high PW in smallholder irrigation schemes in the GRRC. Important is perhaps that these schemes adopted the use of small plots or banded basins (locally known as *vijaruba*), enabling greater control of water levels. The entire small banded basins were cropped and the nurseries prepared at special places (often under trees) to minimize evaporation losses. Thus, improving traditional schemes may significantly help saving water which is currently wasted in unimproved traditional schemes because of the existing poor irrigation infrastructure.

In addition, Adams (1992) presented a very coherent argument for the inherent efficiency of small-scale, traditional irrigation system. He showed, for example, that small-scale furrow irrigation in Tanzania by the Chagga of the Kilimanjaro region and by the Sanjo of Lake Natron is very carefully managed and that, because of this, the Tanzanian government has been able to use traditional irrigation as a basis for further technical improvements, rather than replacing it with modern large-scale systems. Similar examples of productive traditional irrigation systems may be found in the rain harvesting techniques of Northern Kenya, the use of terraces for erosion control in Burkina Faso, and the Molapo Development Project of the Okavango Delta in Botswana (*ibid*).

However, Adams (1992) cautioned that the intervention in such indigenous or traditional irrigation water management systems could have serious drawbacks: for example, altered perceptions of ownership and responsibility, increased economic uncertainty for smallholders,

[8] Productivity of water (PW) is defined as the physical mass of production or the economic value of production measured against gross inflows, net inflow, depleted water, process depleted water, or available water (http://www.vl-irrigation.org/cms/index.php?id=367&type=5). When crop prices are known the PW (expressed as a physical mass of production, e.g. kg or tons) can be converted into economic value by just multiplying the physical mass of production by the unit output price.

and increased dependence on outside support and technology. He noted furthermore that the solution to this is not to leave indigenous systems alone on the premise that they work better without interference but, rather, to insist that "integrated resource management" be followed and that information about new technologies and training in their use be provided as part of the development package.

It is argued elsewhere in the literature that much of the same argument could be applied to virtually all aspects of irrigation development and rehabilitation (see Stiles, undated). Locally oriented solutions are preferable because of the high cost and economic risks associated with externally imposed solutions and because of the "hidden hand" of environmental damage and possible loss of user control over water.

On the other hand, uncritical acceptance of local solutions is little better: a large number of small-scale irrigation systems can be just as environmentally damaging in the aggregate as a few large-scale ones and may be less efficient in their application than they could be with appropriately scaled technological improvements and proper information and training.

3.6. Pricing and Water Markets in SSA

Water is a special good. Although the Dublin Statement labelled water an economic good in 1992 for its many competing uses with economic value, access to water is also considered by many to be a basic human right. Furthermore, water has an environmental value and is difficult to exclude users from, giving it a public good aspect. Water is therefore a highly complex resource to manage. In the face of increasing water scarcity, the proponents of "water as an economic good" have quickly turned to the proposition of water markets to improve efficiency in water use. However, given the complex nature of water, it is not surprising that the spread of water markets has been limited, especially in SSA where low institutional capacity prohibits effective water control.

In the majority of SSA countries, water is considered as either "free" or "as good as free" and there exist no formal markets for trading the resource. Some countries have a system of water rights or permits in place or are working to implement it (e.g. Tanzania) and a few others have already established a form of water markets in parts of the country (e.g. South Africa).

Countries that have adopted the concept of water pricing and markets have different reasons for doing so, including recovering costs, redistributing income, improving water allocation, and encouraging conservation. Pricing schemes often comprise fixed and variable components. Fixed prices vary widely across the region, reflecting the different objectives countries pursue in charging for water.

Most farmers in public irrigation projects pay a tariff or water fee for the O&M of the irrigation projects and some investments in new water storage and conveyance infrastructure. This tariff may be based on area irrigated, types of crops irrigated, volumes extracted, and any combination of these three pricing principles. In SSA, most countries employ area based water charges with the aim of using revenue thus generated to cover O&M costs of irrigation projects.

Many countries subsidize water delivery to the "poor" and the agricultural sectors by charging higher tariffs to sectors with more capacity to pay, but the subsidies are often not transparent. Almost all of the SSA countries use average cost (AC) rather than marginal cost (MC) pricing approaches. Charges are generally not adjusted by location or irrigation schemes, despite the fact that the costs of water supply may vary widely across them.

In some SSA countries (e.g. Chad and Namibia), water charges are heavily subsidized and in others, they apply only to large schemes. Often (e.g. in Togo and Côte d'Ivoire) water charges are applied rarely in spite of the law, or they cover only the costs of operation and maintenance (e.g. in Madagascar). Water and irrigation services are mostly free in Botswana, Ethiopia, Libyan Arab Jamahiriya and Somalia and farmers contribute at most labour to the O&M of schemes.

Overall, one can generalize that most irrigators in SSA countries are paying or contributing at least something to cover O&M costs of irrigation systems. Few countries, however, have attempted to recover capital costs from users. Where attempts have been made, investment costs are almost always subsidized in the form of favourable borrowing arrangements (state guarantees or equity contributions, below market interest rates, extended grace and payment periods, and loan forgiveness for political or natural disaster-related objectives.

The above facts notwithstanding, most SSA countries are increasingly recognizing the necessity of establishing some form of volumetric water pricing and metering. Many are also aware of the need to significantly increase water charges to all users and invest in monitoring and enforcement mechanisms to ensure that water charges are indeed collected. In addition, several SSA countries have recognized the need to use measures to protect the environment, such as pollution taxes and incentives to water suppliers and consumers to conserve water, as reflected in their national policies.

3.7. Extension Services and Research

Policy makers report significant shortcomings in farmer knowledge regarding optimal irrigation practices, including water crop requirements and irrigation timing. They further stress that farmers need to see the benefits of new technologies first-hand before they are willing to invest in them and that they also respond better when they receive demonstrations on how to operate new equipment. In essence, this is making reference to an important role to be played by extension workers. However, most countries in the sub-continent suffer from a shortage of extension workers: Africa as a whole is reported to have, on average, one extension worker per 4,000 farmers compared to the average of one extension worker per 200 farmers in developed countries (AGRA, 2011). Some countries have made head-way in this regard; for example, Kenya now has one extension worker for every 1,470 farmers, but more needs to be done by governments in SSA, especially with regard to improvement of research and extension services (*ibid*).

3.8. Private Sector Involvement

A classic way of improving efficiency and financial sustainability of government enterprises is the involvement of the private sector. This can be justified where governments can underwrite part of the costs of a small-scale initiative that can later be taken to scale by the market (for example, promotion of a treadle pumps supply chain). In some cases, governments may share the costs of major investments with the private sector in order to stimulate growth (for example, the development of the Markala dam by the government of Mali and the private investment in developing the irrigated area). Governments may also promote the development of private or NGO service providers and, where they can provide an efficient and accountable service, may delegate some otherwise public service functions to them.

While in South Asia, successes have been registered in the form of nationalizing production of drip irrigation systems as well as the contracting out of irrigation scheme maintenance to private companies, we find very few success stories in the SSA case. Just as importantly, there has not yet been a case in SSA of what is dubbed a 'build own operate' or 'build own transfer' arrangement in agricultural water, where the government taps the investment resources and management skills of private entrepreneurs to implement a public interest project, but examples from elsewhere outside the SSA region (e.g. in Morocco and Egypt) indicate the potential.

The performance of PPP irrigation development in SSA might have been influenced by the inherent features of the water sector itself, which is dominated by traditions of public investment and strong bureaucratic control. Other factors relate to cultural beliefs about the value of water, and negative experience with privatization, just to mention few.

3.9. Foreign Direct Investments (FDI) in Agriculture

In recent times, a number of countries in SSA have taken a proactive role in attracting Foreign Direct Investment (FDI) in agriculture as a means of economic growth. This has involved the offering of various incentives such as tax holidays within the first few years of establishments (e.g. in Nigeria) and zero duty on agricultural machinery (e.g. Ghana and Nigeria).

The major form of this FDI is acquisition of agricultural land mostly through long-term leasing of up to 99 years. Investments can be large-scale with many covering more than 10 000 hectares and some more than 500 000 hectares, and infrastructural developments such as construction of road or rail links or port facilities are often involved (Cuffaro and Hallam, 2011). These large-scale investments have the potential to supply the recipient SSA countries with much needed capital, contribute to the development of key infrastructure and spread new technologies. Considering that agricultural growth has a bigger impact on poverty reduction than other sectors (WDR, 2008), this trend can be seen as potentially very positive.

However, the investments may also go along with significant risks for the recipient countries' population, especially for the local communities which were using the land before it was sold or leased to foreign investors. In addition, they can lead to increased corruption, unsustainable land use (e.g. land degradation and soil mining), and water shortages with adverse impacts on food security in affected regions.

Where sale or lease agreements have been examined in detail (e.g. in the study by IIED/FAO/IIED, 2009), it is apparent that land has been the hub of the FDI transactions. Water demands for agricultural production are generally not explicitly considered, even though high levels of water abstraction for irrigation may be needed. Progressively, the value of water – which is obtained for free – may exceed the value of the land. As such, concealed behind "land grabbing" may be a significant rush for water. Not only is the value of the water to be used not taken into account in the drafting of agreements, but its potential impact on water-users downstream can become a source of conflict (Cuffaro and Hallam, 2011). In addition to water extraction, opportunities to benefit from timber extraction on forest land granted for agricultural investments may be a significant factor in the investors' interest in acquiring land. This was apparent in the failed attempt by the Sugar Corporation of Uganda to acquire a portion of the Mabira Forest for sugar cane production in 2007.

The major current investors are the Gulf States and to some extent China and South Korea. The main targets are countries in Africa, but there are also investments in South-East Asia and South America (Cuffaro and Hallam, 2011). Gulf countries have concentrated their investments mainly in Sudan and other mainly African OIC member states, while China has mostly targeted Zambia, Angola and Mozambique (*ibid*).

Data on recent FDI in land is scant, but emerging evidence suggests that the number of projects actually implemented is less than the number being planned or reported in the media; moreover, media and civil society attention has played a role in the non-implementation of some of the projects, including the 1.3 million ha deal between the South Korean company Daewoo Logistics and the government of Madagascar. The size of the projects, the pivotal importance of land to the communities involved and the incompleteness and lack of transparency of contracts have caused international concern and raised the question of regulation and corporate social responsibility (Cuffaro and Hallam, 2011).

A good example of the vague nature and resulting worries about unforeseen consequences of these land deals is the agreement between Mali and Libya, which was signed in June 2008 and through which Mali has made 100 000 ha of land available to Malibya-Agriculture for the development of irrigation farming, agro industries and cattle-rearing. The lands have been granted on a 50-years renewable lease without preliminary studies or public consultations performed to ascertain and take account of local interests and concerns. Water provision in the off-season is notably problematic for long-cycle cultivation and the Malian Government has not so far made any arrangements to cover the relocation costs for the people who will be displaced because of the agreement. Apart from the water fees and the obligation to respect the Malian law and regulations on the environment, the contract does not say anything else about any duties or obligations of the Libyan side (GTZ, 2009 – cited in Cuffaro and Hallam, 2011).

Whereas it is too early to come up with a comprehensive analysis of the role of water demand in agricultural FDI, earlier evidence suggests that FDI may compete with existing water uses, given that land deals have in some instances included provisions for priority access to water in cases of scarcity (Woodhouse and Ganho, 2011).

Foreign investments in SSA have therefore tended to be resource-seeking (land and water) rather than market seeking (Cuffaro and Hallam, 2011) and SSA governments should be cautious in negotiating these deals with the aim of maximizing their long-term benefits for their own countries and minimizing future risks including demands on water that may compete with and take away from already under-met local needs.

3.10. Current Irrigation Policies and Commitments in SSA

As mentioned previously, irrigation is coming back into focus on both national government and donor agendas. SSA governments are drawing up irrigation and water sector strategies, attempting to define roles and strengthen the institutional governance of irrigation, and they are investing significant funds into both construction of new dams and the spreading of technologies for small-scale irrigation. In Tanzania, for example, the government launched a National Irrigation Master Plan (NIMP) in 2002 that aims to achieve the Agricultural Sector Development Strategy (ASDS) objective of sustainable irrigation development for increased agricultural productivity and profitability (URT, 2002).[9] The NIMP solely addresses improvement of traditional irrigation schemes, fed by surface water and managed by small holders. It proposes a stage-wise process of planned irrigation development which refines institutional capacity along with human resource development; utilizes that capacity to design, construct, and manage irrigation schemes in compliance with the standards; and improves water use efficiency and expansion of irrigation coverage.

The NIMP recommends an institutional development program to increase the capacity of irrigation managers and technical staff, government agencies, and organizations to design, construct, and manage irrigation schemes to commonly accepted standards.[10] It also recommends improvement in the water use efficiency of traditional systems in order to ensure water supply for expanding intra-basin irrigation development and calls for identification of potential sites where additional irrigation schemes could be developed considering the availability of water, geographic features, level of economic development, and land use in different areas.

The NIMP states that there are about 29.4 million hectares available for potential irrigation development in Tanzania. This total includes areas of high potential (2.3 million ha), medium potential (4.8 million ha), and low potential (22.3 million ha). Of the total area, the NIMP estimates that 405 400 ha can be developed by 2017. As of December 2009, the Division of Irrigation Technical Services (DITS) rehabilitated about 326,492 ha of traditional irrigation schemes (NIP 2010). An important challenge to future development in Tanzania will be bringing down the investment costs for irrigation infrastructure, which have been reported to be quite high at USD 5 000 – 10 000 per ha (TNBC Agriculture Investors Round Table Working Group, 2003).

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[9] The purpose of the National Irrigation Management Plan (NIMP) was to update the 1994 National Irrigation Development Plan (NIDP), which was prepared to improve food security via increased food production. In consideration of the strategic activities and interventions stipulated in the ASDS, the philosophy employed in the NIDP and also the study results, the "*Sustainable Irrigation Development*" was selected as a purpose of the NIMP with emphasis on comprehensive measures through "*Effective Use of National Resources*".

[10] For example the standards set by The International Commission on Irrigation and Drainage, the International Water Management Institute, the International Rice Research Institute, or Asian the Vegetable Research Development Center.

Subsequent to the preparation of the NIMP, the Government of Tanzania began development of the National Irrigation Policy (NIP), which is designed to fully address the challenges that the irrigation sector faces and promote effective irrigation development (URT, 2009). The NIP was endorsed by the national cabinet in early 2010.

The NIP provides a vision and step-wise prioritization of irrigation development in the country. It defines the irrigation roles and responsibilities of different institutions and their relationships with the district level planning process. Normally, the NIMP would have been prepared after the adoption of the NIP. However, as this was not the case, the NIMP will have to be updated to align itself with the NIP to ensure that it becomes the operational tool for its implementation.

Elsewhere in SSA, the government of Ethiopia has of recent developed a five-year Growth and Transformation Plan (GTP) for the period from 2010/11 to 2014/15. One part of the plan is to expand the area equipped for irrigation in the country six-fold, from 127 243 ha to 785 583 ha. It further commits to rehabilitate 6 570 ha and to carry out feasibility studies and design work for an additional 1 208 448 ha. According to the GTP document, this expansion will be achieved through a combination of surface and groundwater development and large-, medium- and small-scale irrigation with the main focus on the latter (Federal Democratic Government of Ethiopia, 2010).

Interestingly, there has been no indication that the Gibre III dam project currently underway in the face of much controversy in Southern Ethiopia will serve to meet these irrigation goals. The dam, with a price tag of Euro 1 470 million is, however, expected to increase the country's power generating capacity by 234 percent.[11]

Meanwhile, donors are also waking up to increasing demands for irrigation. In its latest Business Plan for Irrigation in Africa, the World Bank committed to fund 23 projects, which are aimed to develop or improve up to 260 000 ha of irrigated area, worth a total of USD 618 million. This would represent a 5 percent increase/upgrade on the area under irrigation in Africa in 2007. In a high-case scenario, the business plan foresees an additional USD 320 million in irrigation financing, bringing the total area affected to 420 000 ha or 9 percent of Africa's irrigated area in 2007. The new five-year business plan for 2012 - 2017 has not yet been revealed. The document also identifies the possibility of investing part of the funds for irrigation into water management in rainfed areas, which has a much smaller tag of per hectare costs and could possibly benefit an additional 400 000 ha (World Bank, 2007).

These commitments represent a significant increase over the investments in irrigation by the World Bank since the early 1990s. For the period 2002 - 2007, the World Bank lending to irrigation totalled around USD 280 million for the period 2002 - 2007, which is less than half of current commitments (*ibid*). Furthermore, the Bank has increased its advisory role in the sector and has helped develop recent water sector strategies in Ethiopia, Kenya, Niger and Uganda (*ibid*).

[11] There is no mention of irrigation on the project website and we could not find any other information to the contrary, see http://www.gibe3.com.et/

In the words of the World Bank itself (World Bank 2007):

> "Historically, the World Bank has been a major investor in irrigation. As investments, traditionally in state-run large scale irrigation schemes, began to experience difficulties, the World Bank, alongside most other donors, sharply reduced its involvement in the sector in the 1990s. Since the early 2000s however, and accompanying a global resurgence of interest in irrigation and drainage and agricultural water management, the Bank has supported new Advisory and Analytical (AAA) work and investment lending operations."

We thus see an important recent renewal of international and national commitments to water for agriculture, with both active discussion and policy formulation taking place and concrete funding commitments and development targets set.

3.11. Role of Rainfed Agriculture in SSA

While this paper focuses on the role of irrigation in SSA's development, it is important to acknowledge that rainfed agriculture has its own, continued part to play. In fact, distinctions between what constitutes rainfed agriculture and what defines irrigation are somewhat blurry and almost always, the two are used conjunctively. We have already mentioned various technologies that allow for capture, redirection or simply more effective use of rainwater and indeed, the role of rainfed agriculture for achieving food security and greater prosperity for farmers is well recognized. As put forward by the World Bank, investments in "water management" in rainfed areas have considerably smaller price tags than most irrigation projects and should be pursued as part of its irrigation business plan for Africa (World Bank 2007). Furthermore Wani *et al*. (2009) dedicate an entire paper on "unleashing the potential" of rainfed agriculture, arguing that both better complementary inputs and water harvesting for supplementary irrigation in case of droughts are needed. In a region where agriculture is 95 percent rain-dependent and whose most optimistic irrigation potential is 22 percent of the total cultivated area[12], it is clear that rainfed agriculture needs to be given serious attention in agricultural development planning.

3.12. Obstacles to private/public irrigation development

We have now discussed various aspects of irrigation development in SSA over the past few decades and identified many challenges faced by the various actors in the sector along the way. This section summarizes these challenges to irrigation development, grouping them into obstacles faced by governments and those affecting farmers. The discussion is largely based on the consultations we held in Tanzania and Ethiopia in September to November 2011 but supplemented with themes emergent from the literature.

3.12.1 Obstacles to private investment

Financial Capital

[12] Calculated as the ratio between estimated irrigation potential of 42.5 million and currently cultivated area of 197 189 000 ha

Generally, irrigation investments have high initial costs and the average farmer in SSA is extremely poor. There exists therefore, a very important financing gap for farmers who would like to practice irrigation. Even if the initial cost of irrigation technology is borne by the government and raises farmers' incomes, the latter find it very difficult to reimburse the government's expenditures over time or to make a financial contribution to the upkeep of the systems as there are always more pressing demands for their money (for example, sending their children to school). The poor do not save, so unless the initial investment improves their incomes enough to push them above a certain threshold at which they are able to begin saving and investing, it is difficult to attain self-sustainability in irrigation projects.

Risk Aversion

The poor are generally risk averse and smallholder farmers take time to adopt new farming practices and ways of living. Since irrigation was not a traditional practice among many communities in SSA, its introduction is bound to be met with suspicion. Farmers are only convinced to change their way of farming if they witness the benefits of irrigation first-hand; therefore, use of Farmer Field School (FFS) and demonstration of new technologies is absolutely crucial.

Knowledge Gap

Most farmers lack awareness on many issues regarding irrigation. They do not know with certainty the optimal amount of water required for their crops, are not aware of groundwater potential in their area, and may not have the skills necessary to operate and maintain irrigation equipment (especially more complicated technologies such as drip and sprinkler). The government has a role to play in educating farmers on these and other related aspects.

Subsistence Mentality and Over-dependence to Government and Donor Support

Farmers in SSA region have dominantly practiced subsistence farming for centuries. Because of pressures from the colonial rulers, which had continued even after independence propagated by their new governments, some farmers started to grow cash crops such as coffee and cocoa. Due to the high price volatility in the export markets and repeated incidences of famines, many have started to retreat back to subsistence farming. Furthermore, after some decades of reliance on foreign donors and government support in developing and implementing agricultural projects; receiving free and subsidized agricultural services, many farmers have fallen into a mentality of over-dependence onto these. It is not uncommon to hear farmers demand to be paid (if only in food portions) for contributing labour to community projects or to insist that the government should maintain irrigation canals as it has done in the past. Farmers have also complained about the time-intensiveness of irrigation and the many rules and regulations that accompany membership in an irrigation scheme. Together with other factors, some farmers are forced to rely on rainfed systems and avoid the complexities which are inherent in irrigation schemes. In many places, farmers have become lethargic and rather indifferent to their plight, giving in to a sort of fatalism where they do not believe that they can change their situation so their motivation to invest in irrigation technologies is abysmal.

Low Rate of Farmers' Participation

Related to the previous point, many irrigation projects have been designed as top-down initiatives allowing little or no input from the farmers who are the intended beneficiaries. Other stakeholders, such as cattle herders and large plantation owners, who in one way or another are affected by the developed irrigation systems, are also rarely consulted during project design. This has in turn resulted in developing irrigation systems that are not suited to the demands of the people they are supposed to benefit. Furthermore, it has led to low feelings of ownership or stake in the established or developed irrigation projects by farmers, which in turn threatens sustainability. Recognizing this, many governments have supported the establishment of Water User Associations (WUAs), with the intention of creating a platform for community involvement in irrigation development and management. These are important to ensure that farmers have access to the institutional pulpit through which water and land resources are managed. WUAs are about ensuring the active involvement of water users and stakeholders in making water management and allocation decisions and reflect an emergent recognition of local communities' cultures and their power to shape their future livelihoods. However, the effectiveness of WUAs in managing water resources is still questionable for most parts of the SSA (as explored further in the case studies) and calls for increased efforts to understand what makes WUAs work.

Insecure Land Rights

Many farmers in SSA do not have secure private property rights to their fields. In Tanzania, Ethiopia and Mozambique, for example, all land is legally owned by the state. Even where farmers are able to own land, they may be unclear about the rights associated with such ownership or may not know how to go about obtaining formal ownership. As a result, farmers are less willing to make long-term investments such as purchasing durable irrigation equipment or contributing free labour to canal construction and land management initiatives.

Lack of Complimentary Inputs

Even when farmers are willing to invest in irrigation, they often lack the necessary inputs for complementing production in irrigated agriculture. These inputs include improved seed varieties, affordable fertilizers, storage facilities and transport to markets. Market accessibility is especially important in this regard as it is generally not worthwhile for farmers to invest much in irrigation and produce more output which they cannot sell out. Irrigation is only one part of the overall strategy to boost agricultural productivity and cannot be addressed in isolation from other components.

3.12.2 Obstacles to public investment

Financial Capital

Like farmers, governments in poor countries lack the resources they need to make all the productive investments they envision. International donors still have to play a big role to help SSA governments bridge these financial gaps. However, unless other constraints (especially the institutional weaknesses) are addressed, increased donor money will never reverse this trend. One important contributing factor to the lack of government funds for irrigation is the abysmally low cost recovery from previous projects, which need to be addressed through institutional reforms.

Human Capital

Aside from the limited funds they can contribute to physical irrigation infrastructure development, governments also face a shortage of human capital in terms of adequate personnel to support irrigation development. This problem is very much a by-product of financial constraints as governments must stretch their already thin budgets between hiring sufficient staff to oversee irrigation development and paying high enough salaries to attract quality employees. This applies at all levels, from top managerial positions down to the extension agents who are the most important and direct contact between farmers and government in many countries and thus responsible for crucial knowledge dissemination. Many extension officers are forced to live in remote rural areas, which, combined with low salaries, leads to high turn-over and poor job performance.

Data Constraints

Related to the shortfall in financial and human resources, a lack of reliable data on water potential, water use and other relevant information hinders well-targeted irrigation development in SSA. Policy makers stress the need for more research on crop water requirements, local suitability of technologies and even the macroeconomic contribution of irrigation.

Institutional Capacity

Likely the greatest challenge in improving public investment decisions regarding irrigation comes in the form of weak institutional capacity. The division of responsibilities in policy design and implementation is often unclear, resulting in great inefficiency and low rate of project implementation. Irrigation policy itself is often vague if formulated at all, lacking specific guidelines on how to control the water supply and increase cost recovery, for example. In many cases, cost-benefit analyses of irrigation projects show unequivocal pay-offs and yet, governments simply do not take action.

3.13. Selected Case Studies

To elaborate more on the discussions we have presented in the previous sections and underline the need to educate and effectively involve the intended beneficiaries in management of irrigation systems to create a sense of ownership, we present four case studies with the first two being representing successful cases from Tanzania and the remainder two representing a successful and failure cases from Zimbabwe.

Iganjo Irrigation Scheme in Tanzania: ***An example of a successful farmer-led, government supported irrigation project***

The Iganjo Irrigation Scheme was started in 1967 on a private farmers' initiative. It originally consisted of an 800m long earth canal and a weir made of stones and sand-filled gunny bags. Following the implementation of Tanzania's Obstacles and Opportunities for Development Initiative (O&ODIs), as a part of which local communities were surveyed to identify their top development priorities, the Iganjo farmers succeeded in winning government support in 2006. They were provided with donor funding of TZS 2.1 million and contributed a combination of cash and in-kind payment of TZS 6.5 million to replace the original weir with a cement one and line 621 meters of the main canal. The partnership between donors and the Iganjo Irrigator's organization was renewed several times in subsequent years and today, Iganjo farmers enjoy the benefits of an aqueduct, 4 culverts and soon to be 2 km of lined secondary canals. The scheme supports 1,016 farmers, more than half of whom are women. Before government involvement, the irrigation system supplied 36 ha and production of potatoes ran at 10 tons per hectare; today, the scheme covers 110 ha and potato output has increased to 25 – 30 tons per hectare. Similar yield increases occurred in Iganjo's other irrigated crops, which include tomatoes, peas, beans, carrots, sweet pepper, cabbage, maize and fruits. Farmers continue to carry at least 20 percent of new investment costs in a combination of cash and in-kind payments. Farmer morale is high and the Irrigation Cooperative meets monthly.

Two factors that played an important role in Iganjo's success:

a) **Farmers were intrinsically motivated to practice irrigation.** The farmers at Iganjo had a long history of practicing irrigation and asked for government support on their own volition.
b) **Significantly sized markets are in close proximity of the scheme.** Iganjo is located only 16 km away from the Municipality of Mbeya and close enough to Malawi and Zambia to sell produce across the border.

Case study 1: Iganjo Irrigation Scheme in Tanzania (Source: Personal visit to the scheme and interviews with farmers and officials of the Zonal Irrigation Office in Mbeya, Tanzania)

Mkoji Sub-catchment in Rufiji River Basin, Tanzania: ***An example of where the government through participatory Farmer Field Schools has managed to convince farmers to adopt sustainable use and management of irrigation water***

The Rufiji river basin in Tanzania is faced with many conflicts over water use due to water scarcity problems at local levels which are believed to result from over abstraction of water in irrigation systems located upstream denying access to adequate water by downstream users, especially during the dry season. In order to get water users to understand and frame their own practices, problems and solutions, and to contextualise these within the wider basin, a practical dialogue and decision support tool, called the 'river basin game (RBG)' was designed. RBG was played in Mkoji Sub-catchment (MSC) during three different workshops, each lasting 2 days. Whereas day one of the game was devoted to demonstrating and discussing various scenarios on water availability and water use that had occurred in MSC, day two involved various group discussions, plenary sessions and agreements on ways and strategies to improve water management and increase productivity of water.

At the end of the RBG workshops, participants' understanding of system dynamics, common-property pitfalls, which issues are most critical and what solutions might be considered, was greatly enhanced. Participants learned that being at the top of the river has advantages, whilst tail-end systems experience water shortages; that community actions are better than individual strategies in ensuring equitable water allocation; that local level water users' actions have basin-wide impacts such as environmental degradation and water scarcity to downstream areas; that many solutions and strategies exist whereby crops can be grown using less water; and that a sub-catchment committee is required to oversee water allocation and management. Tracer and impact studies have shown that the RBG triggered not only discussions on technical, institutional and socio-economic arrangements for equitable water allocation, but also behavioural change in the way people regard and use water.

The achievements from the GRB were also complemented by the adoption of the FFS concept, whereby farmers were trained on 'Best Management Practices' (BMP) with support from the WWF in collaboration with the District Councils. The results of FFS have been very impressive, resulting in significant improvement in water management practice with crop yields doubling for farmers who attended the FFS. There is currently a resurgence of water recharges in sources which were completely dry, and increase in dry season water flows for the Great Ruaha River from 0.6 m^3 per second before 2004 to more than 1 m^3/s in 2008 (at Nyaluhanga gauging station) (personal conversation with the WWF Great Ruaha project coordinator).

Case study 4: The boldness of Role Playing Games and Farmer Field Schools (FFS) as powerful tool for creating awareness and triggering behaviour change on various issues and the need to address water problems holistically and in a rational manner: a success story in Mkoji Sub-Catchment in Tanzania (Rajabu, 2007)

Chitora Irrigation Scheme in Zimbabwe: ***An example of effective involvement of farmers in the development and management of irrigation projects***

Chitora is a relatively small scheme, irrigating only 9 hectares with drag-hose sprinklers but it is renowned as one of the successful farmer managed irrigation schemes in Zimbabwe. The scheme was established in 1994 for 18 young people aged 22 to 27 years who were unemployed. The latter received irrigation support from Agritex, the government irrigation development agency. Agritex provided inputs like fertilizers and pesticides for the scheme during the first growing season. Since then the young farmers have been able to finance the scheme themselves. Key to the success of this scheme is the fact that the young farmers were effectively involved at every stage of the development, from planning to implementation and they now have full responsibility for operation and maintenance (O&M). They produce high value horticultural crops for the markets on the outskirts of Harare where there is demand for good quality vegetables. Their average income were reported at Z$ 60 000 per year compared with Z$ 16 800 for unskilled labour in town. They do not see any reason for migrating to towns for search of other employment opportunities. The system is entirely farmer managed through a system of by-laws which are enforced by an Irrigation Management Committee (IMC) that is responsible for coordinating all activities of the scheme, including payment of electricity bills, maintenance work, farmers' monthly subscription fees, and reallocation of plots.

The farmers continue to receive support from Agritex, but solely in form of training and extension services. The successful performance of the scheme is largely a result of creating a sense of ownership of scheme among farmers. Other favourable factors are the type of crop grown (high value horticultural) and the proximity of markets (Harare).

Case study 2: Chitora scheme in Zimbabwe: a success story (Sources: Kay, 2001: Diemer, 2000; Motsi and Madyiwa (undated))

Ngezi Mamina Scheme in Zimbabwe: ***An example of schemes which have performed poorly due to the failure to effectively involve farmers in the development and management of irrigation projects***

The Ngezi Mamina is a communal scheme built at the same time as Chitora but on a large – scale as part of an aid project associated with the dam construction. It is typical of a government-built irrigation scheme that has run into difficulties in getting farmers to "take over" the scheme, which was originally constructed for their benefits. The scheme covers 216 hectares consisting of 154 plots of 0.5 to 1.5 ha. The scheme is equipped with sprinkler technology which is fed by gravity, thereby avoiding the problem of pumping. The scheme is meant for irrigating both low and high value crops. Since its inception in 1994, the scheme has never performed well because farmers were not effectively consulted and they were afraid of losing their own lands. Farmers are reluctant to take over the responsibility of running and maintaining the scheme complaining that the infield designs are inadequate and there are regular disputes between farmers and government institutions responsible water use fee collection. The scheme thus continues to be run by the government and the latter pays for electricity, water and other services, like maintenance of the scheme.

The following are noted as key lessons from the case of Ngezi Mamina (Kay, 2001):

- It is essential for farmers to truly participate throughout the project planning, implementation and evaluation phases and be treated as "owners" and not just beneficiaries of projects
- Only projects that are technically sound should be handed over to farmers
- Government needs to produce a clear, transparent and systematic strategy for handing over government managed schemes to farmers
- The issue of land tenure should be decided in the planning and management of smallholder irrigation schemes

Case study 3: The Ngezi Mamina scheme in Zimbabwe: a failure story (Source: Kay, 2001)

4. Conclusion and Policy Implications

Expanding the area under irrigation, improving water use efficiency and increasing productivity in irrigated agriculture remain the most important domains of the strategies needed to achieve sustainable water management, food security and economic growth in SSA. Food production in the area is still almost entirely rain-fed with irrigation playing a minor role. This is unfortunate because wider use of the region's ample water resources would give a substantial boost to production of food staples and high value export crops and insure farmers against droughts and famines.

Recognizing the potential of irrigation, the governments in SSA and donor agents have placed various levels of emphasis on its development since the 1960s. However, many past projects have performed poorly with relatively higher per hectare capital investment costs than their counterpart irrigation projects in North Africa and the rest of the world. Several reforms have been tried since, including attempts to reduce government involvement and encourage greater farmer and private sector participation in various phases of the irrigation project cycles, efforts to achieve partial to full cost recovery of irrigation development costs, and shifts from large-scale, irrigation projects to small-scale, simple irrigation schemes. Unfortunately, these reforms have to a large extent also not performed smoothly. Investments into irrigation have remained largely unattractive, especially in the face of declining food prices. Many of the irrigation schemes in the region have suffered from rapid degradation of infrastructures, increasing competition for water, low water use efficiency and productivity, weak input and output markets, institutional rigidity, and continued reliance on supply solutions with no attempt to be more demand-responsive.

A new irrigation development paradigm has now emerged and its major focus is on market-driven prosperity and private investment. Under this approach, commercial profitability is the superseding concern and the private sector (farmers and private suppliers of irrigation technologies and services) is expected to assume the leading role in investment and management. The governments only facilitates the private development and invests in economically viable and financially sustainable schemes where market failures mean that the private sector cannot and where there is a clear public interest to remove farmers out of poverty. With this approach, smallholders are essentially expected to become commercial farmers and governments have a major role to play in facilitating the transition.

The entry point for policy makers should be to identify good irrigation development and management practices and use achievements on these as a measure of real progress and commitment. In order to effectively identify these practices, it is important that policy makers are informed by research findings. SSA governments can then work hard to learn from past mistakes and ensure that success stories are scaled out and up. It cannot not be overemphasized here that scaling out and up of "successful" irrigation development initiatives will never be a simple task: it is usually a complex task requiring concerted actions and commitment, both from governments and development partners. It also requires a paradigm shift from holding onto rigid and centrally managed irrigation to implementation of more flexible and holistic governance and development of irrigation schemes. This in turn, highlights the need of SSA water governance regimes to overcome the existing institutional and political drawbacks. These include, among others the fragmented and overlapping jurisdictions and responsibilities, competing priorities, traditional approaches to irrigation development, rights and water pricing systems and diverging opinions.

The key policy lessons drawn from this review of irrigation development in SSA are:

- Governments in SSA need to recognize the importance of irrigation development for enhancing food security and economic growth, as well as the need for water to be developed within a broader framework that promotes agricultural growth through profitable investment and market oriented production
- Irrigation development can only make a contribution to food security and economic growth when investments are profitable at the farm level, economically viable and sustainable
- Efforts should be made to identify the kind of investments in irrigation development that give the best return
- Governments need to provide incentives for farmers to adopt new technologies and move towards intensification of agricultural production, while encouraging the involvement of the private sector to create competitive markets for agricultural inputs and outputs. The relative roles of public and private investment must be clarified in order to foster private investment
- Governments in SSA can promote private investment into irrigation by developing the legal and institutional framework governing agriculture and by investing in infrastructure and research and development
- Transparent, accountable, efficient, and financially self sustaining institutions are key to successful improvement of large-scale irrigation
- Many of the donor-financed projects that have been evaluated as successful on completion in recent years have been characterized by both decentralized and participatory approaches
- More reliable access to irrigation water is part of the story, but other components (e.g. markets, inputs, extension, environmental management, etc) are part and parcel of a comprehensive package that enables farmers to maximize productivity and profitability in agricultural production
- Water markets and pricing mechanisms which were adopted by many governments as water management tools have proven to be largely ineffective, at least in the context of SSA. Alternative demand management mechanisms are needed.

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