Trends and Outlook: Agricultural Water Management in Southern Africa

COUNTRY REPORT ZAMBIA

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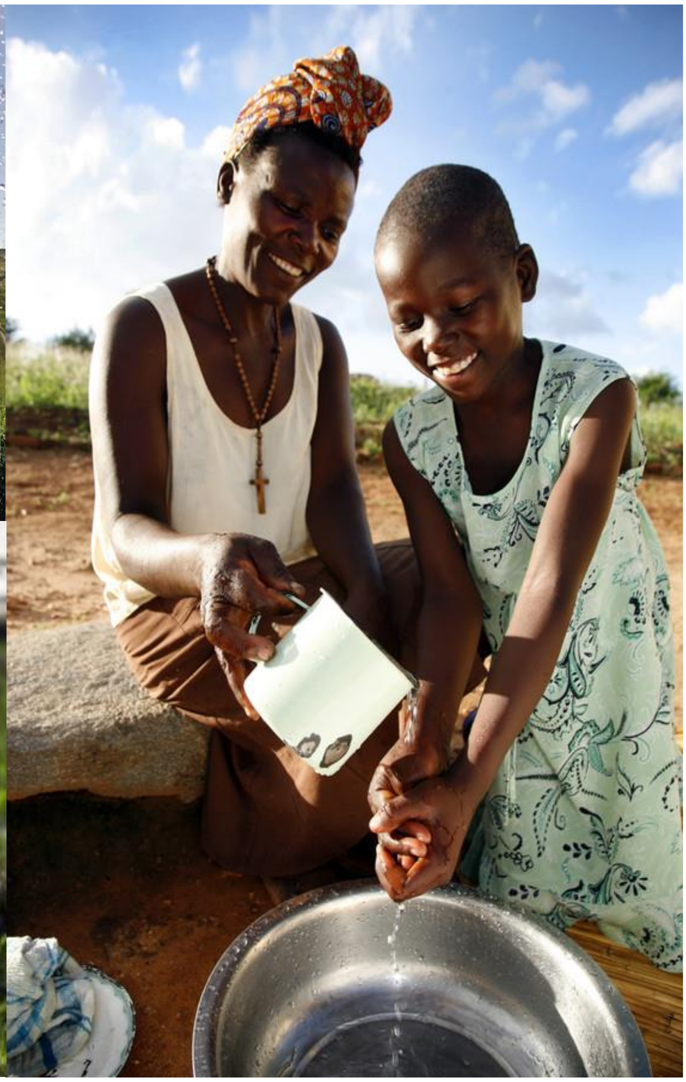
2015



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Acronyms

ADF	African Development Fund
AfDB	Afrian Development Bank
AU	African Union
CAADP	Comprehensive African Agricultrual Dvelopment Program
COMESA	Common Market for Eastern and Southern Africa
DAPP	Development Aid from People to People
FANR	Food, Agricuture and Natural Resources [Division}
FAO	Food and Agricultural Organization of the United Nations
GDP	Gross Domestic Product
ha	hectare
IFAD	International Fund for Agricultural Development
IDE	International Development Enterprise
IWMI	International Water Management Institute
JICA	Japan International Development Agency
KASCOL	Kaleya Smallholders Company Ltd.
KASFA	Kaleya Smallholder Farmers Association
km^3	Cubic km
LuSE	Lusaka Stock Exchange
Mha	Million ha
NEPAD	New Partnership for Africa's Development
NGO	non-governmental organization
pa	per annum
PPP	Public Private Partnership
RAP	Regional Agricultural Policy
ReSAKSS – SA	Southern Africa Regional Strategic Analysis, Knowledge and Support Systems
RSAP IV	Regional Strategic Action Plan IV
SADC	Southern African Development Community
USAID	United States Agency for International Development
WB	World Bank
WUA	Water User Association
ZNFU	Zambia National Farmers Union

Acknowledgements

This report is one of the outputs of the research project 'Trends and Outlook: Agricultural Water Management in Southern Africa'. This research project was implemented by the Southern Africa Regional Program of the International Water Management Institute (IWMI) as part of the Southern Africa Regional Strategic Analysis, Knowledge and Support Systems (ReSAKSS - SA) project. The study covers agricultural water management at the regional level, with a focus on national agricultural water management in Malawi, South Africa, Zambia and Zimbabwe. A team of researchers has contributed to the project's realization: M. Akayombokwa, Y. Altchenko, P. Chilonda, T. Dlamini, H. Gemo, M. Hanjra, J. Jiyane, F. Kalibwani, I. Kumwenda, G. Lacombe, J. Lautze, S. Madyiawa, G. Matchaya, M. Matete, A. Mishra, J. Mutiro, C. Nhemachena, S. Nhlengethwa, J. Stevens, B. van Koppen, K. Villholth, C. Xueliang and C. Zawe.

The research project was supported by the United States Agency for International Development's (USAID's) Feed the Future Program. (The project enhanced regional food security through increased agricultural productivity to sustainably reduce hunger: supporting the achievement of Comprehensive African Agricultural Development Program (CAADP) Pillar 1 in Southern Africa) through USAID's Southern Africa Regional Program. We thank USAID for its support.

1. Introduction

1.1 Agricultural water management for poverty alleviation and sustainable growth

About 70 percent of citizens of the Southern African Development Community (SADC) depend on rainfed agriculture for their livelihoods (SADC 2003). Moreover, enhanced and sustainable development of this sector is the engine of improved economic growth, socio-human development, food and nutrition security and alleviation of poverty (SADC 2014a). Broad-based agricultural growth with agriculture-based industrialization can replace the extractive, capital-intensive and often 'jobless growth' path as currently persists in SADC's dual economies. Inclusive agricultural growth not only contributes to national food security at affordable prices, export and foreign currency; it also creates employment for the rapidly growing new generations, narrows the wealth gaps, and stabilizes SADC's young democracies.

However, rain fed agriculture is directly exposed to the hazards of climate. SADC's rainfall patterns are characterised by high and unpredictable variability over the seasons, years, and decades. Moreover, Southern Africa is predicted to warm up faster than the rest of the world (IPCC, 2014). It is one of the few regions in the world that will experience significantly drier conditions, more extreme and unpredictable dry spells, droughts, and floods, while sea levels will rise faster here than elsewhere. These increased temperatures and less predictable, more variable extreme events hold SADC's farmers and economy 'hostage to hydrology'. This is also true where average rainfall is abundant. These predictions of long-term climate-induced changes render the need for 'no regret' measures today even more urgent.

A key 'no regret' measure that turns these climate hazards into opportunities is improved agricultural water management, or 'agwater management'. Agwater management encompasses a broad menu of techniques ranging from improved on-field water harvesting and soil moisture retention to year-round water storage for year-round fully controlled irrigation of crops, trees and livestock feed; improved water supplies for livestock; and the development of fisheries and aquaculture. Agricultural water management was a vital component in Asia's Green Revolution to boost the 'trickle-up' growth path through poverty alleviation (Jazairy, 1992).

The CAADP of the African Union's (AU's) New Partnership for Africa's Development (NEPAD) recognized this unlocked potential throughout Africa by prioritizing the first of its four pillars, that of 'Sustainable Land and Water Management'. In pillar one, African states committed to the doubling of irrigated area from the 3.5 percent at the time to 7 percent by 2015 (CAADP 2009).

SADC's Regional Indicative Strategic Development Plan (2003, revised in 2007 and 2015) re-affirms CAADP goals, including pillar one. SADC operationalizes this through both its Water Division and the Food, Agriculture and Natural Resources (FANR) Division. The SADC Regional Agricultural Policy (RAP) (SADC 2014a) envisages the improvement of the management of water resources for agriculture (SADC 2014a, section 10.5). In the results framework, outcome 1.4 foresees that water infrastructure for agriculture is expanded and upgraded. The RAP commits to assess the effective utilisation of existing irrigation infrastructure and to promote new infrastructure development (SADC 2014a, section 16.1 (75)). In terms of monitoring, the RAP results framework signals the need to provide baseline data on the number of dams, irrigated area and irrigation management practiced in the SADC region (SADC 2014b).

The Regional Strategic Action Plan IV (RSAP IV) (SADC 2015), which is based on the SADC Water Policy (2006) and Strategy (2007) aims at 'An equitable and sustainable utilization of water for social and environmental justice, regional integration and economic benefit for present and future generations'. Noting that there is about 50 million hectares (ha) of irrigable land available within the SADC Region of which only 3.4 million ha (7 percent) is currently irrigated, the RSAP IV emphasizes the importance of infrastructure development and water resource management for food security in the water-food nexus, and the stronger urgency to take action in the view of climate variability and change. RSAP IV also highlights the benefits of multipurpose dams for both energy and irrigation. At local level, SADC Water commits to conduct action-research to develop and sustainably implement resilient water-related infrastructure; and to innovate affordable and appropriate technologies and innovative approaches and practices. Priority interventions are the demonstration and upscaling of community-based water for livelihoods projects (SADC 2015).

1.2 Trends in irrigated area

In spite of the major unlocked potentials and strong policy commitments, the average percentage of arable land in SADC has only slightly increased from 7.6 percent in 1990 to 8.4 percent in 2012 according to the Food and Agricultural Organization of the United Nations (FAO's) AQUASTAT (see Figure 1). A peak was reached a decade earlier. Moreover, the high average percentage of irrigated land is largely the result of irrigation by large-scale agribusiness in only four countries (Madagascar, Mauritius, South Africa and Swaziland). Moreover, both smallholder irrigation in South Africa and irrigated land area in Madagascar declined.

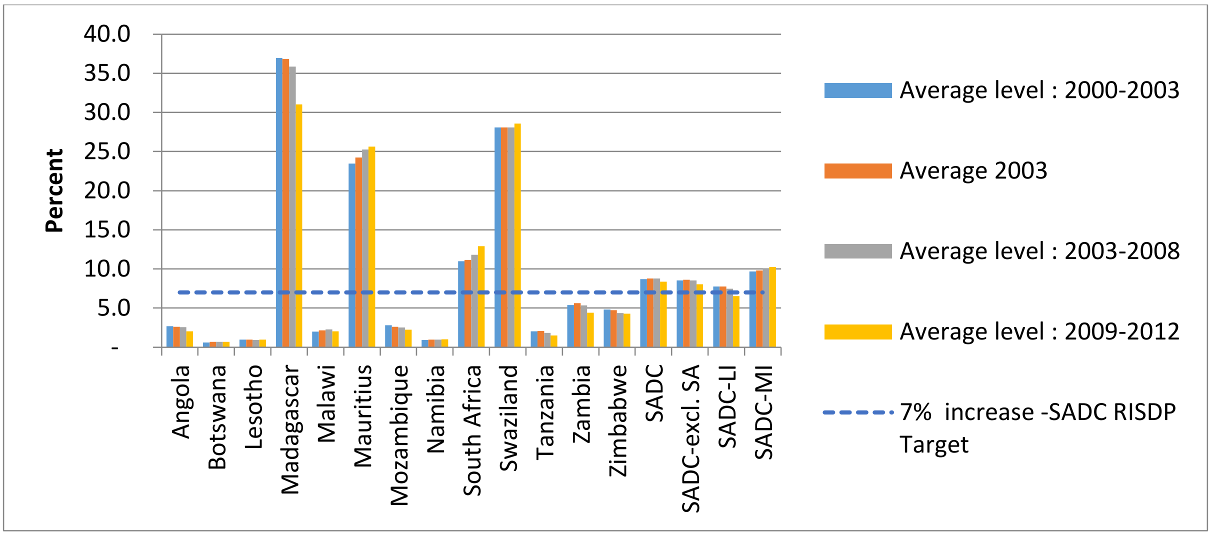


Figure 1: Irrigated area as proportion of arable area

Source: FAO AQUASTAT

This raises a pertinent question: why is irrigation expansion stagnating, and how can this be turned around? Unfortunately, there is no systematic regional body of knowledge to analyze these trends and provide answers. As the Regional Agricultural Policy observes, there is not even a base line on irrigation management practiced in the region, neither for the upgrading of existing infrastructure nor for new investments.

Moreover, in spite of the clearly related common goals of the Water and FANR divisions in SADC and in national states, forums to bring these sectors and other relevant stakeholders together are rare. Potential synergies between sectors that would allow each sector to better achieve its goals remain untapped.

The present study on 'Trends and Outlook: Agricultural Water Management in Southern Africa' seeks to fill these gaps. The project is part of the ReSAKSS – SA project, implemented by the Southern Africa Regional Program of the IWMI. It is supported by USAID's Feed the Future Program through USAID's Southern Africa Regional Program. At the interface of both water and agriculture, the IWMI is well placed to enable such dialogue and provide a robust knowledge base on inclusive agricultural growth in general, and agwater management in particular.

1.3 Study aim and method

In order to explain the current stagnation and find ways to overcome this, the following questions will be answered:

- What are the precise hydrological hazards of climate variability and change, and what is the meaning of 'water scarcity' for agriculture in SADC?

- What lessons can be learnt from past and current investments in agwater management in SADC, in particular from their strengths and weaknesses in sustainably contributing to poverty alleviation, food security and agricultural and economic growth?
- How can SADC and national government, non-governmental organizations (NGOs) and donors build on these strengths and overcome weaknesses?

The method to answer these generic questions consisted of both an extensive literature review and analysis of past performance (Mutiro and Lautze 2015), as well as interviews with key stakeholders at SADC and national levels. Further national studies with illustrative in-depth case studies were conducted in four selected countries: Malawi, South Africa, Zambia and Zimbabwe. This report is the Country Report for Zambia.

The Synthesis Report and the four country reports of the Trends and Outlook: Agricultural Water Management in Southern Africa Project are available at www.iwmi.org - Southern Africa Regional Program.

1.4 Definitions and research approach

Agwater management encompasses a wide range of interrelated hard- and software measures to ensure that the right quantities of water of the right quality reaches the right sites of agricultural (and other) uses at the right time. Improved water control enables crop diversification, stabilizes and increases crop yields, and enables more cropping seasons, including the slack and hunger seasons. Storage in dams or in 'green infrastructure' (such as recharged aquifers or managed wetlands) attenuates floods. Hardware typically includes (combinations of) infrastructure to harvest and store precipitation and run-off water by recharging aquifers, to convey and apply water, and to drain excess water. This study focuses primarily on water supply to crops through infrastructure that extends beyond in-field soil and water conservation alone.

There are various classification systems of agwater management – and even more blends: by source (well, surface storage, stream, wetland, groundwater); by technology (which often determines the scale as well); by ownership and/or management either by individuals or communal groups; by plot size and/or scheme size; by goal of investment and type of beneficiaries (household food security; marketing); by formal or informal in terms of formalized, written and state-backed rules; whether privately invested in capital costs and/or operation and maintenance (O&M), and rehabilitation, or by government, NGOs or otherwise; etc.

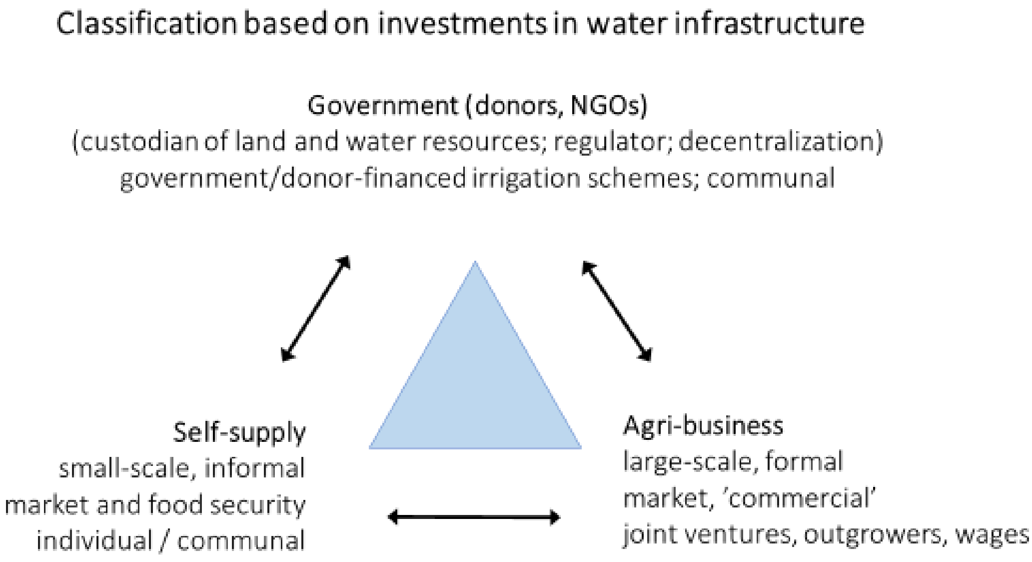


Figure 2: Classification of types of investments in irrigation based on types of investors

For the present purpose of learning lessons for investments, we build on the latter; so the main criterion to distinguish the different types of irrigation is: who is the main investor in the construction and installation of infrastructure? Capital costs are usually the most expensive part of irrigation. Moreover, claims to the water stored and conveyed tend to go together with investments in the infrastructure and subsequent maintenance ('hydraulic property rights creation') (Coward 1986). As we will see, although their performance varies widely, each type is quite specific in terms of the historical and political-economic context in which it emerged and continues to exist, and its strengths and weaknesses in contributing to poverty alleviation and socio-economic growth.

The first type of irrigation investments are by governments, both before and after independence. International donors and financers typically work through governments, while most NGOs also work in close collaboration. Government- or NGO-financed schemes are typically collective schemes. They may be accompanied by resettlement at local or wider scales. The involvement of government can range from very strong (in government-run schemes) to a role that is limited to design and financing of the infrastructure construction and sometimes rehabilitation, leaving all other tasks to communities. In addition to investing in infrastructure, governments also play unique roles as regulator and custodian of the nation's land and water resources in SADC's evolving resource tenure systems. Governments influence the next two types of irrigation in both capacities.

The second type of irrigation investments are by citizens – also known as self-supply – where citizens are the key investors in infrastructure for their own benefits. That is done by individuals or groups, and often is seen as informal. Adaptation to climate variability through these investments has been at the heart of agrarian societies' survival since time immemorial. One strategy for people is move to and from water through their settlement patterns. Both farmers and pastoralists look for the better-watered areas with better rainfall and fertile soils throughout the seasons, also using receding floods and water that accumulates in valley bottoms or entire floodplains for dry season cropping and grazing. People's other age-old strategy is to make water move to them, which requires investments in infrastructure. Household wells provide groundwater for domestic uses, livestock, and small-scale production at and around homesteads. Free gravity energy has long been tapped in mountainous areas in river-diversions, sometimes with night storage. These are typically for domestic uses, irrigation, brick making and other uses. The availability of new appropriate technologies boosts innovation. Multi-purpose infrastructure is the rule; single uses are the rare exception, because rural (and peri-urban) people have multiple water needs, and multi-purpose infrastructure is more cost-effective. People also use and re-use the changing multiple water sources for greater environmental resilience.

The public sector plays a role in supporting technology development and uptake, for example by stimulating market-led equipment supply chains. The Regional Agriculture Policy (SADC 2014a) promotes the removal of import tariffs on equipment for that reason. Effective forward and backward linkages as a result of broader agricultural support for inputs, marketing and skills development are a key 'pull' factor to convince farmers to invest in infrastructure. Further, government's land and water policies, laws and regulations also affect investments for self-supply.

The third type of investments in infrastructure are those by agri-business. Colonial settlement and state formation was largely shaped around this type of investment, and it forms the basis for SADC's dual economy of highly mechanized, often export-oriented large-scale farming; alongside largely manual smallholder agriculture, lack of electricity, poverty and unemployment. The financial crisis of 2008 fuelled further foreign or national investments in SADC's abundant land and related water and mineral resources, also dubbed as 'land and water grabs' (Mehta, 2012). Governments play key roles in these investments through their national investment policies, public-private partnerships and, especially, their post-colonial custodianship of both land and water resources.

In the following presentation of findings in Zambia, we give an overview of the country's water resources availability, agro-ecological zones, current irrigation uses and irrigation potential (in Section two). Section three describes the time line of the evolving composition of irrigators and the estimated areas they irrigate. This is followed in Section 3.2 by a closer look at the two-pronged approach by government and donors: they invest simultaneously in smallholder schemes and in innovative Public Private Partnerships (PPPs). Farmers' investments in self-supply are discussed in Section 3.3. The first case study focuses on a successful example of a government-constructed dam and irrigation scheme that is fully managed by farmers: the Nabuyani scheme near Choma. The second case study analyses the success story of Zambia's oldest PPP: the Kaleya Smallholders Company Ltd. (KASCOL), collaborating with the Nakambala Sugar Estates in Mazabuka. Conclusions are drawn in Section 6.

2. Water resources availability and variability

Zambia is well endowed with water resources. The mean annual rainfall is about 1 000 mm pa with a north-south decline in rainfall receipt. The northern areas receive up to 1 400 mm pa while the southern areas have an average of 900 mm pa. The agricultural belt is located in the central zone along the railway line from Livingston to Lusaka, and from Lusaka to the Copper Belt around Kabwe. This receives 900-1 200 mm per year.

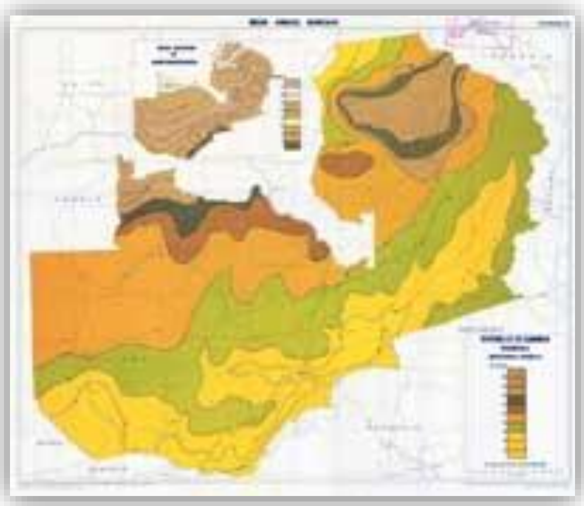
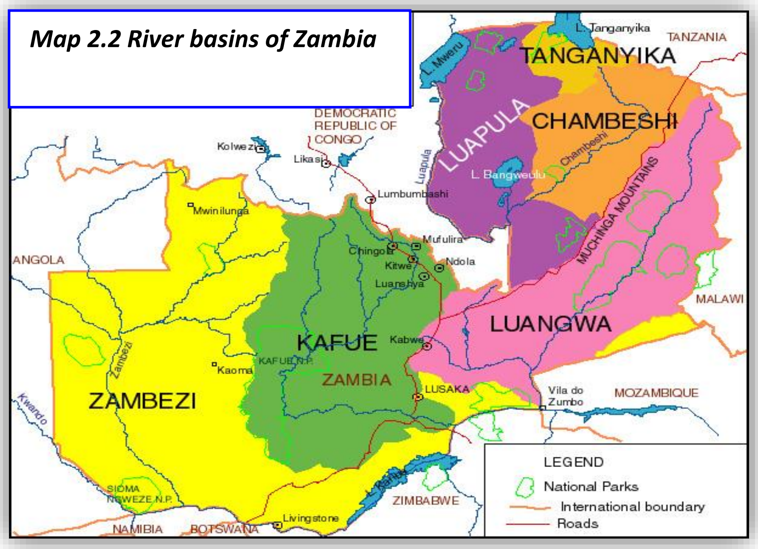


Figure 3: Rainfall pattern

The rainfall regime in the country is uni-modal occurring mainly between November and April. May to August is cool and dry with a gradual rise in temperature as the rainy season approaches. The coldest months are June and July while the hottest temperatures are experienced in October with temperatures reaching 30 ^{o}C. However, rainfall is variable and unpredictable. In recent years, the country has experienced recurrent cycles of drought and floods. These events have had adverse effects not only in terms of reduced agricultural production and multiplier effects, but also in terms of other economic losses arising from infrastructure being damaged or destroyed by excessive rains.

Figure 3 shows Zambia's river basins which are categorised as follows: (1) The upper Zambezi River, with its origin in Mwinilunga and flowing through Angola and back into Zambia and out to Mozambique; (2) The Kafue and Luangwa River Systems which, together drain much of central Zambia and flow into the Zambezi River. This is the most actively irrigated agricultural and industrial zone in the country; (3) The small drainage area of Lake Tanganyika in the north; and (4) The Luapula River in the north, which flows into the Zaire River.



Map 2.2 River basins of Zambia

Figure 4: River basins of Zambia
Source: MEWD 2008

The country is subdivided into 36 agro-ecological zones grouped into three agro-ecological regions (IWMI, 2009). Region I covers the country's major valleys; Gwembe, Lunsemfwa and Luangwa, and the southern parts of Western and Southern provinces. It is a drought-prone area characterized by low rainfall (< 800 mm pa) and a short, hot growing season. However, there is potential for high value vegetables, fruit and rice.

Region II is the medium rainfall area (800-1 000 mm pa) covering the Sandveld Plateau of Central and Eastern Lusaka and Southern Province; Kalahari Sand Plateau; and Zambezi Floodplains of Western Province. The region has a total area of 27.4 Mha of which 50 percent is available for agricultural use. Wetlands, dambos, rivers and lakes allow for agricultural water management and, with good market infrastructure, support high-value crops.

Region III, with rainfall of 1,000-1,500 mm pa and a growing season of 120-150 days, occupies 41 percent of the country including part of the Central African Plateau covering Northern, Luapula, Copperbelt and Northwestern provinces, and parts of Serenje and Mkushi districts. Due to soil conditions, only 53 percent of the land is suitable for cultivation. This, along with poor market access, limits the number of crop types that can be cultivated. There are large areas of wetlands, dambos, rivers and lakes, but low commercialization restricts irrigated production (IWMI, 2009).

Zambia's total renewable water resources are estimated at 165 km^3 pa. Of this, internal renewable water resources are estimated at 115 km^3 pa of runoff and 50 km^3 pa of groundwater. Lusaka area has an extensive limestone aquifer underlying an area of 25 000 km^2. This aquifer has water at depths of 20-40 m. Many boreholes have sustainable yields in the range of 20-30 l/s, which in turn can irrigate up to 20-30 ha. Zambia's renewable water resource per capita is estimated at 8 700 m^3 pa.

Water withdrawals for agriculture currently stand at 1.7 km^3 pa. Zambia has an irrigation potential of about 2.75 million ha of which 423 000 ha are high potential from an economic perspective. In spite of this vast potential only about 7 percent (156 000 ha) is currently being irrigated (MACO/FAO, 2004; IWMI, 2009). What can be done to unleash this potential? This is discussed next.

3. Irrigation investments in Zambia

3.1 Time line of irrigation investments

In the colonial era, copper mining was the main goal of the settlers in the then Northern Rhodesia. The few dams that were constructed in the drier southern region aimed at feeding the mining communities (Venot et al, 2012). With the dawn of independence in 1964, the government supported the Zambia Sugar Company to plant 120 ha of sugar cane at Nakambala Sugar Estates in the Mazabuka era on the Kafue flats. This has expanded to 30 000 ha of irrigated cane. In 2001, ownership shifted to Illovo. In 2010 its sugar cane production was at 2 136 000 tonnes, representing 82 percent of the total national sugar production.

Large scale schemes for wheat production were established in the 1980s in the Ndola region: the Mpongwe Scheme of 1 000 ha and the Mkumpu Scheme of 2 500 ha. These large schemes were later privatized. Wheat production has rapidly increased, along with the inflow of South African farmers. By 2010, production was 216 000 tonnes, while national consumption level was 160 000 tonnes pa.

Further, the independent government developed dams, gravity fed canals and water abstraction equipment including motorised pumps for smallholder irrigation across the country (see Figure 5). A unit called 'Projects Division' was established with the purpose to construct these schemes. The goal was to (1) improve the livelihood of local people; (2) increase crop production, particularly vegetable crops; (3) help displaced people in the Zambezi Valley after the construction of the Kariba Dam; (4) reduce imports; and (5) improve foreign exchange earnings.

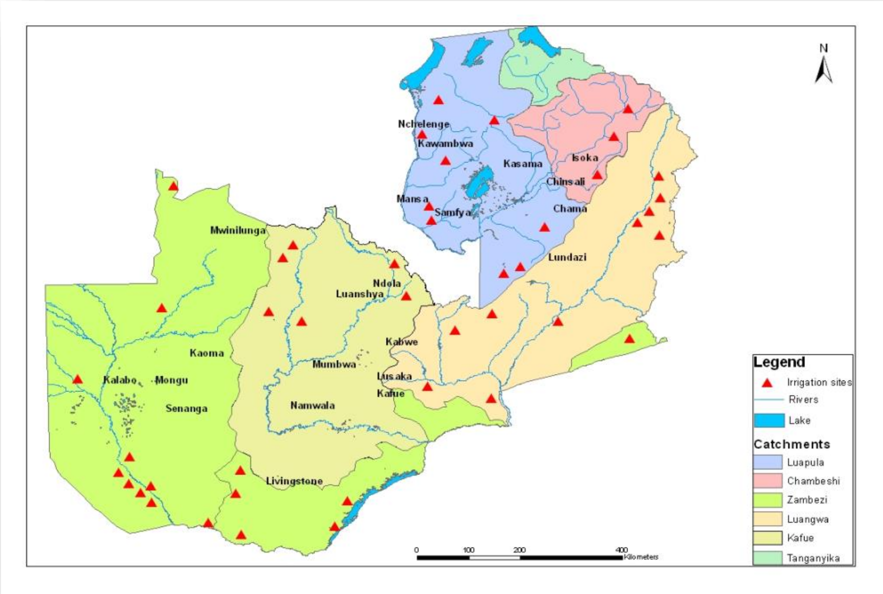


Figure 5: Distribution of smallholder irrigation schemes in Zambia
Source: MACO 2004b

With these government interventions, irrigated agriculture rapidly increased from 120 ha of a commercial cane crop in 1964 to about 10 000 in 1980 of mixed sizes, rising to 27 000 in 1988.

In 1990, a specialized irrigation section was created. Moreover, informal irrigation was also included. Informal irrigation has been practised in Zambia for many years in the low-lying wetland areas, which were equipped with simple technologies by traditional farmers. These irrigated gardens are designated differently in various parts of the country such as *Dimbas* in the Eastern Province, *Zilili* (Lower Zambezi) in the Southern Province and Wet *Litongo* on the Upper Zambezi (Barotse) Flood Plain in the Western Province. Informal irrigation normally takes place during the long dry season after the upland rain fed crops have been harvested. These gardens play a vital role in supplying vegetable and food products to the rural communities and nearby rural towns. However, due to the poor cultural practices crop yields were and continue to be low.

Figure 6 shows these increases in irrigated area from 1988 to 2010.

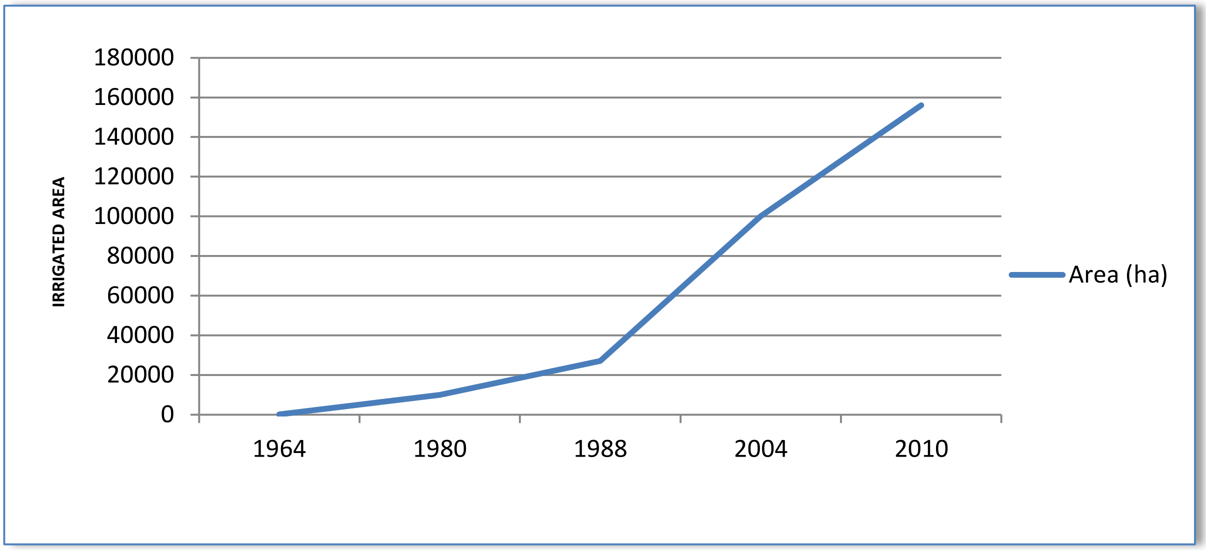


Figure 6: Increase in irrigated area (ha)

By 2004 the area under irrigation in the country was estimated at 100 000 ha with an annual increase estimated at 8 000 ha. Presently, the total irrigated area is at 155 992 ha as shown in Table 1. This shows that 100 525 ha is under the informal type of irrigation from which most of small-scale irrigators emanate. Furthermore, the table broadly categorises the type of irrigation schemes found in Zambia. These are surface irrigation systems (32 139 ha), sprinkler irrigation systems (17 570 ha), and the informal systems (100 525 ha) (MACO/FAO, 2004b).

Besides sugar and wheat, rice and coffee are irrigated crops. Rice is mainly rainfed and grown in naturally flooded low fields, which reduces productivity. Coffee is mainly grown in the northern areas with high rainfall. However, productivity is low, in spite of the support by the Coffee Board. Vegetable production, which is typically practiced by rural and peri-urban small-scale farmers has seen a strong growth. While vegetables used to be imported from South Africa and Zimbabwe, the country has become self-sufficient.

Table 1: Irrigated land area by technology, formal status, water source and farm size

Land under irrigated agriculture	Ha
Land with irrigation potential	2 750 000
Land under surface irrigation	32 189
Land under sprinkler irrigation	17 570
Land under localised irrigation	5 628
Land under developed (equipped) lowlands and wetlands irrigation	100 525
Total irrigated land	155 912
Flood recession cropping area	100
Cultivated lowland	100 000
Total agricultural water managed area	255 922
Land under irrigation by source of water:	
Land area irrigated by groundwater	6 750

Land under irrigated agriculture	Ha
Land area irrigated by surface water	149 162
Power water managed area	38 630
Irrigation schemes by size:	
Total area of small irrigation schemes	111 525
Total area of medium irrigation schemes	7 372
Total area of large irrigation schemes	37 015

Source: MACO/FAO, 2004b

3.2 Government- and donor-supported irrigation investments

Irrigation development in the country is guided by the National Irrigation Policy and Strategy of 2004 (MACO/FAO 2004a) which is being revised. It states that 'Development of small-scale irrigation schemes will be done where these are socially and economically viable'. Its overall thrust can be summarised as follows: (1) to remove constraints for existing irrigators, thereby encouraging new private investment that increases area and productivity; while (2) encouraging the emergence and gradual commercialization of new irrigators from among traditional farmers. The policy is to build irrigation infrastructure and immediately hand over to small-scale farmers.

Constraints that cut across all types of irrigation schemes that the policy seeks to remove include: (1) weak service delivery in irrigated agriculture; (2) lack of appropriate credit facilities and mechanisms; (3) Inadequate access and communication infrastructure; (4) inadequate marketing institutions, infrastructure and services; and (5) high operating costs leading to reduced profitability for irrigated farming. There is also a need to establish a dedicated irrigation agency to drive irrigation development programs. Lastly, land ownership on schemes needs to be looked at so that farmers that are not doing well can be evicted as their poor performance affects others on the scheme.

The 1990s have seen an increase in donor funded projects in the irrigation sector as shown in Table 2 below. The case study of Nabuyani will analyse such a project.

Table 2: Irrigation Projects in MACO since 1990

Project	Duration	Main funding	Cost (USD million)
Special Programme for Food Security (SPFS)	1995-2007	FAO	1.2
Smallholder Irrigation and Water Use Programme (SIWUP)	1996-2002	IFAD/IDA	11.2
Southern Province Household Food Security Programme (SPHFSP)	1995-2003	IFAD	23.4
Small Scale Irrigation Project	2001-2006/extended	AfDB/ADF	10.77

Project	Duration	Main funding	Cost (USD million)
Capacity Building and Development for Smallholder Irrigation in Northern and Luapula Provinces	2009 - 2011	JICA	unknown
Smallholder Peri-Urban Irrigation Study	2009 - 2011	JICA	unknown
Irrigation Development and Support Project	2011-2018	WB	115

The last project in Table 2, the Irrigation Development and Support Project, supported by the World Bank, is innovating a 'three-tier PPP'. The concept is illustrated in Figure 6. The model is similar to that of the Farm Blocks, as implemented in Serenje. Both models learnt from the KASKOL. This is part of the large Nakambala Sugar Estate, as the case study will elaborate.

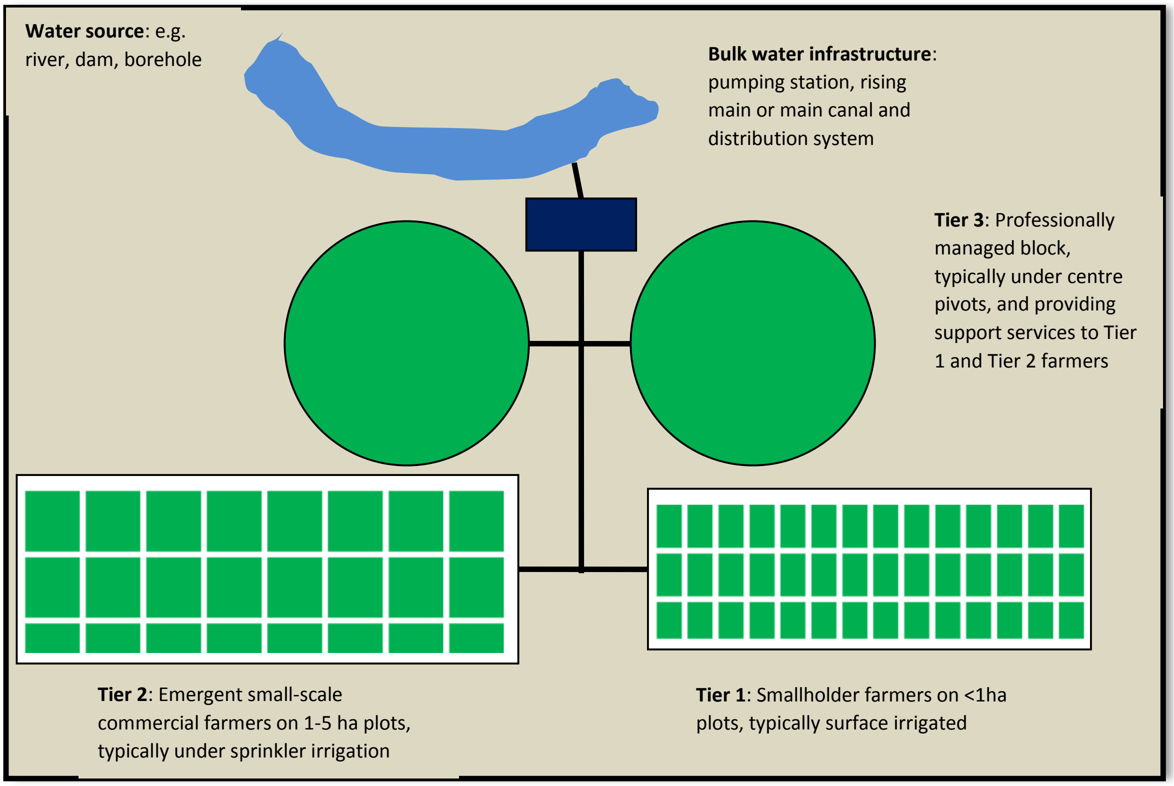


Figure 7: Three tier concept

Tier 1 farmers are agribusiness professionals, who are responsible for the water abstraction and the distribution of water to their own fields upstream (equipped with large-scale equipment such as center pivots), and then to the tier 2 irrigators (emerging farmers on plots between 1 and 5 ha, with sprinklers), and the tier 3 irrigators (with less than 1 ha and practicing flood irrigation).

Table 3 specifies the planned areas for each of the tiers in the three sites where the project is being implemented. Early experiences have shown that local community buy-in is essential. Establishing land tenure and formalizing land titles takes time – but is perceived as essential by investors. And lastly, transferring risk to private investors requires a commercial farming opportunity of an appropriate scale (CEPA, 2015).

Table 3: Envisaged tiers and areas in three sites of the Irrigation Development and Support Project

Scheme level	Scheme name					
	Musakashi (Mufulira)		**Lusitu (Siavonga)**		**Mwomboshi (Chisamba)**	
	Farm size (ha)	***ha***	***Farm size (ha)***	***ha***	***Farm size (ha)***	***ha***
Tier 1	< 1 ha	200	< 1 ha	200	< 1 ha	400
Tier 2	2-5 ha	200	2-5 ha	300	2-5 ha	500
Tier 3	50-60 ha	500	50-60 ha	600	50-60 ha	800
Tier 4	Nil	Nil	Nil	Nil	> 60 ha	1 600 Ha*
Total Area		900		1, 00		3 300

** Existing commercial farms which are being supplied with water*

Zambia's population has grown fast from 2 340 000 in 1950 to 15 519 000 in 2015 (Wikipedia, 2015). Agriculture and the agro-processing sectors contribute about 40 percent of the Gross Domestic Product (GDP) and roughly 12 percent of national export earnings. Primary agriculture employs about 67 percent of the labor force, and produces about 20 percent of GDP. Nevertheless, as Figure 8 shows, government support for irrigation was only 3 percent of total agricultural budget allocations (2004/5). The fertilizer support program, which has been promoted again after the 1990s, takes the largest share (Ministry of Finance, cited in: Jayne et al, 2006).

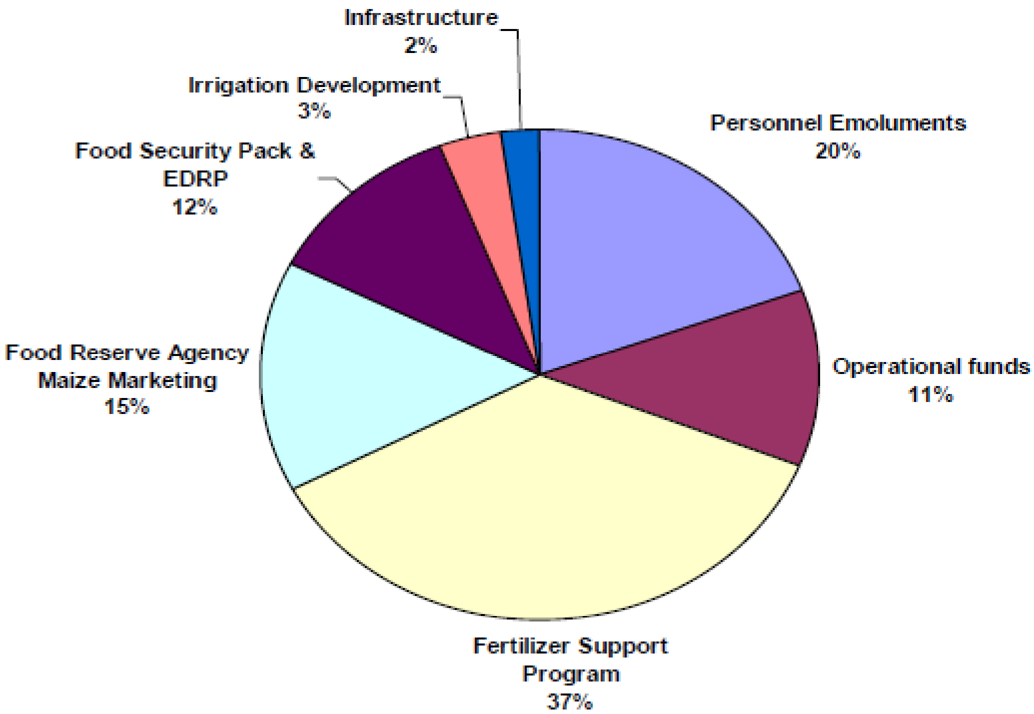


Figure 8: Agricultural sector budget allocations 2004/5
Source: Jayne et al 2006

3.3 Self-supply

Investments for self-supply are widespread in Zambia. Colenbrander and Van Koppen (2012a) estimated that out of the 100 000 ha irrigated land about 15 000 ha is irrigated with motor-pumps; 10,000 ha with river diversions; and 75 000 ha with buckets. These estimates were based on, among other, a survey of 1 935 households in four areas across the country that were chosen because they had high agwater management adoption rates. Of these, 1 230 (64 percent) had adopted an agwater management technology (adopters), while 581 households (30 percent) had not (non-adopters). Six percent of the sample (124 households) had once adopted a technology but had abandoned it (dis-adopters).

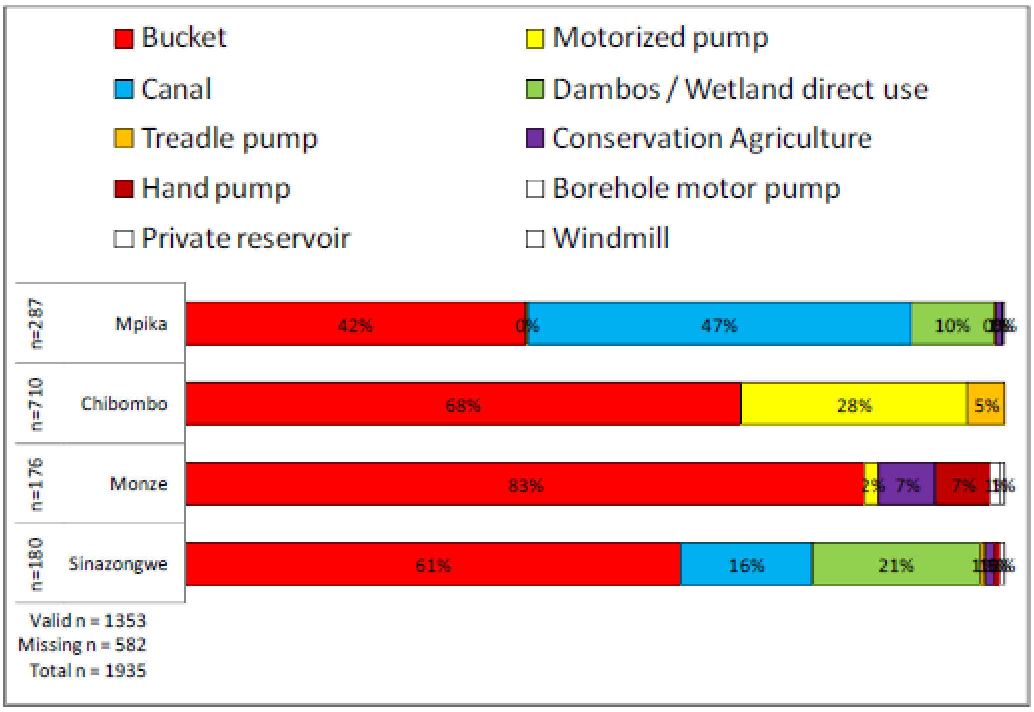


Figure 9: Technologies of adopters in four regions in Zambia

Source: Colenbrander et al 2012b

Figure 9 shows the technologies adopted. Between 42 and 83 percent of the adopters use buckets. In Mpika, canals (informal river diversions) were slightly more frequent. In Sinazongwe, on the shores of the Lake Kariba, the 'canals' refer to a government-supported pump irrigation scheme constructed for the displaced communities. Only 16 percent of the population benefitted from this.

The analysis of obstacles in the supply chains for motorized pumps in Zambia found that the structure of the supply chain and financing facilities in urban hubs was highly centralized. Information was concentrated among a few people only. Many dealers, especially the smaller ones, were not aware of the government's import duty waiver of 2003 on irrigation equipment and pumps. Individual smallholders incur high travel costs to purchase pumps and spare parts from urban centres. They lack information about prices, which is especially relevant because of the extraordinary variation in prices of the same products. They are not informed and trained on the proper use and maintenance of the pumps; and lack after-sales services. They also lack financing facilities to purchase pumps. The conclusion was that farmers' organizations, such as the Zambia National Farmers Union (ZNFU), can play an important role in the motor pump supply chain by providing information to smallholders on importation procedures, pump types, prices and credit facilities. They can also help to improve smallholders' access to pumps through the negotiation of favourable terms for the supply of pumps, spare parts and after-sales services (Colenbrander and Van Koppen, 2012a).

In only one district (Chibombo) did five percent of the adopters use treadle pumps. FAO has distributed over 3 000 in Eastern, Southern, Western and Luapula provinces since 1999. The NGO International Development Enterprise (IDE) has also sold 3 500 treadle pumps and drip kits, and established maintenance and retail markets. The Ministry of Agriculture and Cooperatives has been promoting the technology with vegetable growers, and Kickstart has also started operating in Zambia. However, the capital cost of up to USD 200 is prohibitive for many smallholder farmers. This is the same price as the cheapest Chinese motorized pump (IWMI, 2009).

The rope and washer pump is another newly introduced pump but is operated by hand and can lift water from deeper wells. It has been promoted by Development Aid from People to People (DAPP) for 5 years. DAPP has set up systems for production, promotion and sale, but these pumps are still relatively new to Zambia and not well known by farmers (IWMI, 2009).

A main complaint of both irrigators on government schemes and individual irrigators were the "middle people". There is a strong need to cut down on the many existing middle people who are distorting the price structure of produce (Hichaambwa, 2009).

In the following, we will complement the insights presented in the foregoing through two case studies. Both schemes are located in the Southern Province: the Nabuyani Scheme in Kalomo District as an example of a government-supported scheme (Section four), and the Kaleya Scheme located in Mazabuka District as the oldest example of an outgrower PPP with agri-business (Section five).

4. Case study government-supported scheme: Nabuyani Scheme

The source of this case study is Akayombokwa (2011). The scheme was selected because the agricultural officials considered this a success in the sense that the government only provided support to construct a dam and two canals. After that, farmers were able to continue on their own, in line with the Irrigation Policy of 2004.

The scheme is 35 km south west of Choma. The Nabuyani Dam was built in 2000. It has an estimated capacity of 55 000 m^3. In 2005 the Department of Agriculture initiated a 5 ha scheme 50 m downstream. In the past, people could only cultivate this dambo in the few months immediately after the rainy season. The soils of the scheme primarily consist of sandy loams. The irrigation scheme enables year-round cultivation. The scheme has 60 farmers (28 women and 32 men). Plot sizes vary: 0.05 ha (36 farmers), 0.2 ha (8 farmers) and 0.1 ha (5 famers).

The water is abstracted from the dam using four-inch siphons for delivering 12 l/s. This is discharged into two parallel open lined canals of about 30 cm x 30 cm. One canal is 450 m long and the other is 250 m (see Photographs 1 and 2).

Photographs 1 and 2: Nabuyani Scheme
Left: Dam wall with siphon and canal **Right: Canal and farmers**

The irrigated plots are not fully adjacent. Some plots are situated higher than the canals; these are irrigated by buckets or treadle pumps. One farmer uses a motorised pump. Plots located below the irrigation canals are irrigated by gravity through tertiary canals either into furrows or basins. Farmers irrigate as and when they want; there is enough water for all to irrigate at the same time. However, some 15 percent of the farmers do not use their fields.

During the construction farmers made bricks and carried these bricks, sand and stones to the construction site. They also helped dig the canals. The Department of Agriculture provided funding and sourced skilled technicians for the construction of the scheme. It also designed and supervised the construction of the infrastructure.

Upon completion of the scheme farmers were trained in irrigation agronomy. After that only one other training was given, by the USA-based NGO Africare International. They also donated 13 treadle pumps. An extension worker provided further support, but after he retired there has been no replacement.

The scheme is managed by a Water User Association (WUA) comprising of three committees: the main body (the executive arm), the maintenance committee (to organize maintenance) and the fisheries committee (to develop fish ponds). Each farmer has to contribute USD 2 per year for maintenance. Even though this fee is low, none of the farmers paid this because the scheme had not faced any major crisis. There are no by-laws and it is difficult for the leadership to manage, organize and co-ordinate the scheme activities, especially to take punitive measures. The authority with which they adjudicate over the scheme is based on existing norms. Also, they have no specific agreements on the sale of plots. When some farmers sold their fields to outsiders, the main committee was unable to intervene.

Photographs 3 and 4: Nabuyani Scheme

Left: Rape plant infested by pest **Right: Committee members**

The main crops grown are vegetables such as onion, tomatoes, rape and cabbage. However, crops suffer from pests, and productivity is low (see Photographs 3 and 4). However, farmers do not have money to buy pesticides.

Taking the 'Farm Management Resource Guide' used by the Department of Agriculture and Cooperatives (2007) as a yardstick, only three out of a sample of ten farmers reached that yield (for cabbage and tomato), according to the farmers' estimates. Moreover, the difference between the weakest and best producer was strong: 7 tonnes compared to 45 tonnes. Hence, with year-round water availability, there is a significant potential to increase yields. However, this requires more extension support.

The farmers self-finance all their farming operations, as there are no micro-financing facilities. Inputs are bought in Choma or Kalomo. There is no coordinated input supply or marketing structure. Vegetables are sold to the towns of Choma, Kalomo, Livingstone and

Zimba. The farmers either take their produce individually to these towns or buyers come to the Scheme and procure their produce. The main challenge faced by farmers is the uncertainty of markets. There are no defined or secured markets. However, crops that remain in the field unsold get wasted while the produce that is transported may not be sold or may get spoiled in transit. The farmers are seeking assistance to get a cold room for storing their fresh vegetables.

Thanks to the irrigation scheme, farmers gain an additional income. Some farmers are able to take the children to school, build proper houses, acquire livestock (cattle and sheep), and have good clothing. Some have opened bank accounts. Some women even boast that their dressing is now as good as that of town dwellers; they cannot be identified anymore as coming from villages. Especially the active irrigators, some three quarters, are considered to be better-off than their neighbours. The other quarter who are not sufficiently productive is only slightly better-off or equal to neighbours.

Another benefit is fish. Soon after the scheme was established, the Fisheries Department suggested the building of fish ponds in low lying wet areas that cannot be cultivated. The Fisheries Committee has constructed eight fish ponds without external financial help. All ponds have a depth of 1.5 metres but vary in sizes. The largest is 21 m x 32 m and the smallest is 10 m x 5 m. The farmers stated that they now have fish for consumption nearby.

5. Case study Public Private Partnership (PPP): Kaleya Farmer Assoc

The sources for this case study are Akayombokwa (2011) and Bangwe and Van Koppen (2012). The KASKOL is located 3 km west of Mazabuka town, which itself is 125 km south west of Lusaka along the Great North Road. It is part of the 17 000 ha Nakambala Sugar Estate and its factory and refinery plants. This estate was set up in the early 1970s with a World Bank loan and a government majority shareholding. Illovo bought it in 2001. Sugar is exported to the European Union under a preferential sugar export treaty, SADC and Common Market for Eastern and Southern Africa (COMESA) countries as well as for local consumption in Zambia. The company is listed on the Lusaka Stock Exchange (LuSE) and employs over 5 100 permanent workers and about 3 400 seasonal workers during periods of peak operation.

However, at the start a major area of concern to Nakambala Sugar Estate was that while it was rapidly expanding, the smallholder farmers in surrounding communities faced sluggish or declining agricultural productivity and income. In 1980, therefore, the estate piloted a smallholder expansion project at Kaleya to supplement its sugar cane output. Later, private commercial farms also started to supply about 2 085 ha of sugar.

The smallholder scheme was developed in 1980 and production commenced in 1981. It was initiated by the government, which sourced the land and donated it to Zambia Sugar

Company at Nakambala Sugar Estates. The scheme construction was funded by four equal shareholders who each held 25 percent of shares: the British Commonwealth Development Corporation (£ 5 million), African Development Bank (USD 10 million), Development Bank of Zambia and Barclays Bank of Zambia. The Development Bank of Zambia has continued its 25 percent share, while the three other shareholders sold their 25 percent shares to Mazabuka Sugarcane Growers Trust, Growers Investment Holdings, and Viewpoint Investment Holdings. Tate and Lyle Technical Services of the United Kingdom designed and supervised the construction of the scheme infrastructure. In 1981 poor farmers were recruited from various localities, without bringing any property. Each farmer got a farm plot and a piece of residential land that included 0.25 ha land for maize cultivation. Recently, the farmers' association has been registered as a fair-trade organization as an outgrowing initiative to promote their products by putting a premium on the export markets.

The irrigation scheme covers 2 207 ha and is owned by KASCOL. KASCOL cultivates 1 133 ha as an estate and also acts as the managing entity for the scheme of 1 074 ha that is cultivated individually by the 160 smallholder farmers (36 women and 124 men). Land holdings are either 6.4 ha or 7.4 ha and are leased to the smallholders.

Irrigation water is supplied by Nakambala Sugar Estates, which owns all equipment and irrigates all cane. The water is pumped from the Kafue River and conveyed by an earthen canal (of 14 km) and pipeline (10 km) at a flow rate of 1.59m^3/s. The total volume pumped per day is 150 000 m^3. Water is conveyed to two night storage dams (of 27 930 m^3 and 17 000 m^3). Then it is channelled to four other storage reservoirs. From there, water is released to lined primary, secondary and tertiary canals. With siphons water is taken from the tertiary canals into the fields for flood irrigation between the ridges with cane (see Photographs 5 and 6). The cane is irrigated once a month for 7 months.

Photographs 5 and 6: Kaleya Scheme

Left: Water intake structure **Right: Siphons irrigating young cane**

As stipulated in a Cane Farmers Agreement between KASCOL and the smallholders, KASCOL:

- Distributes water (although only 70 percent of the full entitlement was being delivered because of limited pipeline capacity and electricity interruptions; this has somewhat affected the yields).
- Maintains the infrastructure (which is in good condition).
- Procures and delivers seed and fertilizer, and mechanized services timeously.
- Assists with harvesting and transport of the cane to the mill.

KASCOL employs a full time agricultural manager and an extension worker for this. In return, KASCOL retains 55 percent of smallholders' gross income as service fee to KASCOL (although the proportion keeps being contested). The farmer has to receive his or her payment within 15 days of delivery of the crop. Otherwise interest will begin to accrue. Thus, the farmer is assured of early payment. These payment arrangements are in a cane price agreement between every smallholder and Zambia Sugar Company Limited.

The smallholders are responsible for cane production, including irrigating, weeding, applying fertilizers and chemicals as may be required. There are by-laws with punitive measures to enforce. Since the start of the scheme, farmers have received regular training in various areas such as agronomy and business management. Production levels compare well with production levels elsewhere in Nakambala Sugar Estate.

There is a farmer organization at Kaleya, the Kaleya Smallholder Farmers Association (KASFA). This focuses on social issues, such as funerals or recreation. The elected chair and one committee member represent KAFSFA on the Board of Directors of KASCOL.

Average net income is about USD 6 200 from cane production. The 0.25 ha maize plots can generate some USD 200. This income allowed all Kaleya smallholders to build brick houses with iron roofs (see Photograph 7). They own television sets and cell phones. One sixth of them own cars. Some send their children to university. The Kaleya smallholders also benefit from electricity, clean and safe water services, a new school, a new clinic and a recreation centre. Their football team is in the national league and one smallholder became a parliamentarian.

Moreover, the 160 smallholders of Kaleya scheme provide employment to some 1 000 farm workers who earn up to USD 122 per month.

On the downside, the high volume of water in the reservoirs, canals and fields leads to cases of malaria and water-borne diseases. Frequent spraying mitigates these negative environmental factors.

Picture 7: Kaleya Scheme
A woman farmer standing beside her house

These are the successes that the Zambian government, the World Bank and others are trying to replicate in the Farm Blocks and new three-tier irrigation schemes.

6. Conclusions and recommendations

Recapping the questions, the study found the following answers.

6.1 Hydrological hazards

What are the precise hydrological hazards of climate variability and change, and what is the meaning of 'water scarcity' for agriculture in Zambia?

Water in Zambia is scarce in the dry season. Even then, cropping and livestock grazing can continue for at least some months on the soil moisture of Zambia's widespread flood plains, valley bottoms and wetlands. Across Zambia, rainfall is sufficient for one season of rainfed agriculture, also in the drier southern agro-ecological region. Variability and unpredictability are the key obstacles for farmers' crop choice, cropping calendar and productivity. It is widely agreed that the irrigation potential is about 2.75 million ha. In spite of this vast potential only about 7 percent (156 000 ha) are currently being irrigated (MACO/FAO, 2004b; IWMI, 2009). The question is how to address the country's economic water scarcity.

6.2 Lessons from past and current investments

What lessons can be learnt from past and current investments in agwater management in Zambia, in particular from their strengths and weaknesses in sustainably contributing to poverty alleviation, food security and agricultural and economic growth?

How can the Zambian government, NGOs and donors build on these strengths and overcome the weaknesses?

6.2.1 Irrigation scheme investments by government, donors and NGOs

Without a colonial tradition of investments in irrigation, the independent government took a two-pronged approach: it invested both in estates, in particular sugar but also some wheat, and in smallholder irrigation schemes. The latter were often low cost reservoirs for which siphons were used. The schemes that perform well generate substantive benefits. But performance is often sub-optimal. Key conditions for success include:

- Secure markets, especially for perishable vegetables.
- Low-cost technologies that farmers can easily operate and maintain, so that governments and donors can hand-over a scheme immediately after their investments in the infrastructure or rehabilitation.
- Micro-credit to pay for inputs.
- Crop cultivation skills.

Collective schemes can bring economies of scale and bargaining power, and are preferred by government. However, group management and adjacent collective land acquisition in customary tenure are complex. Local norms and networks are the main institutional capital as extension workers to serve everybody are lacking. Smart, well-targeted support by government, donors and NGOs is needed to improve productivity.

6.2.2 Investments by individuals or groups for self-supply

Already in the 1980s, the Zambian government realized the wide scale of agricultural water management for self-supply, and included those water-managed areas in calculations of total irrigated area.

Rainfed rice cultivation has always been an important smallholder crop (but has not received much attention yet). With the booming urban horticulture markets, many farmers started irrigating, most often with buckets, gravity streams where available, and motorized pumps. The latter covers an estimated 10 percent of the irrigated area. Governments' tax exemptions for motorized pumps supported the adoption of these labor-saving devices. The government aims to further accelerate this shift from buckets to motor pumps. This could be achieved by better spreading of information, technical training and better after-sales services. In other respects, individual farmers need the same support as the above-mentioned farmers in government-funded schemes.

6.2.3 Investments by agri-business

Agribusiness in Zambia has embarked on the piloting of innovative PPPs that combine the strengths and needs of the different players to achieve a win-win arrangement for all. Agribusiness brings the economy of scale in self-financed production and irrigation for secured markets; farmers bring, and keep, their land and provide labor and cultivation skills; and government and partners invest in a sustainable benefit stream to national food security, exports and Zambian citizens, including those most in need. KASCOL and KASFA have proven that it can work. More research is needed to systematically compare the costs and benefits and the distribution of costs and benefits of the various PPP models, and compare these PPP arrangements with the other two types of investments in irrigated agriculture.

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