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Investing in Agricultural Water Management to Benefit Smallholder Farmers in Zambia

AgWater Solutions Project
Country Synthesis Report

Alexandra E. V. Evans, Meredith Giordano and Terry Clayton, Editors

IWMI International Water Management Institute
CGIAR Research Program on Water, Land and Ecosystems
AGWATER SOLUTIONS
Improved livelihoods for smallholder farmers
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Meredith Giordano
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Terry Clayton
Editors

International Water Management Institute (IWMI)
P. O. Box 2075, Colombo, Sri Lanka

The editors: Alexandra E. V. Evans is Strategic Science Uptake Coordinator at the International Water Management Institute (IWMI) in Colombo, Sri Lanka; Meredith Giordano is Co-Project Manager, AgWater Solutions at IWMI in Colombo, Sri Lanka; and Terry Clayton is a Consultant to IWMI based in Udon Thani, Thailand.

Evans, A. E. V.; Giordano, M.; Clayton, T. (Eds.). 2012. *Investing in agricultural water management to benefit smallholder farmers in Zambia. AgWater Solutions Project country synthesis report.* Colombo, Sri Lanka: International Water Management Institute (IWMI). 37p. (IWMI Working Paper 150). doi: 10.5337/2012.212

/ water management / agricultural production / investment / research projects / smallholders / farmers / pumps / costs / reservoirs / dams / watersheds / irrigated land / water conservation / soil conservation / horticulture / markets / food security / gender / social aspects / environmental effects / Zambia /

ISSN 2012-5763
ISBN 978-92-9090-757-2

Please direct inquiries and comments to: *IWMI-Publications@cgiar.org*

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Acknowledgements

The editors would like to thank all the people whose work contributed to the content of this report. We are grateful to a number of independent consultants for various case studies that enabled us to build up a picture of the current and potential agricultural water management situation in Zambia. These independent consultants include Lewis Bangwe, for the work on out-growers; Munguzwe Hichaambwa, for the research into Zambia's fresh produce markets; Joseph Mbinji, for the inventory of small reservoirs in Zambia; Willem Colenbrander and Mukelabai Ndiyoi, for their research into the motor pump supply chain and duty waiver; Vincent Akamandisa, for the study of the role of gender in the adoption of agricultural water management technologies and his contribution to the dialogue process; and Andrew Kabwe, for his work with Willem Colenbrander on the adoption dynamics of water management options; We would also like to acknowledge the contribution made by researchers from the International Water Management Institute (IWMI) to these studies, namely Barbara van Koppen, who oversaw and coordinated much of the work, including the gender mapping and contributing to several of the case studies and to the dialogue process; and Jean-Philippe Venot, who was responsible for the work on small reservoirs. We are also grateful to Charlotte de Fraiture (UNESCO-IHE Institute for Water Education, formerly IWMI) for her overall guidance and the contributions made to these studies. We are grateful to the Farming Systems Association of Zambia (FASAZ), who undertook the situation analysis and surveys of pump adoption. We appreciate the work of the Stockholm Environment Institute (SEI), including Jennie Barron (the team leader), Victor Kongo, Annemarieke de Bruin, Monique Mikhail, Christian Stein and Steve Cinderby, who undertook the research in the Mwembeshi watershed. For the mapping work and agricultural water management suitability domains, we would like to thank the team from the Food and Agriculture Organization of the United Nations (FAO), namely Guido Santini, Livia Peiser and Jean-Marc Faurès. For the work associated with stakeholder engagement through the dialogue process, we would like to thank the FAO dialogue leader, Domitille Vallée, and her colleague, Bernadete Neves. We appreciate, especially, the invaluable contribution of the National Focal Point, George Sikuleka, Chief Irrigation Engineer of the Department of Agriculture and Food, and the Dialogue Facilitator, Kenneth Chelemu, and his team at iDE. We would also like to recognize the important work of the AgWater Solutions Project Secretariat, especially Mala Ranawake and Wendy Ells, who contributed to various pieces of writing that supported this report. None of this work would have been possible without the involvement and support of the local communities, experts, authorities and non-governmental organizations (NGOs). We are indebted to all of them. This report is based on research funded by the Bill & Melinda Gates Foundation. The findings and conclusions contained within are those of the authors and editors and do not necessarily reflect the positions or policies of the Bill & Melinda Gates Foundation.

Project

The AgWater Solutions Project was implemented in several countries in Africa and Asia between 2009 and 2012. The objective of the project was to identify investment options and opportunities in agricultural water management with the greatest potential to improve incomes and food security for poor farmers, and to develop tools and recommendations for stakeholders in the sector including policymakers, investors, NGOs and smallholder farmers. This report synthesizes

the research findings and contributions made by the team and stakeholders in Zambia over the project period.

The leading implementing institutions were the International Water Management Institute (IWMI), the Food and Agriculture Organization of the United Nations (FAO), iDE, the International Food Policy Research Institute (IFPRI) and the Stockholm Environment Institute (SEI). The partner organization in Zambia was the Farming Systems Association of Zambia (FASAZ).

For more information on the project or for detailed reports, please visit the project website (http://awm-solutions.iwmi.org/home-page.aspx) or contact the AgWater Solutions Project Secretariat (AWMSolutions@cgiar.org).

Contents

Summary

This Working Paper summarizes research conducted as part of the AgWater Solutions Project in Zambia from 2009 to 2012. Approximately 48 million hectares (Mha) of land in Zambia are suitable for agricultural use. An estimated 67% of the Zambian labor force is employed in the agriculture sector. Researchers from the AgWater Solutions Project examined ways of improving the motor pump supply chain, how to make better use of small reservoirs and improving the function of horticultural markets. Researchers also explored gendered aspects of agricultural systems. Research methodologies included rapid rural appraisals, interviews, survey questionnaires and literature reviews.

Research suggests that small improvements in the motor pump supply chain could catalyze significant increases in farm productivity similar to what has been achieved in parts of Asia.

Measures likely to improve the performance of small reservoirs include coordinating and integrating multiple users, facilitating multiple institutional arrangements and strengthening existing policies, procedures and links within organizations along with more transparency in planning, contract awards and construction.

Out-grower schemes can be improved by building trust, market information for smallholder farmers and reducing transaction costs for companies. Improving horticultural markets will depend on developing a legal framework in which all major stakeholders participate as stipulated under the Bus Stations and Markets Act and/or Public Private Partnership Act of Zambia.

INTRODUCTION: SMALLHOLDER AGRICULTURAL WATER MANAGEMENT

Across Africa and Asia, a growing number of smallholder farmers are finding ways to better manage water for agriculture to increase yields and income, and diversify their cropping and livelihood options. Farmers buy or rent irrigation equipment, draw water from nearby sources, and individually or collectively build small water storage structures. This development is often overlooked by external investors, yet the smallholder agricultural water management (AWM) sector is contributing to food security, rural incomes, health and nutrition. While small-scale AWM practices could potentially benefit hundreds of millions of farmers, this potential is far from being realized.

The AgWater Solutions Project examined this trend together with the opportunities and constraints associated with smallholder AWM in five countries in Africa, Zambia, Burkina Faso, Ghana, Ethiopia and Tanzania, and two states in India, West Bengal and Madhya Pradesh. Through this, the project identified a number of ways in which the potential of the smallholder AWM sector can be realized, including:

- **Building supportive institutional structures:** Existing governing bodies typically cater for public irrigation systems and are often not adapted to capitalize on the opportunities and to handle the challenges posed by this alternative mode of irrigation development. Traditional agricultural institutions rarely focus on market-oriented smallholder crop production, such as high-value vegetable production in the dry season.
- **Overcoming value chain inefficiencies:** Market inefficiencies negatively affect farmer decision making and access to technology. Inefficiencies include: poorly developed supply chains; high taxes and transaction costs; lack of information and knowledge on irrigation, seeds, marketing and equipment; and uneven information and power in output markets.
- **Improving access to technology for all sectors of society:** Better-off farmers have greater access to information and technology than their poorer counterparts and women who face several hurdles: high upfront investment costs, absence of financing tools, and limited access to information to make informed investment and marketing choices.
- **Managing potential trade-offs:** While smallholder AWM can be beneficial for an individual farmer, its uncontrolled spread can have unexpected consequences. If not managed within the landscape context, the many small dispersed points of water extraction can negatively impact downstream users and cause environmental damage.

Addressing these challenges requires a fresh look at new and existing AWM technologies, products and practices to enhance the potential of the smallholder AWM sector and find solutions.

WHY INVEST IN SMALLHOLDER AWM IN ZAMBIA?[1]

An estimated 67% of the Zambian labor force is employed in the agriculture sector. There are 1.1 million farmers in Zambia: 96% are smallholder or 'traditional' farmers cultivating less than 5 ha each and consuming most of their own produce. They farm 76% of the cropped area. The remaining 4% are medium-scale farmers cultivating 5 to 20 ha each, and large-scale and commercial farmers cultivating more than 20 ha each and selling most of their produce.

[1] This section is based on FASAZ 2009; and AgWater Solutions Project 2009.

Approximately 48 Mha of land in Zambia are suitable for agricultural use (Table 1). In most parts of the country, rainfall is sufficient for rearing livestock, wet-season crop production and storing water for irrigation during the dry season. Year-to-year variability in rainfall is an important determinant of crop output and household food security.

Zambia's total renewable water resources are estimated at 163.4 cubic kilometers (km^3)/year. Water withdrawals for agriculture currently stand at 1.7 km^3/year. Zambia has an irrigation potential of 2.75 Mha, but only 156,000 are currently being irrigated.

The Zambia Development Agency has announced incentive packages for investors. Several of these plans highlight irrigation as a key investment area.

TABLE 1. Estimates of irrigated land in Zambia.

Land under AWM	Area (ha)
Irrigation potential	**2,750,000**
Total land under irrigation	**155,912**
Surface irrigation	32,189
Sprinkler irrigation	17,570
Localized irrigation	5,628
Developed lowlands (equipped wetlands)	100,525
Total area under AWM (includes irrigated area)	**256,012**
Flood-recession cropping area	100
Cultivated lowland	100,000
Land under irrigation by water source	
Groundwater	6,750
Surface water	149,162
Power-irrigated area	38,630
Irrigation schemes by size	
Small	111,525
Medium	7,372
Large	37,015

Source: MACO/FAO 2004.

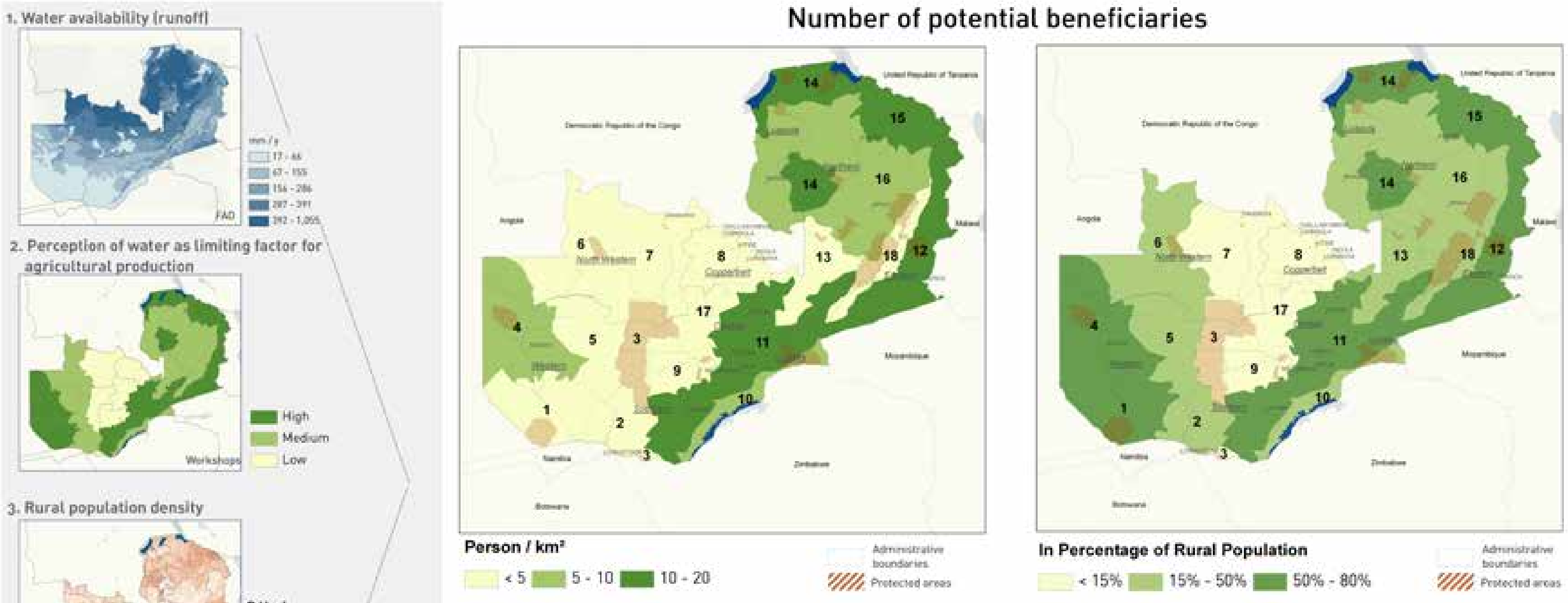
The AgWater Solutions Project mapped the potential for AWM to improve the livelihoods of smallholder farmers in Zambia and found that almost 5 million people could benefit – more than 60% of the rural population (Figure 1).

AWM Investment Opportunities in Zambia

The AgWater Solutions Project identified many existing AWM practices that could support the realization of the estimate that 5 million people could benefit from AWM in Zambia. The project initially discussed which AWM options to review with a group of stakeholders and agreed to investigate motorized pumps, small reservoirs, *dambos*[2] for rice cultivation, river diversions, and

[2] *Dambos* comprise a class of complex shallow wetlands in central, southern and eastern Africa, particularly in Zambia.

FIGURE 1. Where to invest for maximum impact on rural livelihoods.



Livelihood zone No	Livelihood zone Name	Water availability: (m³/p/y)	Rural population Total (,000)	Rural population Density (p/km²)	Rural population % poor (underweight)	Perception of water as limiting factor for agricultural production	Potential beneficiaries Person (,000)	Potential beneficiaries In % of rural population
1		2,660	201	5	24	High	161	80%
2		3,854	98	4	24	Medium	49	50%
3		18,354	102	4	26	Low	15	15%
4		3,923	516	9	24	High	412	80%
5		7,644	218	6	24	Medium	109	50%
6		29,949	310	5	27	Medium	155	50%
7		29,975	275	6	27	Low	41	15%
8		15,451	306	13	29	Low	46	15%
9		4,425	199	10	24	Low	30	15%
10		2,393	187	12	23	Medium	93	50%
11		3,470	1,426	17	25	High	1,141	80%
12		4,499	1,220	24	32	High	976	80%
13		23,632	177	6	27	Medium	89	50%
14		10,739	606	16	33	High	485	80%
15		6,264	600	21	34	High	480	80%
16		19,628	1,125	9	33	Medium	562	50%
17		9,202	207	9	27	Low	31	15%
18		7,090	177	9	32	Medium	89	50%

Source: FAO 2012a.

soil and water conservation. Field-level research was conducted on motorized pumps, particularly in relation to adoption dynamics and the supply chain, small reservoirs and the dynamics of AWM adoption, with a focus on gender. The locations in which these options are most suitable were assessed and the potential number of beneficiaries was calculated. Although fieldwork was not conducted on soil and water conservation, *dambos* and river diversions, suitability domains were mapped and number of beneficiaries estimated (Table 2).

TABLE 2. Review of AWM options, recommendations and potential beneficiaries.

AWM option	AWM investment opportunity	Beneficiary households (% of rural households)*	Area in hectares (% of total agricultural land)*	Estimated investment costs (USD)
Low-cost motor pumps	Improve the supply chain and reduce costs by making better use of the duty waiver and zero VAT rating. Information is an essential part of this.	66,000-268,000 (4-16%)	53,000-214,000 (1-2%)	400 USD/household
Soil and water conservation	Not studied in the field	20,000-64,000 (1-4%)	94,000-307,000 (1-2%)	300 USD/ha
Dambo (wetland rice)	Not studied in the field	31,000-70,000 (2-4%)	46,000-105,000 (1%)	600 USD/ha
Small reservoirs	Small reservoirs provide multiple products and services for communities and costs must be assessed on this basis, not on irrigation benefits only. Costs must be kept in check through better management. Community engagement is essential.	51,000-232,000 (3-14%)	51,000-232,000 (1-2%)	750,000 USD/cubic meters (m^3) of water stored
River diversions	Not studied in the field	41,000-89,000 (2-5%)	41,000-89,000 (1%)	4,250 USD/ha

Source: This study; all data: FAO 2012a.

Note: * Figures assume that out of the total potential beneficiary households calculated, 50% adopt the AWM option.

These findings are derived from an approach that combines primary and secondary data collection, stakeholder involvement and mapping. Details of the approach taken by the AgWater Solutions Project and the related studies are given in Box 1 and elaborated in subsequent chapters. Further information, including case studies and mapping data can be found on the project website (http://awm-solutions.iwmi.org).

Box 1. AgWater Solutions Project approach.

Situation analysis and selection of AWM options: An initial analysis was undertaken of the conditions in each country and the AWM practices already being undertaken. These were reviewed with stakeholders and some of the most promising practices were selected.

Field-scale and community-level case studies: Researchers used a participatory opportunity and constraint analysis and methodology to understand the complex interaction among social, economic and physical factors that influence the uptake and success of AWM options, and to identify technologies appropriate for different contexts in each of the project countries.

Watershed-level case studies: Researchers used a multidisciplinary approach to look at how the natural resource base impacts on, and is impacted by, AWM in one watershed each in Tanzania, Burkina Faso, West Bengal (India) and Zambia. The analysis concentrated on the hydrological impact of current and potential AWM interventions; the current resource-based livelihoods and dependencies on sources of water and water management practices; an impact assessment of potential AWM scenarios; and a review of formal and informal institutional capacity to deal with AWM interventions and potential emerging externalities.

National AWM mapping: Maps were developed to help assess where AWM will have the greatest impact within a country or state, and where specific interventions will be most viable. The steps followed were to use a participatory process in which experts defined the main livelihood zones based on farming typologies and rural livelihood strategies, and the main water-related constraints and needs in the different rural livelihood contexts. Using this, the potential for investment in water to support rural populations could be mapped based on demand and availability of water. A further step was to map the suitability and demand for specific AWM interventions, such as motor pumps or small reservoirs, and to estimate the potential number of beneficiaries, application area and investment costs. These allow investors to choose entry points and prioritize investments in AWM that will have the most beneficial impacts on rural livelihoods.

Regional AWM analysis: Researchers used geographic information system (GIS)-analysis, crop mix optimization tools and predictive modeling techniques to assess the regional potential for the 'best-bet' AWM technologies in South Asia and sub-Saharan Africa in terms of: potential application area (in hectares), number of people reached, net revenue derived and water consumption. Scenarios were also developed to factor in climate change and potential.

Stakeholder engagement and dialogue: An integral part of the entire project was the engagement of stakeholders from the initial assessment of AWM opportunities through to the identification of possible implementation pathways. The dialogue process was used to ensure that project results reflected stakeholder perceptions and addressed their concerns. National and subnational consultations, dialogues, surveys and interviews were fed into all stages of the project.

AWM OPTIONS REVIEWED

Improving the Motor Pump Supply Chain[3]

Many more farmers could use motor pumps if the supply chain could be improved. This would require greater government support, better information, suppliers closer to rural farming areas and appropriate financing options. Farmers' associations could play a major role in improving the supply chain.

Where the opportunity lies

The estimated total area under small-scale irrigation in Zambia is over 100,000 ha. An estimated 15,000 ha are irrigated by motor pumps. Profit margins for smallholders using motor pumps are considerably higher than for smallholders using other technologies. Many more farmers would like to use motor pumps but expansion is limited by gaps in the supply chain.

The research

Interviews were conducted with the Zambia National Farmers' Union, smallholder farmers in peri-urban areas, three NGOs, 21 retailers, the Customs Department of the Zambia Revenue Authority (ZRA), the Ministry of Finance and National Planning, a Customs Clearing Agent, and three micro-finance institutions (MFIs). The research examined the following:

- Duty waiver and zero value added tax (VAT) rating.
- Retail pricing.
- After-sales service and spare parts provision.
- Credit facilities and subsidies.
- Farmer's position in the supply chain.

Duty waiver and zero VAT rating

At 15% of the cost of the item being imported, the duty waiver is significant. It applies to all machinery for projection of liquids/powders for agriculture. The main categories, covered by this duty waiver (Tariff Code 84248100), of importance for AWM are:

- Irrigation equipment in general, such as center pivots, sprinklers and drip irrigation systems.
- Water pump sets without irrigation equipment.
- Submersible pumps for boreholes.
- Agricultural sprayers (manual or tractor mounted) for spraying chemicals on crops. Less than 1% of imported irrigation equipment is comprised of water pump sets only and is imported by just seven companies.

The aim of zero VAT rating on agricultural equipment and spares is: *"To ensure that unregistered farmers that cannot claim input VAT on such equipment do not incur any VAT.*

[3] Based on Colenbrander 2011; and AgWater Solutions Project 2012.

The measure will also reduce input costs and enable farmers [to] expand production and make farming a viable sector" (ZRA). Zero VAT became effective on January 31, 2009, for a variety of agricultural equipment including pump sets and reduced VAT from 16 to 0%.

Retail companies can import irrigation equipment duty free and sell to farmers with zero VAT. In theory, they could set prices that would promote more sales by enabling farmers to access cheaper motor pumps but in practice this does not happen, in part because of lack of information. The rules and regulations can be confusing and the information provided to dealers and farmers has not been clear.

Proximity of retailers

Whether or not a farmer can buy a motor pump is not just an issue of cost but also whether the equipment is easily available. The importers, wholesalers and retailers of motor pumps are concentrated in urban centers and usually only the large companies provide spare parts or after-sales services. The cost of traveling to retailers can increase the cost of buying a pump by up to 30%.

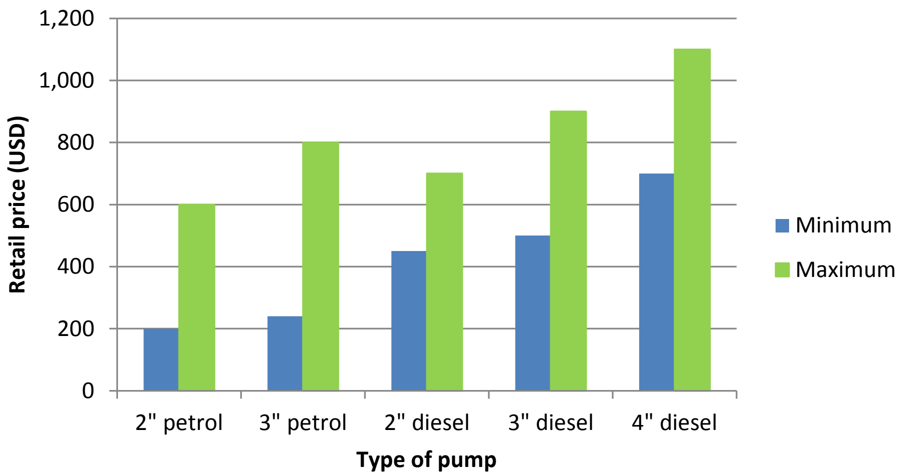
Farmers who live in remote areas are poorly informed about the range of pumps and prices, and know little about pump maintenance.

Costs and specifications

Not only is there inadequate information on the duty waiver and zero VAT rating but also on the cost of pumps in general and on technical specifications. Costs can vary from USD 200 to 1,000 depending on the make and model (Figure 2). There are retail price differences of up to 50% between different companies for exactly the same make and type of pump.

The cheapest 2 inch, 5 horsepower (HP) Chinese water pump set is now the same price as the treadle pump. Access to energy and labor will influence the decision between a motor pump and a treadle pump. Electricity is only available to 20% of the total population of Zambia and to only 4% of the rural population.

FIGURE 2. Price range in the cost of motor pumps.



Source: Colenbrander 2011.

Financing

Farmers usually need financing (Box 2) but most of the 24 official MFIs in Zambia operate in urban and peri-urban areas and the cost of expanding into rural areas is high. In rural areas, more than 65% of the population are excluded from any form of financial services and women have less access than men. Only a few micro-finance facilities provide credit to smallholder farmers.

Box 2. Financing irrigation pumps.

The Rural Finance Programme: The Rural Finance Programme (RFP 2007-2013) under the Ministry of Finance and National Planning aims to increase the use of sustainable financial services in rural areas. The RFP is not a micro-finance institution but it facilitates MFI expansion into rural areas by providing them with grants for operations and low interest loans for credit lines for smallholder farmers. The RFP channels funding from the International Fund for Agricultural Development (IFAD) to the Development Bank of Zambia (DBZ), which in turn supports MFIs. Among the beneficiaries of credit lines from the DBZ are such MFIs as the Christian Enterprise Trust of Zambia (CETZAM) Financial Services Limited and MicroBankers Trust (MBT).

CETZAM: Provides agricultural loans to smallholder farmers for inputs and irrigation equipment for cash crops and market gardening. Loans are for less than 6 months with a grace period of 3 months. Interest rates are 4% per month (48% per annum) plus a processing fee of 3.8%. A refundable deposit of 10-20% is required and assets are used as security.

MBT: Provides loans for irrigation and tilling. The repayment period is less than 36 months with a three-month grace period. A reducing balance method of 25% per annum is charged. No down payment is required. The farmer chooses the equipment and the supplier for the equipment and brings the invoice to MBT for payment. MBT also has a loan facility for individual members of women's groups, with an initial ceiling of ZMK 600,000 (USD 115) per member, weekly repayments and an interest rate of 0.6% per week (31% per annum).

A number of NGOs provide subsidies, vouchers or purchase pumps to distribute to farmers. This has mainly been done for treadle pumps to date. The downside of this approach is that farmers do not always chose the equipment to match their needs and do not develop a relationship with the suppliers, which is important for after-sales services.

Value Chain Financing: MFIs do not necessarily deal with the end-user farmer only. Some finance any stage in the value chain, e.g., importer, manufacturer (in Zambia), supplier, retail outlet, sales agent or farmer.

Source: Colenbrander 2011.

Where to invest

Farmers' organizations and cooperative societies are in a good position to help. An agency like

the Zambia National Farmers' Union, through its decentralized district associations, could:

- work with the ZRA to confirm the exact procedures around VAT and import duty for pumps for irrigation;
- work with the ZRA to develop an information campaign to make these procedures more widely available to the public;
- provide information on the range of pumps available, their specifications, sources of supply and retail prices;
- coordinate the supply of pumps and spare parts;
- support pump suppliers who have already shown an interest in training local mechanics; and
- approach MFIs and provide them with information for their market research, thereby supporting the development of appropriate finance packages in rural areas.

Small improvements in the motor pump supply chain could catalyze significant increases in farm productivity similar to what has been achieved in parts of Asia. More valuable crops could be grown for the market, thereby providing more income and improving nutrition.

Who benefits and where

Using the biophysical criteria of travel time to markets (defined as centers of 20,000 inhabitants or more), availability of surface water and soil type (as a proxy for availability of shallow groundwater) combined with livelihood-based demand, the AgWater Solutions Project estimated that, at a 50% adoption rate, low-cost motor pumps could benefit 66,000 to 268,000 households (4 to 16% of rural households) (Figure 3).

The potential application area is 53,000 to 214,000 ha (1-2% of total agricultural land) in Zambia. Figure 3 shows where motor pumps could have the greatest livelihood benefits.

Stakeholder recommendations.

Dialogue participants felt that the following knowledge gaps need to be addressed:

- The costs of different types of pumps and of operation and maintenance are still not well known.
- The role played by the VAT and import duty exemption is also not well understood.
- How should access to loans for pumps and rental markets be developed?

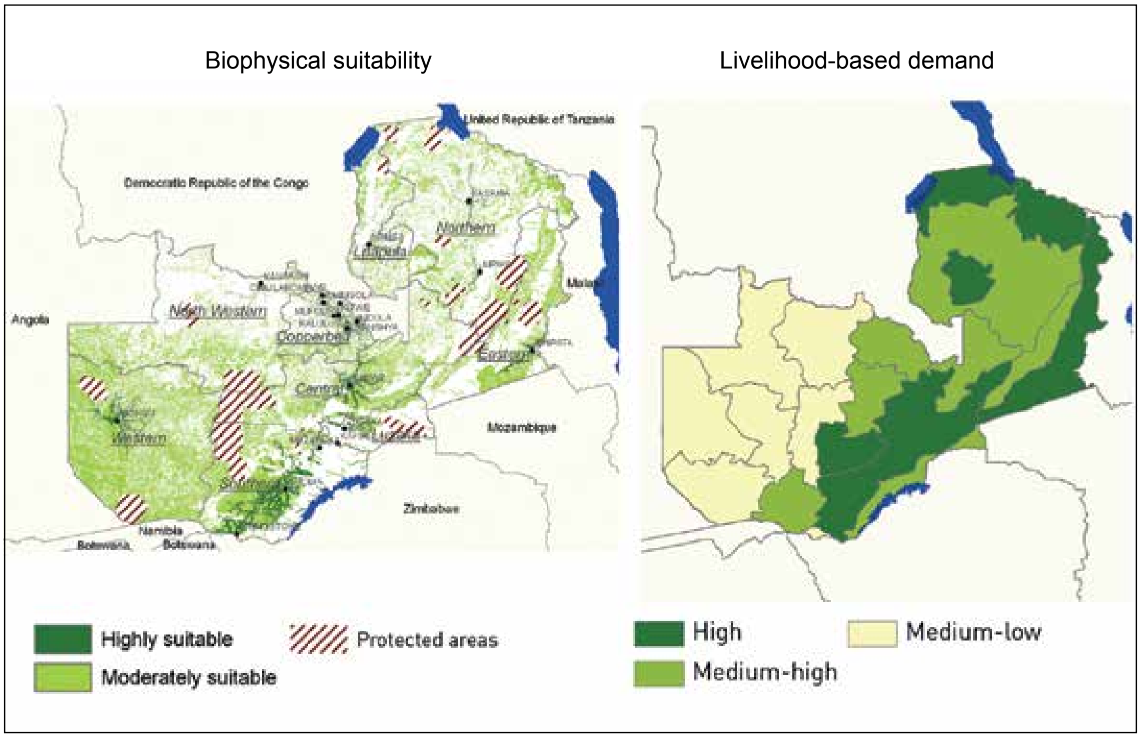
Source: FAO 2012b.

Realizing the Benefits of Small Reservoirs[4]

For investors interested in small reservoirs, the challenge lies in coordinating and integrating multiple users and social groups around a common resource. Limiting costs through improved procedures and financial management will be critical to success.

[4] Based on Mbinji 2010; Venot 2011; and AgWater Solutions Project 2011a.

FIGURE 3. Potential for small motor pump use.



Source: FAO 2012a.

Where the opportunity lies

In sub-Saharan Africa, the term 'small reservoir' generally refers to surface water bodies created by constructing earthen or cement dams less than 7.5 meters (m) high. They can store up to 1 million cubic meters (MCM) of water and sometimes have a downstream irrigation area of up to 50 ha. Capital investment is generally externally driven and community management remains the norm. A well-designed reservoir can sustain multiple uses, including livestock, fisheries, domestic needs and small businesses. Small reservoirs support soil and water conservation, drought proofing and small-scale community irrigation.

Significant investments have already been made by governments, donors, NGOs and communities, not least because they are in high demand among local communities, fit with national strategies and policies, and attract funding from international development agencies. While they generally perform below expectations for irrigation, they have multiple-use benefits which are often unaccounted for.

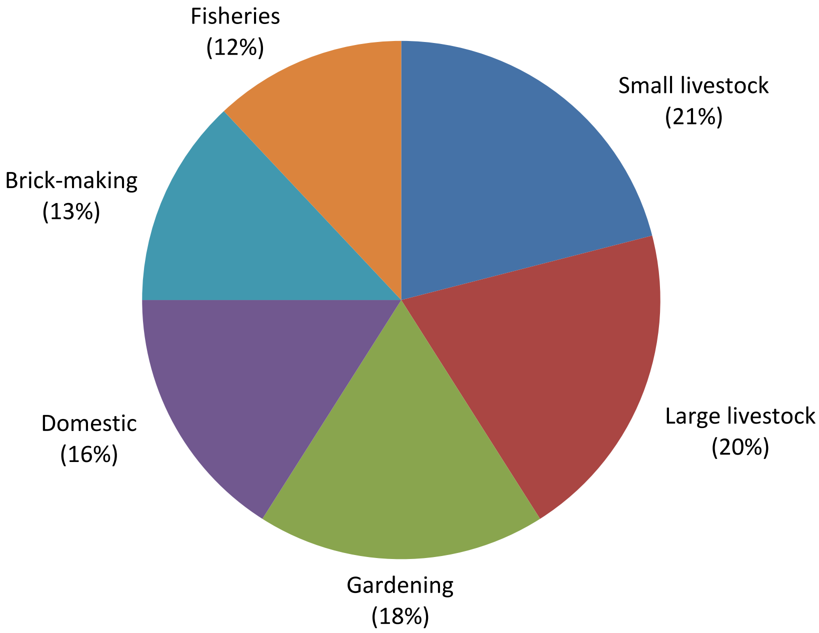
The research

Researchers from the AgWater Solutions Project conducted studies on 205 small reservoirs in Livingstone, Kazungula, Kalomo, Choma, Monze and Mazabuka. There are an estimated 600 to 3,000 small reservoirs in the country. Most were constructed by the Ministry of Agriculture and Cooperatives (MACO) with donor funding and 89% are community-owned. They were mainly constructed for livestock drinking and to mitigate the impact of droughts, but many other uses have been added, including irrigation (Figure 4).

Some 310,000 people directly benefit from the use of small reservoirs in the Southern Province, using them for livestock, gardening, fisheries and domestic purposes. Each small reservoir serves a population between 60 and 8,600. However, land constraints mean that only 10% of householders use the reservoirs for irrigation, of whom 55% are women. Approximately 50% of the irrigable land under small reservoirs is cultivated.

As user fees are low and often in-kind, economic barriers to the use of reservoirs are minimal, but financial costs of irrigated agriculture (e.g., dry-season vegetable cultivation) can still limit production.

FIGURE 4. Uses of small reservoirs in the Southern Province of Zambia (n=205).



Source: Mbinji 2010.

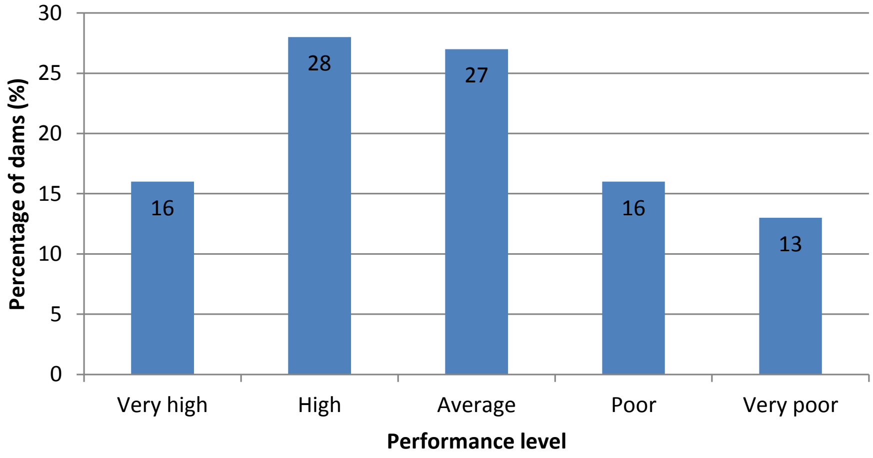
Performance

Analysis of 197 reservoirs indicated that 29% were performing poorly (Figure 5).

Poor performance was found to be due to:

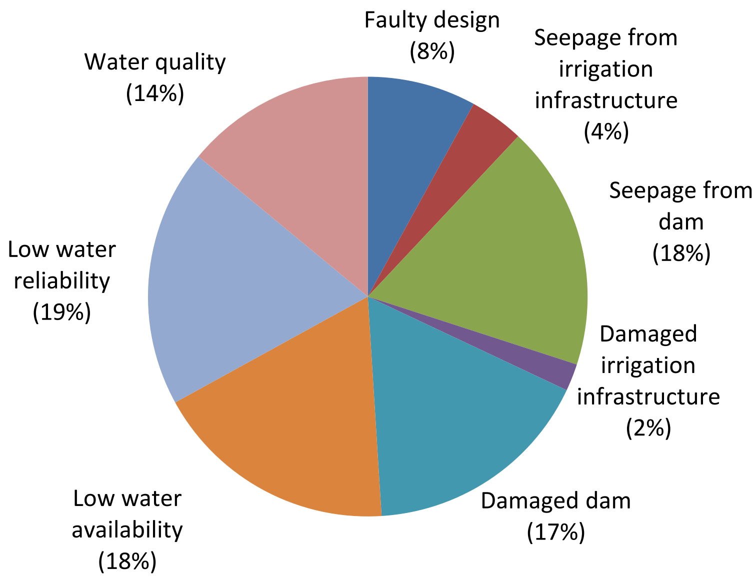
- Infrastructural factors, including low water reliability, low water availability, seepage from dam and damaged dam (Figure 6).
- Environmental factors, especially siltation and soil erosion.
- Agricultural and economic factors such as lack of access to credit, plant diseases, low market prices and poor transport.
- Organizational factors, including funding availability and organizational problems.

FIGURE 5. Performance of small reservoirs in the Southern Province (n=205).



Source: Mbinji 2010.

FIGURE 6. Infrastructural factors affecting performance of dams in the Southern Province (n=205).



Source: Mbinji 2010.

Management

- Most dams are located on customary tenure land, which is administered by traditional authorities (chiefs).
- Management responsibility lies with the user communities through Water Users Associations (WUAs) or Dam Management Committees (DMC). Most are composed of all water users.

- However, out of 184 small reservoirs, only 76 had active WUAs or DMCs.
- Communities are still heavily dependent on MACO, NGOs and donors to support major rehabilitation. MACO also plays an important role in training farmers in irrigation and organizational management of small reservoirs.
- Conflict resolution is done by traditional authorities.

Where to invest

Maximizing the benefits of small reservoirs

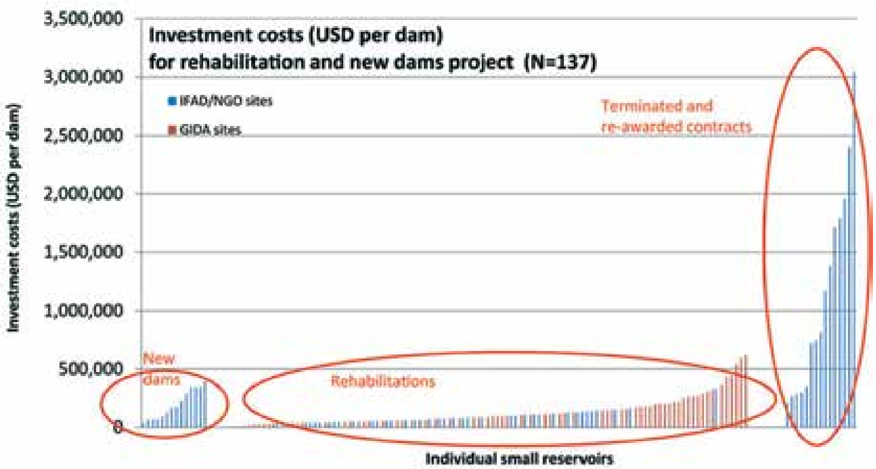
Storing surface water is an expensive way to invest in agricultural water management, but in many cases it is the only way to ensure rural communities have access to water. The high costs often arise from flaws in project design and construction.

To effectively evaluate small reservoirs and to compare them with other agricultural water management interventions, a cost-benefit analysis needs to be considered on a per capita basis and for the entire lifetime of the project. If well managed, costs are comparable to investments in other types of AWM interventions.

The overly high investment costs for small reservoirs can be avoided by improving procedures (Figure 7). Better feasibility studies, better preparation and more strict accountability to decision makers, funders and local communities would help control costs and improve the outcomes.

Benefits are greater if multiple uses, existing farming systems, water recharge and direct pumping are taken into account. Investments in irrigation extension and monitoring are also needed. To be effective, small reservoirs need an effective institutional component. WUAs, for example, are not adequate as they ignore multiple uses. To be successful, the approach should provide communities with multiple organizational options and promote coordination with traditional and other authorities.

FIGURE 7. Investment costs for rehabilitation and new dam construction (USD).



Source: Venot 2011.

AgWater Solutions Project research indicates that investments should be directed towards improving the performance of irrigation through increasing local capacities to manage irrigation, and efficient use of water and land resources. Organizational capacity should also be improved. Specific areas that would result in a positive return on investment include:

- Providing support to MACOs so they can offer services to communities, such as agricultural extension and small dam rehabilitation.
- Coordinating and integrating multiple users spatially around the small reservoirs and watersheds and over time throughout the project cycle.
- Facilitating multiple institutional arrangements.
- Strengthening existing policies, procedures and links within organizations.
- Introducing a step-wise approach to assess feasibility and needs when planning rehabilitation or new construction.
- Establishing mechanisms for prequalification of contractors and more transparent oversight on the awarding of contracts.
- Developing guidelines for contractors on the design of multiple-use reservoirs.
- Building capacity for extension workers, especially regarding multiple-use systems and social aspects.

The return on investment

- Better information will lead to more effective decision making.
- Improved planning processes will reduce investment costs with a positive impact on performance.
- Improve performance through a multiple use perspective for monitoring.

Who benefits and where

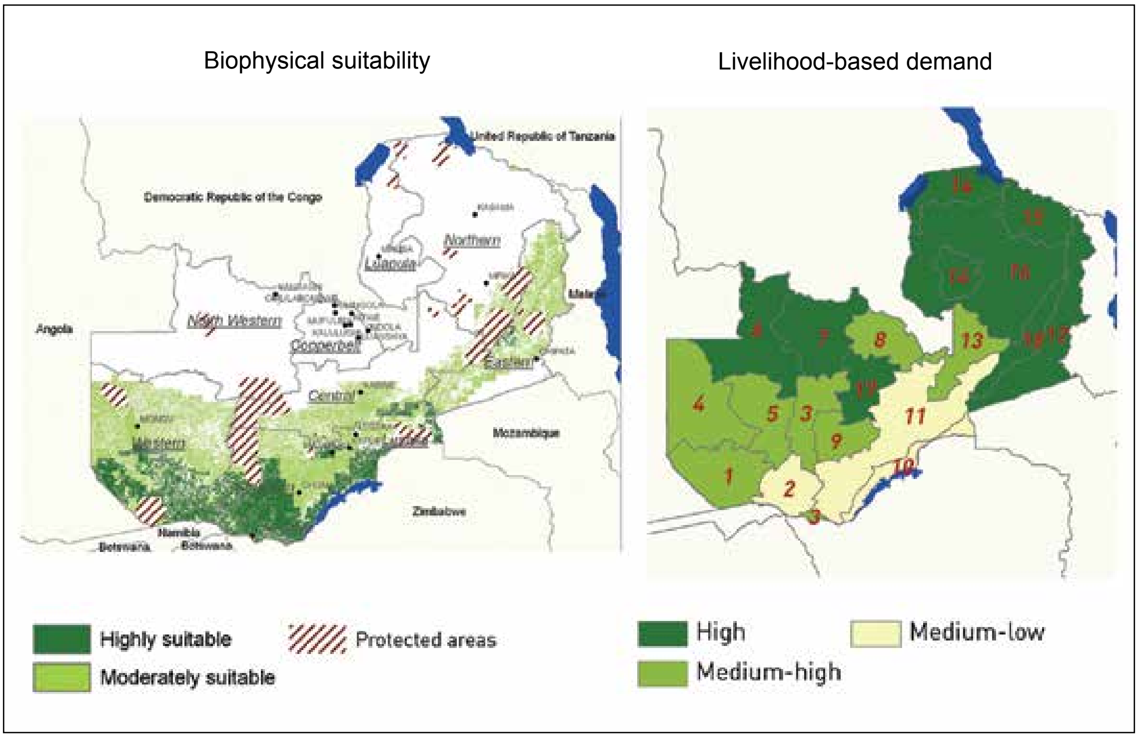
Suitable areas for small dams are defined as agricultural areas where the aridity index (yearly precipitation divided by yearly reference evapotranspiration) is between 0.2 and 0.65, semiarid to dry sub-humid. A higher livestock density is assumed to be correlated with enhanced multiple uses of small dams, and livelihoods benefits are assumed to be greatest where there is relatively higher prevalence of market-oriented smallholder farmers. Based on these criteria, suitability maps were generated (Figure 8) and it was estimated that at a 50% adoption rate, up to 232,000 households (14% of rural households) could benefit from small reservoirs. The area covered would be 323,000 ha (2% of the agricultural land).

Out-grower Schemes and Contract Farming[5]

Out-grower schemes seem to offer promising opportunities. Multinational agribusinesses and large supermarket chains are using them to secure their supplies. Donors are also showing interest and offering support. However, is this a good model to improve access to water and incomes for poor men and women farmers?

[5] Based on Bangwe and van Koppen 2010; and AgWater Solutions Project 2011b.

FIGURE 8. Potential for small reservoirs.



Source: FAO 2012a.

Where the opportunity lies

In Zambia, out-grower schemes (Box 3) are increasingly seen as a sustainable approach to empower smallholders economically while addressing their production constraints. These schemes are seen as models for mutually inclusive and productive partnerships between organized smallholders, commercial farmers and agribusinesses, provided there is equitable sharing of the benefits between parties and adequate smallholder representation in the governance of the schemes.

Box 3. What are out-grower schemes?

Out-grower schemes are contractual relationships between smallholders and commercial enterprises that buy agricultural produce from farmers. The arrangements differ from one company to another but, in most cases, farmers are provided with a guaranteed market and receive agribusiness support services such as irrigation water, inputs and extension services.

These are usually provided on a credit basis so that farmers pay at the end of the season when they have money. Benefits include:

- A guaranteed market for produce.
- Access to inputs.
- Access to modern technologies.

(Continued)

Box 3. What are out-grower schemes? (Continued)

- Information on improved farming techniques.
- Risk minimization through pooling resources and cost-sharing.
- Access to machinery or services.

Source: Bangwe and van Koppen 2010; and AgWater Solutions Project 2011b.

The research

Researchers from the AgWater Solutions Project conducted two case studies involving:

- Community Markets for Conservation (COMACO), a group set up by the Wildlife Conservation Society to enable poor farmers to protect their natural resources while still making a living from them (Box 4).
- Kaleya Smallholders Company Ltd. (KASCOL), a smallholder group supplying cane to Zambia Sugar Plc (Box 5).

Main findings

Out-grower schemes have been effective for many products, including flowers, vegetables, poultry, pig-raising, dairy-farming, bee-keeping, and growing barley and sorghum. Several challenges need to be addressed for smallholder farmers to benefit from out-grower schemes.

Trust: Smallholder farmers can be taken advantage of by unscrupulous companies. Likewise, the company is taking a risk that smallholders can and will hold up their end of the bargain. Both parties need a long-term perspective. Strong, democratically elected farmers' associations or cooperatives help resolve potential tensions and mistrust. Donors can encourage companies to contract with smallholders by mitigating the risks. Governments can institute legal frameworks to clarify rights and responsibilities.

Information: Smallholders lack access to market information and may have limited power to negotiate. Donors and development agencies can facilitate the formation of farmers' organizations or cooperatives to represent their interests.

Costs and incentives: Dealing with a large number of smallholders means higher transaction costs for the company. Smallholders often live in remote areas, making transportation and communication difficult and expensive. Networks of farmer-agents and mobile phones could help. Incentives offered by donors and governments can also offset some of these disadvantages.

Links to markets: Financial sustainability and performance for both out-growers and the promoters depend on effective links to markets and the range of value chain services. Schemes that have adopted vertical integration across the value chain, for example, combining production, processing and marketing, seem to work best.

Public investments: Investments in regulatory and arbitration institutions are required.

Box 4. Out-grower case study: COMACO.

COMACO was set up by the Wildlife Conservation Society to help poor farmers protect their natural resources while making a living from them. COMACO operates as a contract farming promoter through their Conservation Trading Center (CTC). Farmers join registered Producer Group Cooperatives (PGCs) and have access to Trading Depots. These serve as trading hubs where PGC members market and receive direct payment for their produce along with price bonuses for conservation compliance. They also serve as community centers for providing training in livelihood skills and coordinating information on market opportunities guided by improved land-use practices and production technologies. The PGCs are represented on a Board that ensures out-growers are shareholders in the CTC. A team of professional managers and technical staff assist the Board in day-to-day management. COMACO PGC members learn skills in conservation agriculture, smallholder irrigation, composting and bee-keeping. They are also provided with inputs, and CTC provides loans and assistance to farmers who want to dig wells and access irrigation equipment. Lundazi CTC has evolved into a limited liability profit-making company and supports more than 20,000 out-growers.

Benefits

Conservation farming reduces the incidence of bushfires, increases crop yields and improves soil fertility. In 2006, about 73% of 7,375 farm plots inspected were compliant with conservation farming guidelines. COMACO manages the entire supply chain on behalf of producers and helps them diversify their livelihood activities.

Source: Bangwe and van Koppen 2010.

Box 5. Kaleya Smallholders Company Ltd. (KASCOL).

Zambia Sugar Plc., decided there were tremendous opportunities in contracting out-growers. Private commercial farms now cultivate 2,085 ha of sugarcane. KASCOL, the oldest smallholder group, supplies 2,156 ha of sugarcane. Farmers are provided with inputs and services such as cane harvesting and hauling as well as irrigation and training. Out-growers are responsible for in-field irrigation, weed control, fertilizer application and removal of diseased cane stalks. Farmers have to sign a Cane Growers Agreement (CGA). A Cane Purchase Agreement (CPA) defines the pricing mechanism and they must grow only sugarcane with the irrigation water supplied. Each farmer earns a net income averaging ZMK 25-40 million (USD 6,200) a year after deductions for inputs. Kaleya is one of several arrangements Zambia Sugar Plc., has with out-growers.

Source: Bangwe and van Koppen 2010.

Improving Horticultural Markets[6]

For farmers to invest in AWM, they need to know they can make sufficient profits to cover costs. This is only possible where there are well-functioning markets within a reasonable distance. Zambia's fresh market sector needs supportive policies, better controls on brokers and infrastructural investment to meet growing demand.

Where the opportunity lies

Of the smallholder farmers in Zambia, 20% sell irrigated horticultural produce. In the next 30 years, urban populations will rise by 170% increasing the demand. Farmers selling fresh horticultural produce earn 35% more than other farmers. The lack of physical market infrastructure and management systems is hampering the sector. Informal markets have increased dramatically raising concerns about hygiene.

The research

Researchers from the AgWater Solutions Project examined the physical structure and procedures of the Lusaka fresh produce market. Primary data came from Michigan State University's Food Security Research Project (FSRP) Urban Consumption Survey (UCS) during 2007-2008 and a survey supported by IWMI during 2009-2010. The latter included interviews with sellers and brokers as well as tracking of prices paid along the chain.

Main findings

The study found that the Lusaka fresh vegetable market plays an important role in trade across Zambia. About 38% of the onions and 31% of the tomato crops entering the market are redistributed outside Lusaka, and the trade is worth around USD 10 million.

In spite of its importance, the market does not legally exist, has poor infrastructure, and is not protected by laws and institutions. The poor infrastructure impacts on trade and also creates a health risk, because the floor is earthen, and there are no running water or toilet facilities.

Brokers control the market, taking a 20% commission even though the official rate is 10%. Farmers wait near the market to ensure the brokers pay them at the end of the day, a considerable and unproductive investment of their time. Because no official market information system exists farmers must rely on other farmers or the brokers.

Where to invest

- **Develop a legal framework** in which all major stakeholders (private-sector investors, the government, city council, traders, brokers and farmers) participate as stipulated under the Bus Stations and Markets Act and/or Public Private Partnership Act.
- **Build a new market facility** at a new legally acquired location in Lusaka, with custom-built facilities for wholesaling fresh produce. Similar markets should be built in other cities.

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[6] Based on Hichaambwa 2010; and AgWater Solutions Project 2011c.

- **Implement a market information system:** The FSRP together with the Zambia National Farmers' Union have already developed such a system but lack the means to implement it. An information system would allow the farmers to negotiate a better deal and not be beholden to the brokers.

AWM Adoption Dynamics[7]

Researchers compiled an 'inventory' on rainy-season cropping and dry-season irrigation 2009/2010 with the aim of capturing the use of buckets, *dambos*, river diversions, treadle pumps and motor pumps, conservation agriculture and public irrigation schemes. The research was conducted in Mpika, Chibombo, Monze and Sinazongwe districts. Fieldwork was carried out by FASAZ.

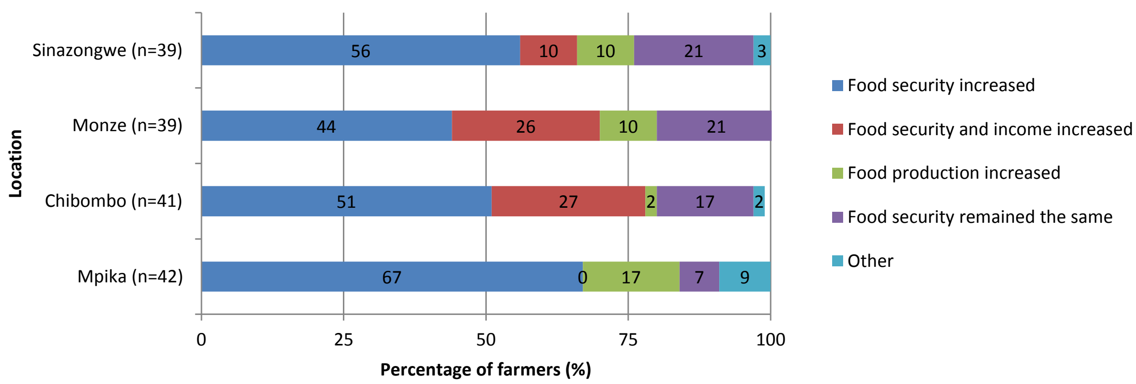
Nearly 2,000 households were sampled. Between 75 and 85% (depending on location) were male-headed and between 51 and 72% had adopted some form of water management technology. The preferred technology (aside from the ubiquitous bucket) varied by district, and is a function of geography and water availability (Mpika: river diversions; Chibombo: treadle and motor pumps; Monze: conservation agriculture; and Sinazongwe: a public irrigation scheme).

Adoption and abandonment rates differed only slightly by gender (adopters: men: 67%; women: 53%). There were no significant differences among the groups in terms of formal education. The greater difference was in the non-adopting group where nearly twice as many female-headed households were non-adopters.

Implications of AWM adoption

AWM increased food security significantly in 55% of households and little difference was found between male- and female-headed households (Figure 9).

FIGURE 9. Change in food security in the four sample districts after the adoption of AWM.



Source: Colenbrander et al. 2011.

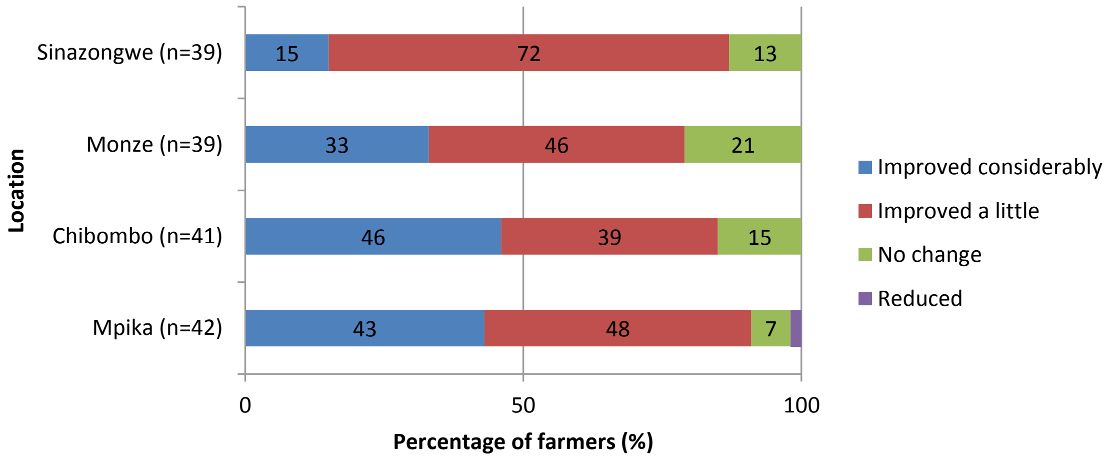
AWM also increased incomes for 80 to 95% of the adopter households (Figure 10). The majority of women who own irrigated land control the money they earn (female-headed households: 93%; married women: 66%).

[7] Based on Colenbrander et al. 2011.

In-situ water harvesting

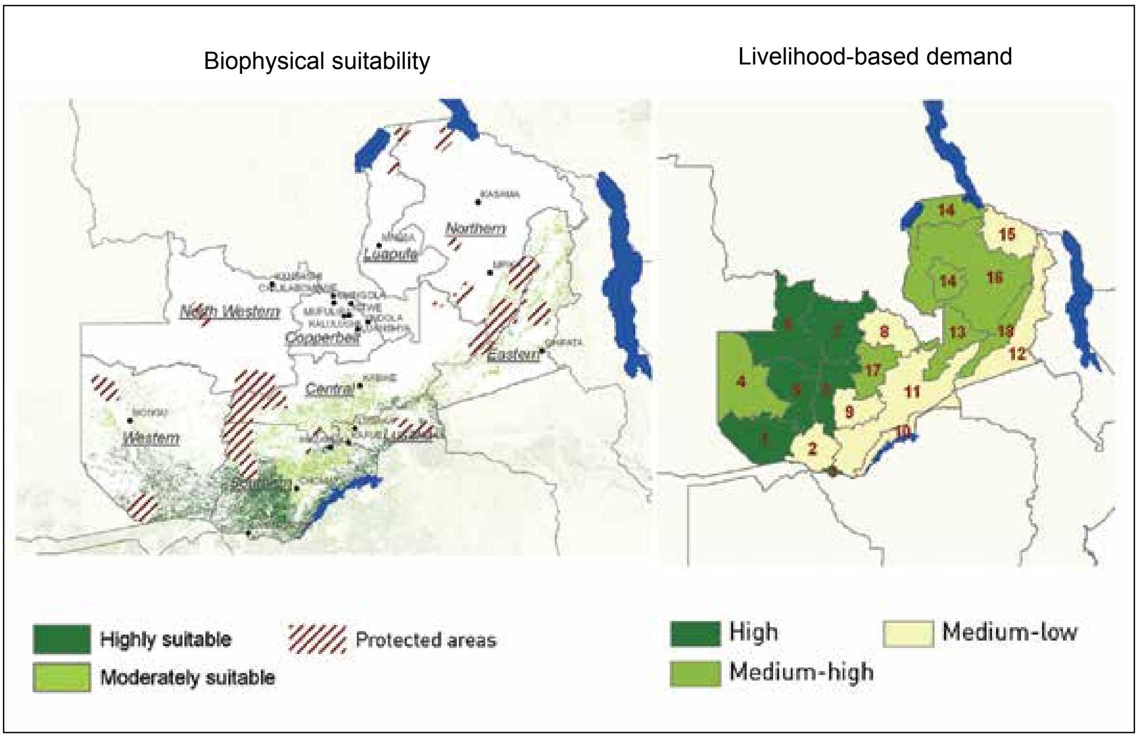
The geographical suitability for soil and water conservation practices was assessed on the basis of climate conditions. In-situ water harvesting (increased soil moisture retention) is assumed to be suitable in semiarid (higher suitability) to dry sub-humid (medium suitability) cultivated areas. The livelihood demand is assumed to be higher in areas with relatively higher prevalence of traditional smallholder farmers and limited accessibility to market infrastructures (Figure 11).

FIGURE 10. Change in income in the four sample districts after the adoption of AWM.



Source: Colenbrander et al. 2011.

FIGURE 11. Potential for soil and water conservation measures (in-situ water harvesting).



Source: FAO 2012a.

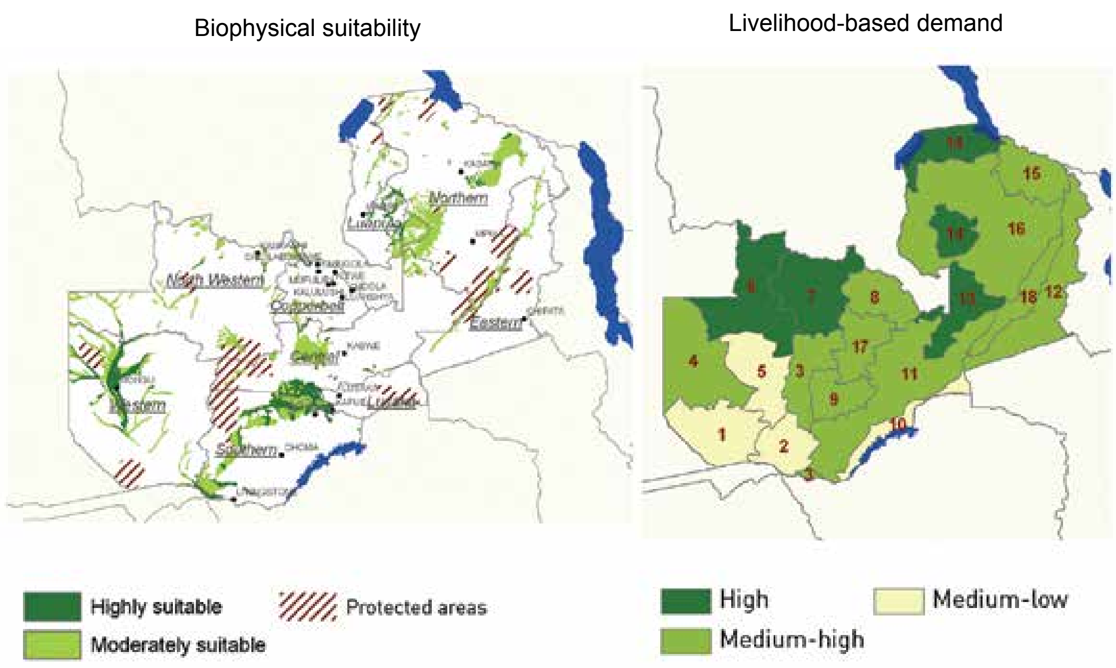
At a 50% adoption rate, up to 64,000 households (4% of rural households) could benefit from in-situ water harvesting. The area covered would be 307,000 ha (2% of the agricultural land).

Potential for dambos development (wetland rice)

Geographical suitability for wetland rice was assessed on the basis of land cover characteristics (floodplains, swamps, *dambos*) and travel time to markets (centers of 20,000 inhabitants or more). The livelihood demand is assumed to be higher in areas with a higher prevalence of market-oriented smallholder farmers and high poverty rates (Figure 12).

At a 50% adoption rate, up to 70,000 households (4% of rural households) could benefit from *dambos*. The area covered would be 105,000 ha (2% of the agricultural land).

FIGURE 12. Potential for *dambos* development (wetland rice).



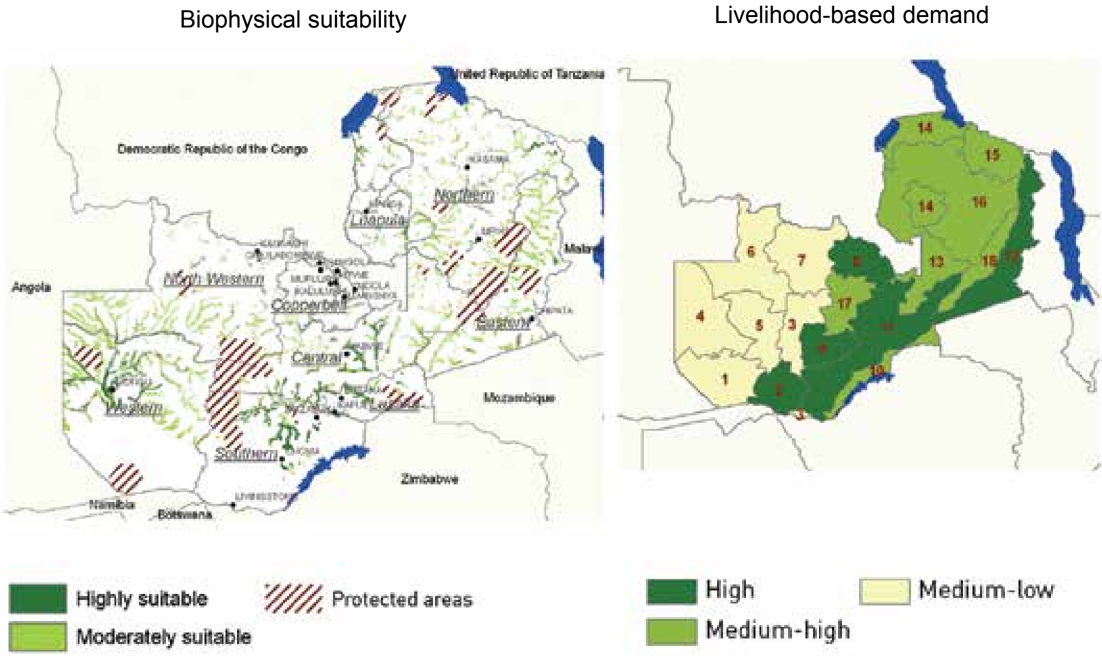
Source: FAO 2012a.

Potential for river diversion

Geographical suitability for river diversion was assessed on the basis of travel time to markets (defined as centers of 20,000 inhabitants or more), proximity to surface water and aridity index. The livelihood demand was assumed to be higher in areas with relatively higher prevalence of traditional and market-oriented smallholder farmers (Figure 13).

At a 50% adoption rate, up to 89,000 households (5% of rural households) could benefit from river diversions. The area covered would be 89,000 ha (1% of the agricultural land).

FIGURE 13. Potential for river diversions.



Source: FAO 2012a.

Stakeholder recommendations.

The future is in developing new wholesale fresh markets with appropriate infrastructure and a more equitable brokerage system to finance provision of services (e.g., refrigerated storage facilities). Dialogue participants cited the example of neighboring South Africa where 5% goes to the market, 7.5% goes to brokers and services are provided.

Source: FAO 2012b.

GENDER AND AWM[8]

Researchers from the AgWater Solutions Project conducted studies to explore the diverse gender roles shaping agricultural farm management systems, and specifically how women and men engage in small-scale private irrigation. By identifying gender-specific differences and barriers, practitioners can offer suggestions designed to improve the productivity of both men and women.

Researchers did not find any evidence of cultural taboos, monopolization of mechanized technologies or men taking over irrigation for high-value crops. The equal capacity of men and women in irrigation skills and labor inputs is socially acceptable and should be promoted through appropriate interventions (Table 3).

[8] Based on Akamandisa 2010; and Meinzen-Dick et al. 2012.

TABLE 3. Labor is usually provided by both men and women, although the use of motor pumps is predominantly by men.

Technology	Family labor provision for irrigation by technology (%)			
	Male	Male and female	Female	Children
Bucket (n=81)	16	51	13	2
Canal and river diversion (n=24)	17	67	8	8
Motor pump (n=13)	54	31	8	8

Source: Akamandisa 2010.

Decision making about the use of incomes from agriculture is not always as expected, for example, in 24% of male-headed households, the wife controlled the money earned on the husband's land.

Plot ownership and management are complex and determined by such factors as inheritance customs, and tribal norms and laws. These must be understood in each setting to improve recommendations for agricultural water management options.

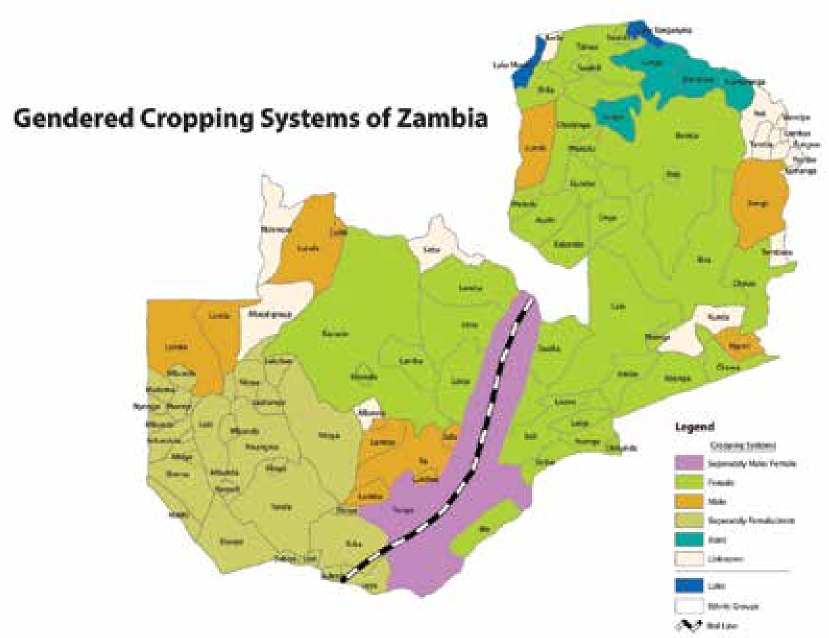
Mapping Farming Systems According to Gender

In 2010, 20 gender experts met to define the gendered production patterns of various regions, districts and zones. As ethnicity was a priori supposed to be an important variable for differences in the gendered organization of cropping, ethnicity maps provided the basis for the gender maps. The workshop was followed by a qualitative gender study in four areas. Key determinants were ethnicity, economic development (e.g., the railway line), resettlement, land allocation and other livelihood activities (Figure 14).

Farming system management types used in the map development are:

- *Male:* Production is completely or mostly controlled by the male head of the household.
- *Female:* Production is completely or mostly controlled by women in either a female- or male-headed household.
- *Separate:* Both men and women control production subunits and are farm decision makers in their own domains.
- *Joint:* Men and women share labor and decision making, and control outputs with joint landholding and accounts.

FIGURE 14. Gendered cropping systems in Zambia.



Source: Meinzen-Dick et al. 2012.

Stakeholder recommendations.

In consultations, stakeholders raised the following questions:

- How do gender balance issues in Zambian rural households affect adoption of improved agricultural water management?
- Do women face greater obstacles in getting financial assistance to invest in irrigation and market access?
- What coping strategies should be tailored specifically for women? (e.g., loans that do not require land titles, if via producer associations)?

Source: FAO 2012b.

SOCIAL AND ENVIRONMENTAL IMPACT: ANTICIPATING THE CONSEQUENCES[9]

An AWM solution that benefits one farmer may negatively impact someone else or the environment, for example, by diverting water from ponds used for fisheries or livestock or lowering the water table. For any AWM solution to be sustainable, the negative impacts have to be anticipated and minimized as much as possible. AWM solutions may also have unexpected benefits.

The possible and probable impacts of interventions were reviewed through studies in the Mwembeshi watershed. These studies showed that while expansion of most AWM options will

[9] Based on SEI 2012.

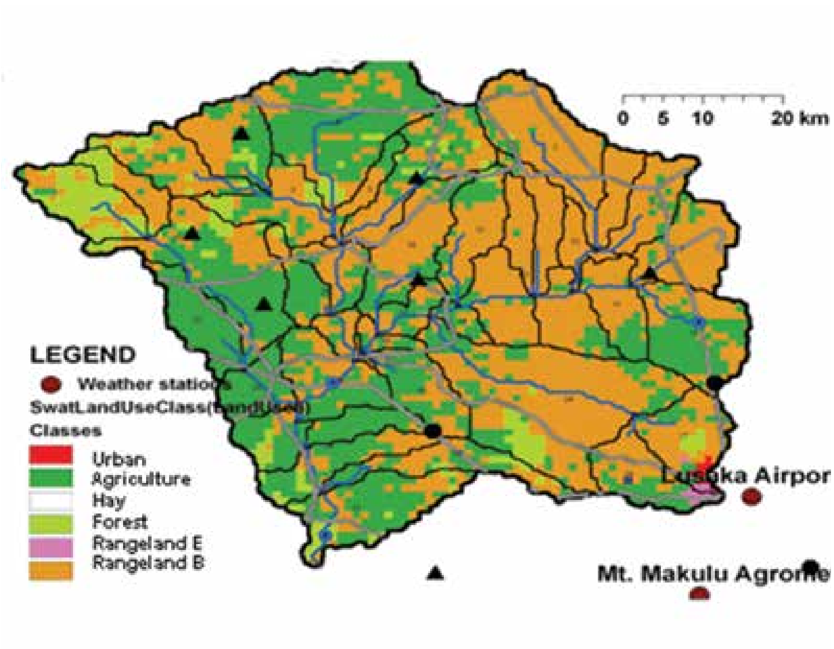
have some negative impacts on water quantity and quality, overall they have positive implications for poverty reduction and gender equity.

Mwembeshi Watershed

The Mwembeshi watershed covers 4,118 square kilometers (km^2) in Central and Lusaka provinces (Figure 15). Water flows into the Mwembeshi River, which feeds the wetlands of Kafue Flats and the Kafue River. Commercial farming and small-scale farming for markets are concentrated along the main roads. Large parts of the watershed are sparsely occupied.

Subsistence agriculture is usually seasonal and yields average about 2 tonnes per hectare (t/ha). Smallholders cultivate less than 5 ha (each) and consume most of the produce. Commercial farms harvest 2-3 crops per year with maize yields of 10-12 t/ha. Less than 10% of the *designated* agricultural land (4% of the watershed) is under production, so expansion is possible. There are abundant groundwater and surface water resources, but the area irrigated by smallholders is small. Irrigation technologies used by smallholders are low-technology, accessing surface water or shallow groundwater through gravity, labor and treadle or motor pumps.

FIGURE 15. Land use in Mwembeshi watershed.



Source: SEI 2012.

Social and environmental impacts

Four intervention scenarios for smallholder farmers were explored to assess the potential impacts on water balances and crop yields.

1. Improved soil and nutrient management in existing rainfed crops:

- could increase maize yields by 150% to 5.7 t/ha and vegetable yields by 80% to 7.5 t/ha;
- would have an insignificant impact on surface flows (8% reduction) and groundwater baseflow (9% reduction); and
- would have a major impact on livelihoods as more than 80% of the rural population in the watershed relies on rainfed agriculture.

2. Intensification of current irrigation areas by adding two irrigated post-rainy seasons of vegetable crops per year:

- could decrease surface flows by 13% and groundwater baseflow by 25%;
- yield gains could be 185% (11.7 t/ha); and
- intensification of existing irrigated areas would only benefit a small number (< 20%) of farmers.

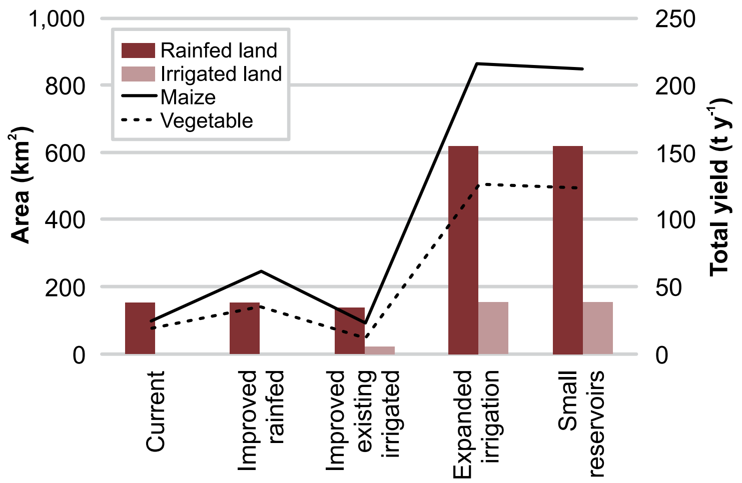
3. Doubling the irrigated area through wide adoption of water-lifting devices by smallholders, in particular, small motor pumps:

- could enable abstraction of groundwater and surface water resources for irrigating high-value crops (e.g., vegetables) and rainfed crops (e.g., maize);
- would likely be concentrated along the West and North roads;
- would decrease surface water by about 20% and groundwater baseflow by 25% of current annual flows;
- yield gains in vegetable crops could reach 175%, which would be a sizeable income; and
- improvements in maize would be a slight 4%.

4. Construction of small dams for multiple use and benefits (adding up to a 331,499,000-m^3 storage volume for the entire watershed, equaling 10% of annual rainfall):

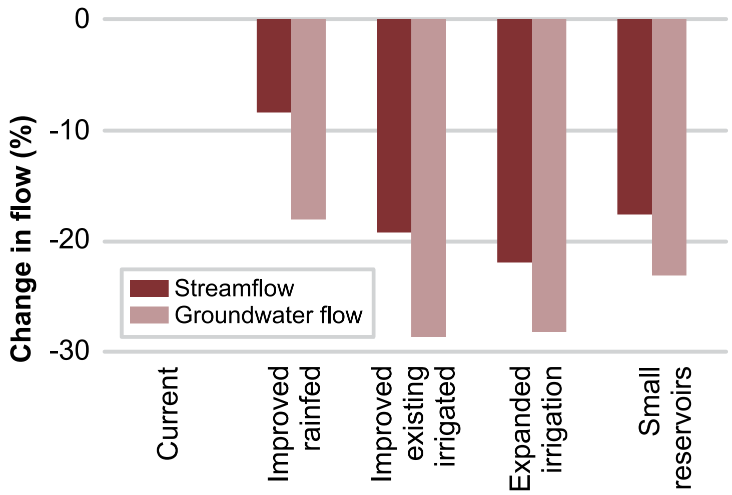
- would decrease surface water and groundwater flows by about 15 and 20%, respectively (Figures 16 and 17);
- would increase smallholder vegetable yields (around 170% to 11 t/ha);
- would moderately increase maize yields (13% to 2.6 t/ha); and
- could have other multiple-use benefits, such as access to water in the post-rainy season.

FIGURE 16. Impact of scenarios on crop area and associated maize and vegetable production.



Source: SEI 2012.

FIGURE 17. Hydrological impact of scenarios on streamflow and groundwater flow.



Source: SEI 2012.

Dealing with impacts of development

Adequate institutional arrangements need to be in place to ensure sustainable interventions. Currently, it seems that no organization coordinates the various land- and water-related activities at the watershed scale. Since formal and informal institutional arrangements for land and water resources management are already in place, coordination should build on existing institutional and social structures. New partnerships can be formed that address the need for coordination.

Traditional leaders, agricultural extension officers, and local NGO workers could facilitate stakeholder dialogue and strengthen interaction between local farmers and higher levels of governance. This would allow better harmonization and coordination of the development of the watershed as a whole.

CONCLUSIONS[10]

A broad range of AWM options was reviewed that offer different opportunities and benefits.

- **Motor pumps** could benefit some 268,000 households. The investment cost per household would be around USD 400. To achieve this sort of uptake would require better information about pump types, more suppliers who operate close to agricultural areas, and after-sales service and spare parts. Financing is also critical and farmers need financial service providers nearby; they also need terms and conditions that suit agricultural cycles, e.g., repayment after harvest. The cost of pumps could be lower if the duty waiver and zero VAT rating were used more often and the benefits passed onto the farmer. The Zambia Revenue Authority should be encouraged to clarify procedures and circulate more information about these options.
- **Soil and water conservation** could benefit up to 64,000 households. The cost of developing this land would be up to USD 30 million.
- ***Dambos*** could benefit a similar number of people. The cost of developing this land would be up to USD 63 million.
- **Small reservoirs** could provide irrigation water and a number of other benefits, such as livestock watering, fishing, domestic water supply and protection in low rainfall years, benefitting up to 232,000 households. This would be a costly investment at up to USD 713 million, but if a full cost-benefit analysis is undertaken this will often be shown to be a viable option. Small reservoirs are in demand from users. To maximize the benefits from small reservoirs it is necessary to coordinate users to fully utilize the resource. At present, much of the irrigable land around reservoirs remains fallow. Pumps can be used to irrigate high-value crops upstream.
- **River diversions** could benefit up to 89,000 households. The cost of developing this land would be up to USD 377 million.
- **Out-grower schemes and contract farming** currently benefit wealthier farmers, especially men, more than smallholders, including women, mainly because of inadequate trust on both sides and the distance between smallholders and points of collection and distribution. This could change and smallholders could benefit if external agencies (e.g., donors, NGOs or governments) provided support.
- **Improved horticultural markets** would increase profits for smallholder farmers and ultimately support AWM. This requires implementation of a legal framework in which all major stakeholders participate, with improved market infrastructure and an information system that reduces farmers’ dependence on brokers.

[10] All figures provided in this section assume that 50% of the total potential users adopt the AWM option. All figures in this section are taken from FAO 2012a.

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Postal Address
P O Box 2075
Colombo
Sri Lanka

Location
127 Sunil Mawatha
Pelawatta
Battaramulla
Sri Lanka

Telephone
+94-11-2880000

Fax
+94-11-2786854

E-mail
iwmi@cgiar.org

Website
www.iwmi.org

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Research Program on Water, Land and Ecosystems

ISSN: 2012-5763
ISBN: 978-92-9090-757-2