

**Evaluation of USAID/OFDA Small Scale Irrigation Programs
in Zimbabwe and Zambia 2003-2006: Lessons for Future
Programs**

by

FANRPAN

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List of Acronyms

ACF	Agricultural Consultative Forum
AREX	Agricultural Research and Extension (Zimbabwe)
C-SAFE	Consortium for Southern Africa Food Emergency
CLUSA	Cooperative League of USA
CRS-Z	Catholic Relief Services-Zimbabwe
COMESA	Common Market for Eastern and Southern Africa
DAI	Development Alternatives Incorporated
ENDRA	Emergency Nutrition and Drought Recovery Assistance
FACT	Family Aids Counseling Trust
FANR	Food, agriculture and natural resources
FANRPAN	Food, Agriculture and Natural Resources Policy Analysis Network
FARA	Forum for Agricultural Research in Africa
FSP	Food Security Program (Zambia)
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
HNG	Household nutrition garden
HVI	Household Vulnerability Index
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDE	International Development Enterprises
IPTRID	International Program for Research on Irrigation and Drainage
ITC	Intermediate Technology Consultants
IWMI	International Water Management Institute
LEAD	Linkages for the Economic Advancement of Disadvantaged
MDG	Millennium Development Goal
MSU	Midlands State University (Zimbabwe)
NEPAD	New Partnership for Africa's Development
NFI	Net farm income
NGI	Net garden income
NGO	Non-government organization
OFDA	Office of United States Foreign Disaster Assistance (USAID)
ORAP	Organization of Rural Association for Progress

RCSA	Regional Center for Southern Africa (USAID)
SACAU	Southern Africa Council of Agricultural Unions
SADC	Southern African Development Community
SIWUP	Smallholder Irrigation and Water Use Program (Zambia)
SMC	Smallholder Market Creation Project (Zambia)
TLC	Total Land Care
USAID	United States Agency for International Development
UZ	University of Zimbabwe
WSU	Washington State University (USA)

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This paper draws on more specific work led by several of the co-authors. Amy Sullivan visited Zimbabwe and Zambia and carried out the qualitative assessments designed to identify lessons for the future. Julius Mangisoni also visited the two countries and provided technical assistance on the sampling and analytical methodologies used in the two country-level quantitative assessments, drawing on work he had done previous on the impacts of treadle pumps on poverty in Malawi. Mwalimu Simfukwe and his team carried out the quantitative assessment of treadle pumps in Zambia, while Francis Mugabe and his team at Midlands State University did the quantitative assessment of drip irrigation kits in Zimbabwe. We are grateful to all of them for their hard and persistent work and professionalism in completing this work.

We received very useful and constructive comments on an earlier version of the Zimbabwe quantitative report from Godfrey Nehanda of LEAD Trust (Zimbabwe); we have used his comments to improve our reports. We also received comments on the Zambia quantitative report from a USAID staff member in Zambia who helped us correct some factual errors. We are grateful to both for their comments. Harlan Hale also provided comments on an earlier draft of this report that led us to improve the recommendations, for which we are grateful. Lindiwe Sibanda made excellent suggestions for the final recommendations and presentation.

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FANRPAN will share the results of this work more widely through its network and using various media and forums; for us this project provided an opportunity to build a more comprehensive database on experiences with small-scale agricultural water management technologies, which we believe have considerable potential in sub-Saharan Africa.

With all these comments and supporters, the authors remain responsible for this work; it does not represent the views of USAID/OFDA.

Major Recommendations and Conclusions

Background

The recommendations in this report are based on studies commissioned by USAID's Office of U.S. Disaster Assistance for Southern Africa. The studies were an assessment of outcomes, experiences and lessons learned in two countries where OFDA had invested in small scale water management technology: treadle pumps in Zambia, and drip irrigation kits in Zimbabwe. These studies were intended to provide guidance to future programming not only by OFDA but by other agencies as well. The details regarding implementation of the country studies are contained in the main report.

Recommendations

The major action recommendations we make in this paper are as follows:

1. **Carry out needs assessments.** Careful needs assessment and targeting of those most in need are both complex but critically important for disaster assistance to be effective. *We recommend carrying out detailed local assessments as pre-requisites to providing assistance.* Needs assessments can be done through locally active NGOs, local governments and councils, and consultations with local communities, depending on the circumstances. It is important to gain an accurate local perspective on who will be the long-term users of the assistance—who may not be those first in line when NGOs arrive. The FANRPAN 'household vulnerability index' (HVI) also provides a tool for identifying the households most vulnerable and in need and can be adapted to identify opportunities as well; it can also be used to monitor impacts over time. For example, if the problem is malnutrition from lack of micro-nutrients, assistance to improve household nutrition gardens may be most appropriate, but if the problem is insufficient calories, short term food aid may be more useful. Similarly, households need minimum levels of human, natural and social capital to be able to make good use of water management technologies. Finally, using local knowledge to identify groups or local institutions as conduits for assistance will pay dividends; for example, churches, mosques or other community groups can often be used; and provision of assistance through community-based hospitals is worth exploring.
2. **Serious gender targeting.** Women in most southern African rural areas play key roles in food production, especially gardening, and are also responsible for feeding children. They are also the least likely to be provided opportunities to receive training, access to technologies, and market access. Yet most relief as well as development programs still fail to reach women effectively. It is not enough to target female-headed households though this may be a part of the solution; within nominally male-headed households, women are often the actual gardeners and users of drip kits and treadle pumps. Giving training and technology to men simply delays access and productive use of the innovation. The first step is a proper needs assessment as described in the previous paragraph, which will include identifying who are the real users of the type of assistance on offer. *We recommend that USAID/OFDA require its partners in future to develop detailed plans and strategies for ensuring that a needs-based proportion of assistance is provided directly to women, and that they*

report their results on this basis. This means, for example, if 90% of gardening is done by women, then 90% of drip kits should go to women. Implementing partners could also be supported—and required—to recruit gender specialists at a sufficiently senior level to enable more effective gender-balanced implementation programs. Possible strategies include: providing training to two persons per household (at least one of whom must be female); using female trainers; paying for child care while women attend training; and making use of women trainers and extension workers even if additional support is needed to recruit and train them. Training women and providing materials to enable them to train other women can lead to more rapid replication as well.

3. **Targeting the needy and testing community-based approaches.** Targeting of water management technologies emerged as a critical issue in both Zambia and Zimbabwe: how to balance “needs based criteria” with “ability based criteria.” Those households best able to use technologies like drip irrigation kits and treadle pumps because they have the minimum necessary labor, land and water resources, are not necessarily the most needy people. In reviewing an earlier draft of this report, both LEAD Trust and USAID/OFDA suggested a community-based strategy may work, by increasing the overall supply of food in a community and creating opportunities for sharing through transfers or labor opportunities. This hypothesis is well worth testing. *We recommend USAID/OFDA review past experiences for evidence regarding this community-based approach, and support pilot-testing in a sufficient variety of socio-economic circumstances to enable reasonable conclusions to be drawn to guide future relief and development programs.*
4. **Take advantage of programs on the ground.** The Zambia treadle pump program implemented through C-SAFE demonstrates the potential for using disaster assistance resources to supplement and enhance long-term development programs, and also demonstrates the efficacy of NGO consortia. In this case, USAID/OFDA funds were used to scale up and enhance work that was underway in any case, and that was well within the mandate and capacity of the implementing agencies. *Therefore, we recommend that USAID/OFDA take advantage of on-going programs where appropriate to create synergies and enhance development programs.*
5. **Work with governments wherever possible.** The Zambia case also demonstrates the potential for higher sustainability and commitment by working through government, for example to provide training, where possible. This seems to have led to capacity strengthening of government, and also led to a higher level of commitment to supporting the program in the long term. *We recommend integrating USAID/OFDA programs with government wherever this is feasible.*
6. **Use of vouchers for targeting subsidies.** FANRPAN has a separate program (supported by USAID/RCSA) that is examining the use of vouchers (coupons) to target agricultural input subsidies to poor farmers. The advantage of vouchers over subsidies provided through other means (including direct distribution of drip kits and other technologies by NGOs) is that they can be used to strengthen and support commercial markets, make targeting more precise, and possibly reduce costs. *We recommend that USAID/OFDA and its implementing partners explore the*

possibility of using vouchers as a means to target and support needy households to purchase technologies that fit their needs through the commercial retail markets.

7. **Use a consistent reporting format.** *We recommend that OFDA develop a user-friendly, practical and consistent format for implementing agencies to use for reporting on the outcomes and real as well as potential impacts of their programs.* Ideally, these should include preparation and use of participatory impact assessment pathways and network mapping (these are similar to logical frameworks but express the relationships graphically), but this will require a training program for implementing partners. The basic idea is to clearly specify how the proposed intervention solves a particular problem, and what short term outcomes and long term impacts are anticipated. Some suggestions are made in the report on what is needed.
8. **Realism about potential development impacts of relief programs.** Short term disaster assistance or relief projects cannot substitute for long term development programs. Many relief projects, including those studied here, seek to achieve in a year what decade-long programs struggle to achieve; but few have a sustainable impact. *We recommend providing immediate relief where it is needed and avoiding projects that are “relief projects masquerading as development”* as they are unlikely to put people on the road to long term sustainable development.
9. **Implementation check list.** USAID/OFDA has requested that this report include a checklist of key factors for success and major constraints. Because of the diversity of conditions and the danger of uncritical application of checklists, we hesitate to do this. Nevertheless, we do provide guidelines for introduction of treadle pumps and drip irrigation kits in Appendix 4.

Lessons from Comparison of Zimbabwe Drip Kit and Zambia Treadle Pump Experiences

The following are some lessons that emerge from comparing the two programs.

1. The Zambia treadle pump program has had a measurable impact in terms of improving food security and reducing poverty, while the Zimbabwe drip kit program has not had any statistically significant impact. This is consistent with other assessments of treadle pumps (e.g., in Malawi: Mangisoni 2006; and in Ghana: Adeoti et al. 2007) and of drip irrigation kit experiences in Zimbabwe (e.g., Rohrbach et al. 2006; Moyo et al. 2006). Many recipients of drip kits have benefited, demonstrating the potential usefulness of this technology under the right conditions; but drip irrigation kits are not an effective way to reduce poverty and increase food security among very poor households, especially in the context of drought relief programs.
2. There was a sharp contrast between the two programs in terms of the support provided by the local USAID mission. In Zimbabwe, the mission was not able to provide adequate support as it did not have a long-term development program and was being dismantled at the time of implementation. In Zambia on the other hand, the OFDA support was provided through existing development programs and contracts

with NGOs, and the USAID mission played a key role in overcoming bureaucratic hurdles and ensuring the effectiveness of the aid.

3. An important issue in both cases is the trade-offs involved in local manufacture versus importing, and maintaining both quality and a supply chain of spare parts and replacement equipment. An important lesson is that simply importing or even sourcing locally such technologies for distribution on a “drop and go” basis will not lead to long-term development. Investing in setting up a local supply chain including retail outlets carrying equipment and spare parts, sources of advice and technical assistance, and some means for quality control, are critical. Evidence from East and West Africa suggests investment in ‘social marketing’ to raise awareness among potential customers can also make a big difference (e.g., Adeoti et al. 2007; www.kickstart.org). Whether to encourage local manufacture or imports—or both—is a more complex issue whose answer may depend on the circumstances in each country. However, encouraging local manufacture (or even joint ventures of foreign and local firms) over the long run may contribute more in terms of job creation and economic growth. Encouraging regional markets would lower costs and lead to more competition (see Merrey and Sally forthcoming, 2008).
4. Targeting has been a problem in both Zimbabwe and Zambia. First, in both countries but especially in the case of Zimbabwe drip kits, the criteria for selection of beneficiaries used locally were not always consistent with the expectations of USAID/OFDA: they were not necessarily the poorest and most vulnerable households. However, the poorest households did not necessarily have the necessary conditions (e.g., labor, water) to make best use of the technologies. Second, while all the evidence suggests that women produce much of the food, and certainly manage most household gardens, especially among the poorer households that were the intended beneficiaries, they were not effectively targeted in either program. Some female-headed households were selected, but these were a minority; but even in households nominally male-headed, women play a critical role in cultivating vegetable gardens. We suspect but cannot say for certain that even training programs probably benefited the official “recipient” but not necessarily the actual “user” in many cases. Especially in cases where the implementing agency has roots in local communities (as was the case in both programs), it should be possible to do a better job of targeting women gardeners.
5. In both country programs, there is evidence that the implementing agencies were learning from experience and adapting their strategies based on lessons learned. However, the Zambia program seems to have been more effective than the Zimbabwe program on this score, and seems to have been particularly adept at assessing the local situation and conditions of households. Both had the advantage of adding short-term relief resources to longer-term programs, but in the Zambian case, the longer-term programs included specific water management components whereas this seems less often the case in Zimbabwe.
6. Training, not only in the operation of the technology itself, but in improved crop husbandry, marketing, and business management, proved to be valuable in both cases. Beneficiaries by wide margins expressed appreciation for the training.

7. In Zambia, the Ministry of Agriculture and Cooperatives was deliberately involved, to the extent that implementing agencies provided resources to government staff to carry out training. In Zimbabwe, the relationship with Agricultural Research and Extension (AREX) seems to have varied, but often excluded AREX from playing an active role. Involvement of government field staff can contribute greatly to the longer term sustainability of such programs.
8. Both programs had interesting experiences with groups. In Zambia, groups were created as a mechanism to guarantee credit and manage revolving funds. This seemed to be very effective in the short run, but we are not certain about the sustainability of these groups after withdrawal of the implementing agency; using existing groups where they exist may be a more sustainable option. In Zimbabwe, the LEAD-CRS program worked with about twenty hospitals to improve their nutrition gardens, and these hospitals often engaged with local communities as well. We did not assess their sustainability separately but based on reports from the implementing agency, we believe it is likely this approach has a lot of merit. Further, ORAP's inclusion of lead farmers with links to poor and vulnerable households in Zimbabwe is an attractive approach, though we did not have the opportunity to evaluate this in the field. In their comments on an earlier draft of this report, both LEAD Trust and USAID/OFDA suggested "community targeting" may help raise overall food production and income at community level, and vulnerable groups who are not direct beneficiaries may benefit indirectly. We are not aware of much evidence on this hypothesis, but agree it is well worth further exploration.
9. In both cases, access to output markets where produce could be sold was very important, but did not receive sufficient attention in Zimbabwe—indeed because of the economic situation such opportunities are very limited in Zimbabwe. In Zambia, the implementing agency did seek to enhance farmers' access to output markets but found itself in the position of acting as a broker, which is not sustainable, and probably led to an exaggeration of benefits in the sense that upon withdrawal of the implementing agency, farmers' profits most likely were reduced.
10. For many rural households in Zimbabwe and to a lesser extent Zambia, dry land cultivation is a more important (but also risky) source of income than are household gardens. For example, in Zimbabwe gardens produced just 4-20% of total net farm income, limiting the potential impact of drip irrigation kits. In Zambia however, treadle pump adopters on average earned nearly 60% of their income through its use. This may reflect the greater versatility of the treadle pump: where necessary it can be used even for supplementary irrigation of dry land staple crops.

Major Conclusions and Lessons Learned

These conclusions and lessons provide the basis for the action recommendations.

1. Treadle pumps, drip irrigation kits, and indeed many other small-scale low-cost individualized water management technologies have a great deal of potential for enabling poor rural households to improve their livelihoods and food security in southern Africa. However, for long term sustainability they require effective support

systems, including continuing access to replacements and spare parts, training, and technical advice on the input side, and access to output markets as opportunities to earn an income from sale of produce.

2. Drip irrigation kits and treadle pumps are often not appropriate if the objective is to provide support to the “poorest of the poor,” i.e., those households with insufficient labor, land, access to water, technical competence, and access to output markets. This observation combined with the previous point regarding the need for effective support systems leads to the conclusion that these technologies are not appropriate as stand-alone “relief” investments. However, where the shorter-term relief investments can be integrated with longer term programs to improve households’ livelihoods through improved water and land management, as was the case for the Zambia treadle pump program, the results can still be very positive. Using “relief” in ways that contribute to long-term sustainable improvements in household food security is a very worthy objective, but this does not mean that investing in short-term versions of programs that require a long-term approach will be effective.
3. This conclusion begs the question, how can the most stressed, marginalized and vulnerable households be identified and assisted? This is a difficult question going beyond what this study could address. FANRPAN (2007) has recently published a book describing how to construct and use a “household vulnerability index” (HVI). Although developed in the context of supporting HIV/AIDS-affected households, it lends itself to identifying those households who are most at risk, and is also a tool that can be used to track impacts over time. Rohrbach et al. (2006) have suggested that assisting households to improve the productivity of their home gardens can have enormous benefits in Zimbabwe, as vegetables and fruits can have major positive impacts on child nutrition. We have also highlighted, above, that community-based approaches may offer another avenue to providing benefits to the very poor. Finally, we reported on but were unable to assess the effectiveness of “institutional nutrition gardens” such as those promoted through hospitals in Zimbabwe. We believe this may be another effective mechanism for reaching vulnerable people and youth in surrounding communities, as is claimed by LEAD Trust and Catholic Relief Services.
4. Both programs demonstrate the complexity of “targeting” support to those most in need. First, the criteria used “on the ground” by some of the implementing agencies appropriately included access to water, land and labor (otherwise the technology is useless to the household). However, these criteria effectively excluded the poorest and most vulnerable households who are USAID/OFDA’s intended beneficiaries. One implementing agency in Zimbabwe (ORAP) tried to overcome this in part by including lead farmers who had clear links to vulnerable households. Further, none of the programs sought explicitly to target women. This refers not only to women-headed households (the traditional means to reach women), but those women who are often the actual gardeners in nominally male-headed households. There is considerable incidental data from both programs showing that women were often the users, but less often received the technology and the training directly.
5. A major drawback of both programs is that they focused on the use of a specific single technology as a means to provide support to households. This can lead to over-emphasis on the technology itself, possibly providing the technology to the wrong

households (i.e., those not able to make best use of it), and using as a major measure of performance, the number of kits delivered. A “one-size-fits-all” approach ignores the high degree of diversity among households; for example a common complaint expressed about the drip irrigation kits is they were seen as too small by many respondents. Given the diversity of agro-ecologies and household characteristics, a better approach will be to offer a larger menu of technologies and practices, and assist farmers to choose and mix and match based on their needs. For example, it is clear that some households receiving drip kits in Zimbabwe could have overcome its largest drawback, the need to lift heavy buckets over a meter high to fill the drum, if they also had a treadle pump; and many may have benefited from interventions to improve water management on their rain fed fields.

6. Where households do not have good access to profitable output markets for sale of surplus produce, the usefulness of technologies like drip kits and treadle pumps is limited (though not zero). Access to output markets is critical for households to earn income and improve their wellbeing. While both the Zimbabwe and Zambian programs realized this, the Zambian program put more effort into linking farmers to markets—to the extent of becoming brokers, an unsustainable role. NGOs should get out of the business of being market intermediaries themselves—it is not sustainable.
7. Both cases, but especially the Zimbabwe case, demonstrate that the policy and macro-economic environment is critical to success. The hyperinflation in Zimbabwe undoubtedly reduced the impacts of the drip irrigation programs, by disrupting both the input side (e.g., availability of spare parts) and output side. Similarly, government off and on again subsidies and import policies undermined the Zambian program, though less dramatically.
8. The study has confirmed the value of broad-based training, i.e., training not only specific to the technology, but for improving crop husbandry, marketing, and management of accounts.
9. There is evidence from Zambia that working closely with government pays dividends in terms of government capacity building and ownership. In addition, from the perspective of FANRPAN, it increases the likelihood of influencing policy to make it more favorable for supporting the small-scale irrigation technology industry. One important policy issue is the consistency of support to the business environment to scale up manufacturing and marketing of these technologies and provision of after-sales services including spare parts.
10. Finally, we note that there is no consistent reporting system used by the implementing agencies receiving support from USAID/OFDA. The implementing agencies therefore devised their own reporting formats using their own criteria and measures, designed, understandably enough, to put their results in the best possible light. This makes it impossible to track in a systematic and comparative manner the outcomes, short-term impacts, and potential long term impacts of OFDA investments.

Evaluation of USAID/OFDA Small Scale Irrigation Programs in Zimbabwe and Zambia 2003-2006: Lessons for Future Programs

1. Introduction

The United States Agency for International Development's Office of US Foreign Disaster Assistance, Southern Africa Regional Office (USAID/OFDA/SARO) requested the Food Agriculture and Natural Resources Policy Analysis Network (FANRPAN) to carry out an evaluation of two types of small scale irrigation programs that it had been supporting: drip irrigation programs in Zimbabwe, and treadle pump irrigation programs in Zambia. USAID/OFDA requested that the evaluation build on recent research where possible, determine whether the technologies were actually adopted by recipients and if not why not; identify, for those who had adopted the technologies and integrated them into their livelihood strategies, what the perceived benefits were; and determine the factors for successful adoption and continued use after project completion. The intent therefore is to identify the lessons learned in the past in order to design more effective programs in the future.

Box 1. The Food Agriculture and Natural Resources Policy Analysis Network

Launched formally in 2002, FANRPAN's mission is to promote effective Food, Agriculture and Natural Resources (FANR) policies by facilitating *linkages and partnerships* between governments, Regional Economic Communities and civil society, and *building capacity and implementing* effective, targeted and demand-driven policy analysis and dialogue at national and regional levels. Its work is focused on southern Africa, where it collaborates with both SADC and COMESA. Its modest Secretariat is located in Pretoria, South Africa. It has national nodes in 12 of the 14 SADC countries, and has strong partnerships with a large number of international, regional, and national institutions, including governments in the region, research institutions, farmer organizations (e.g., SACAU), agro-businesses, and NGOs. FANRPAN works closely with both the NEPAD Secretariat and FARA. Its comparative advantage lies in its ability to manage regional and multi-country policy research programs, and at both regional and country levels, convene multi-stakeholder policy dialogues including representatives from government, private sector, farming unions, policy research institutions and non-governmental organizations. Therefore, it has a unique capacity to provide evidence-based support for stakeholders' deliberations on FANR policy discussions. Further information is available at www.fanrpan.org.

This report is organized as follows: section two provides an overview of the methodology and approach of the study, and the following section (three) is a brief synthesis of and guide to the research literature on small scale (micro) irrigation technologies. There are then two sections (four and five) synthesizing the major findings from Zimbabwe and Zambia. Section six compares the findings from the two countries. This is followed by section seven summarizing the main findings and conclusions. Section eight provides

specific action-oriented recommendations for future small scale irrigation programs while section 9 contains brief concluding remarks.

2. Methodology and Approach

The study combines qualitative and quantitative methodologies in each of the two countries in order to identify in an objective manner the actual impacts and outcomes of the programs, and to obtain the views, perspectives, observations and suggestions of a cross section of program participants from USAID, NGOs, and farmers themselves. It builds on a previous broad assessment of experiences with micro-agricultural water management technologies in the southern African region that was partly supported by USAID/OFDA (IWMI 2006), and uses a quantitative methodology for impact assessment that was used to assess the impact of treadle pumps in Malawi as part of that regional study (Mangisoni 2006). In Zimbabwe, it also builds on a recent larger-scale assessment of experiences with drip irrigation kits done by ICRISAT and the University of Zimbabwe (UZ) (Rohrbach et al. 2006).

For the quantitative assessments, FANRPAN engaged with the Department of Land and Water Resources Management at Midlands State University, Gweru in Zimbabwe (hereafter MSU/Gweru), and in Zambia with its national host institutional node, the Agricultural Consultative Forum (ACF), Lusaka. FANRPAN requested Dr. Julius Mangisoni, who had carried out the Malawi treadle pump poverty impact assessment study mentioned above, to go to each country and provide training and technical support to design the studies. Given resource limitations, in both cases the teams focused on specific districts or regions where the USAID/OFDA programs had been implemented, and drew a sample of both beneficiaries and non-beneficiaries. These reports are critical sources for this report and constitute two of the study outputs (Simfukwe et al. 2008; Mugabe et al. 2008).

For the qualitative assessment, Dr. Amy Sullivan visited both countries for about a week each, and with the assistance of our national partners, interviewed as many of the participants in the small scale irrigation programs as was possible. Her reports are outputs for this evaluation (Sullivan 2008a, 2008b). In Zimbabwe, she found that the USAID Mission staff members who had been involved were no longer at USAID but some were available for discussions (current USAID Mission staff had no knowledge of the program); she also did field visits and interviewed farmer beneficiaries with the assistance of the Midlands State University team. In Zambia, she met a wide range of participants from USAID and NGOs, as well as selected farmer beneficiaries. Her observations are a major source of insights, conclusions and recommendations of this study.

The overall leader of the study, Douglas Merrey, had led the regional assessment of experiences carried out previously by IWMI (2006), and was also a consultant to the ICRISAT and UZ study (Rohrbach et al. 2006) of Zimbabwe drip kit experiences. He took responsibility for integrating the findings from the literature reviews, quantitative studies and qualitative assessment in the two countries to prepare this final synthesis report.

Our expectation was that Dr. Mangisoni's visits to work with the country teams would result in the use of appropriate sampling procedures, similar data collection tools and analytical methods, and therefore some degree of comparability. This expectation was partly but not fully achieved, as both teams adapted their quantitative surveys to their understandings of the situation on the ground. Therefore, for example, the Zimbabwe team felt the techniques for measuring impacts on poverty are not relevant since people obtain their staple food from dry land maize fields, not drip irrigated gardens. We also expected that Dr. Sullivan's visit and interaction with the country teams would result in more integration between the two analytical streams, but largely because of delays in implementing the quantitative studies, this too was not fully achieved. Nevertheless, given the resources available, the findings of both the qualitative and quantitative studies in both countries do provide a basis for arriving at important conclusions and presenting specific recommendations for the future.

3. Regional Overview: Brief Literature Survey

Small scale farmers in southern Africa face many constraints to improving their productivity and raising their incomes. Staple grain yields have stagnated for several decades while population continues to rise. This lack of progress in agriculture can be attributed to many factors: civil strife; unfavorable government policies and weak institutions; inadequate infrastructure for transportation and communication; declining soil fertility; lack of farmer capacity to adopt and adapt productivity-enhancing innovations; and more recently the devastating impacts of HIV/AIDS on households.

In addition to these problems, unreliable and often insufficient water for crop production is also a major impediment to sustainable productive agriculture. Rainfall is highly variable, unpredictable and unreliable—even in areas where “average” rainfall appears statistically adequate. There has been minimal development of irrigation—sub-Saharan Africa has the lowest percentage of cultivated land that is irrigated in the world. Although some countries have ambitious plans for irrigation expansion and in some cases at least theoretically have sufficient land and water for development, a major expansion in formal publicly supported irrigation in the next decade or so is very unlikely. Therefore, it is critical for southern Africa to focus on stabilizing and increasing the productivity of rain fed agriculture. For most of this region, the low productivity and uncertainty of rain fed agriculture is largely a management problem and not inherent in the technology itself: there is considerable evidence, cited in IWMI (2006:9), that technologies such as rainwater harvesting and conservation agriculture, use of appropriate crop varieties, among others can lead to substantial yield increases even in so-called ‘drought’ years (see also Mazvimavi et al. 2007; Rockström et al. 2007a, b).

Globally there is a growing repertoire of low-cost individualized water management technologies that farmers can use to increase their agricultural productivity and incomes. In 2005-2006, IWMI carried out a broad comprehensive assessment of experiences with “micro-agricultural water management” technologies in 12 SADC countries, complemented by a review of literature from Asia and other African countries (IWMI

2006)¹. Among these technologies are water-lifting devices such as treadle pumps—pumps driven by human power modeled on a bicycle—and water application technologies such as drip irrigation, in which small amounts of water are applied directly to the root zone of crops through pipes and ‘drippers’ located at each plant.

3.1 Treadle pumps

There is a growing movement to promote low-cost treadle pumps and drip irrigation as practical means to enable farmers to grow more food and lift themselves out of poverty: Paul Polak, founder of International Development Enterprises (IDE, www.ideorg.org), for example, makes a powerful argument that a package of affordable irrigation and access to markets can make a substantial contribution to achieving the MDGs (Polak 2005)². An evaluation of the impact of IDE’s treadle pump program as of the late 1990s in Bangladesh (Shah et al. 2000) provides strong evidence for this optimism – though it must be noted that the hydrological conditions there are not replicated anywhere in Africa. In 2000, IPTRID published a report (Kay and Brabben 2000) evaluating the potential for treadle pumps in Africa, based on an analysis of experience in Zambia, Zimbabwe, Niger and Kenya; it remains one of the few comparative studies of the technical performance of the different treadle pumps then available, though is now in need of updating.

The treadle pump is a low-lift, high-capacity, human-powered pump designed to overcome common obstacles of resource-poor farmers to irrigation (see Figures 1 and 2). The treadle pump can lift five to seven cubic meters (5-7 Mm³) of water per hour from wells and boreholes up to seven meters deep, as well as from surface water sources such as lakes and rivers. There are two types: those that lift water from a lower level to the height of the pump, commonly called *suction pumps*; and those that lift water both from a lower level and propel it to a height greater than the height of the pump, known as *pressure pumps*. In most forms, water is pumped by two direct-displacement pistons, which are operated alternately by the stepping motion of the user³. The treadle pump has an important advantage over motorized pumps for irrigation of agricultural land of less than one hectare: it is considerably less expensive to purchase and operate, needing no fuel and only limited maintenance.

The treadle pump also possesses a number of features which sets it apart from other non-motorized irrigation pumps.

- First, its water lifting capacity of five to seven cubic meters per hour meets the irrigation requirements of most African farmers, who cultivate less than one hectare of land.
- Second, because a well-designed treadle pump employs the user's body weight and leg muscles in a comfortable walking motion, use of the pump can be sustained for extended periods of time without excessive fatigue. The treadle

¹ The IWMI 2006 regional study produced a CD with many references and sources included, and is available from IWMI’s Southern Africa Regional Office in Pretoria.

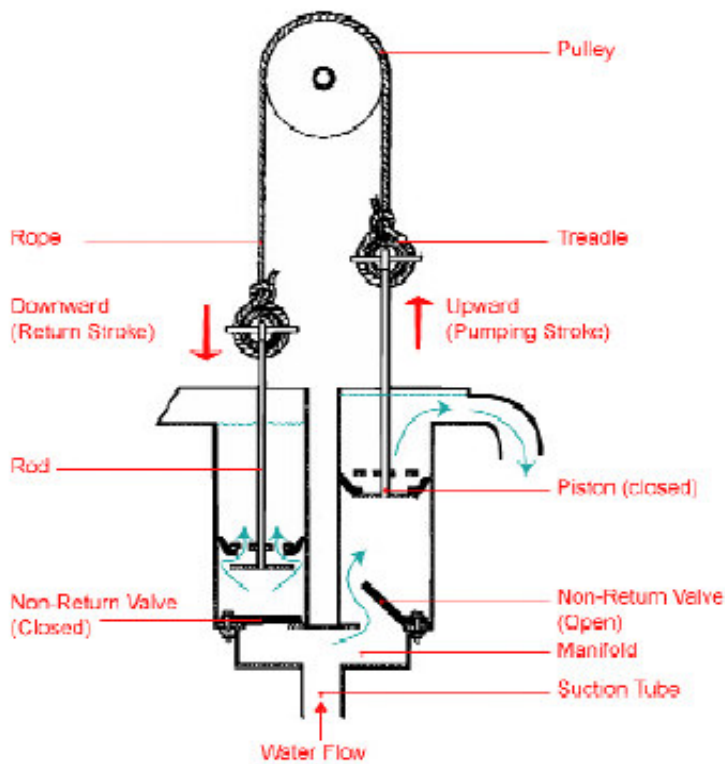
² See IDE’s website (www.ideorg.org) for various reports on cases in Asia, Africa and Latin America.

³ Kickstart has recently begun marketing a low-cost single-piston model (www.kickstart.org).

pump is much less tiring than other manual pumps that utilize the upper body and relatively weak arm muscles.

- Third, the treadle pump can be manufactured locally; experience in West Africa has shown it can be fabricated entirely from locally-available materials and by using welding equipment and simple hand tools in the metal workshops commonly found in Africa. Otherwise, small scale machine shops do manufacture them in modest quantities in several southern and eastern African countries. However, unlike South Asia for example, they are not widely available.

Figure 1. Treadle pump operating principles



Source: Kay and Brabben (2000: 11; Figure 1).

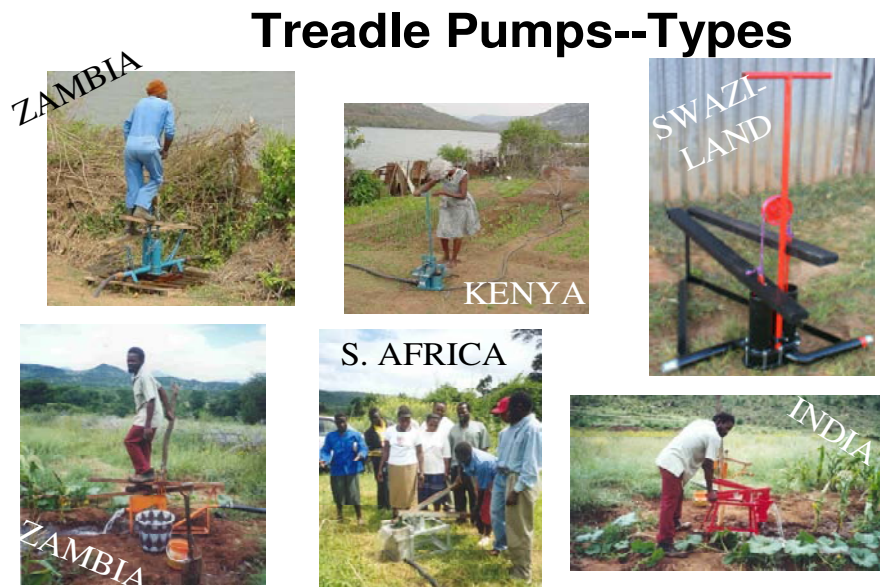
Observations in Zambia and Malawi suggest that the large areas of inland wetlands, *dambos*, are an especially appropriate context for treadle pumps because water is relatively close to the surface. However, a major problem in Africa has been the relatively high costs of treadle pumps compared to India: retail prices for standard treadle pumps vary regionally from US \$65-85 (Tanzania) to nearly \$300 (Lesotho); the average is over \$100 in the SADC region⁴. This is roughly three times the Indian retail price for the same model. In the present study, Sullivan (2008b) reports a cost of US\$ 220 in

⁴ Adeoti et al. (2007) report prices ranging from \$70-\$240 in West Africa depending on the model.

Zambia—more than double the SADC average and 2.5-3.5 times the Tanzanian price. In a few countries including Zimbabwe and Ghana, cultural factors are mentioned—the elevated pump makes women uncomfortable to use it, and some engineers and planners consider human-powered pumps that require hard physical labor to be “immoral.” However, in parts of Malawi and in Zambia this was reported as a non-issue (though it did emerge as an issue in our Zambia study)⁵ (IWMI 2006).

In Malawi, Mangisoni (2006) reports on a systematic comparison of treadle pump adopters and non-adopters using a sample drawn in two districts. The results are summarized in Box 2. They demonstrate a substantial impact in terms of improved incomes and food security, reduced poverty, and a higher level of resilience by adopters, i.e., they are far less likely to fall back into poverty. Overall, an equal number of adopters were male and female, but there was a significant difference between the more urbanized Blantyre District and the more rural and traditional Mchinji District: in the former, 83% of the adopters were women while in Mchinji only 21% were women. All members of the family in both districts participate in pumping, and the resistance among women for cultural reasons is said to be fading. Using a similar methodology of comparing adopters and non-adopters, Adeoti et al. (2007) report comparable positive findings on treadle pump impacts in Ghana and other West African countries. This study has adopted the same quantitative approach as that used by the Malawi study to assessing poverty impacts. There is evidence from Tanzania showing not only substantial improvements in household incomes as a result of using treadle pumps, but discernible impacts on GDP growth (Box 3).

Figure 2. Illustration of treadle pumps



⁵ In Kenya, KickStart responded to this issue by redesigning its MoneyMaker pump to be lower.

IWMI (2006:37-38) concludes that the successful programs to promote treadle pumps have paid considerable attention to the manufacture, sales, and after-sales service of treadle pumps, and to training farmers in their use. It is quite likely that the additional attention to helping farmers link effectively to output markets as advocated by Paul Polok further enhances their positive economic impacts. Providing packages that combine treadle pumps with water-efficient application technologies such as low-cost drip systems can further enhance the returns, especially where either water is scarce, or labor shortage limits the capacity to pump.

Box 2. Results of treadle pump impact assessment in Malawi

The Malawi Government has intensified the use of treadle pumps to increase agricultural production and enrich the livelihoods of resource-poor farmers. The treadle pump as a result is gaining popularity among smallholder farmers throughout the country. This study was conducted in two purposively selected districts: Blantyre in the Southern Region and Mchinji in the Central Region of Malawi. A total of 50 treadle pump and 50 non-treadle pump farmers (who use buckets to irrigate) were interviewed in each district to assess the impact of the treadle pump on food security and poverty. Secondary data sources, e.g., from organizations involved in treadle pump distribution and dissemination as well as major suppliers and manufacturers of treadle pumps, were also used to understand the level of adoption.

The results showed that maize, beans, tomatoes, onion and leaf vegetables are the key crops grown using treadle pumps. Economic analysis using gross margin analysis showed that treadle pump adopters had significantly higher Net Farm Incomes (NFI) as well as NFIs/ha for both irrigated and rain fed production than non-adopters. The treadle pump adopters also reported a number of material gains realized during the period of adoption such as food security, building good houses, payment of school fees and graduation from taking loans from neighbors. The adopters also created employment for fellow villagers and owned livestock, working tools and ox-carts for transportation.

Well-being measurements and analyses of poverty revealed more serious poverty levels among non-adopters compared to adopters. The non-adopters also had a greater relative risk of falling into deeper poverty than adopters. Transition matrices depicting movement in and out of poverty showed that from 2004 to 2005, some poor adopters moved out of poverty while some non-adopters dropped from being non-poor to being poor. No adopter moved from non-poor to poor.

These analyses demonstrate that the treadle pump is a key to generation of income, reduction of poverty and maintenance of food security among smallholder farmers in Malawi. To fully realize this potential, some constraints to the dissemination of the treadle pump such as water shortage; relatively high treadle pump and spare parts prices; lack of capital for manufacturing the treadle pumps; and lack of well-organized markets, need to be resolved.

Source: Mangisoni 2006.

Box 3. Treadle pumps in Tanzania: Kickstart's experiences

In Tanzania, KickStart has successfully introduced its various "Money Maker" brand treadle pumps. After five years, and building on its experiences in Kenya, it has managed to achieve the following:

1. One manufacturer – Karam Engineering
2. Eight wholesalers
3. Forty nine retailers
4. 650 - Money Maker plus pumps sold
5. 10,216 - Super Money Maker Plus pumps sold
6. 461 - Money Maker hand pumps sold.

The returns to treadle pump investments are reported to be very high: for every dollar KickStart receives in outside support it generates over \$19.00 in economic growth and higher food security. Net annual incomes in many cases increase ten-fold, from \$120 to \$1,200 through irrigation of highly profitable fruits and vegetables. Farmers are using their higher incomes to improve the well-being of their families. Regassa Namara, using as a source an internal KickStart report dated 2003, reports household incomes in a sample of 64 households increased from \$621 to \$1,800 per treadle pump two years after adoption. Further, although KickStart had not specifically targeted poor farmers—and indeed expected early adopters to be better-off farmers— 80% of adopters had previously been living on less than a dollar a day. The very poor were able to adopt treadle pumps because of the rapid pay-back. KickStart's survey also showed that even though most pumps were initially sold to men (95%), over a period of a year, women increasingly took over as pump managers.

On its website (www.kickstart.org/tech/pumps) as of April 2006, KickStart claims to have sold 45,000 pumps in East Africa (including a few in Mali), creating 29,000 new waged jobs and generating \$37 million in new profits and wages. More than half these pumps are said to be managed by women entrepreneurs. More recently the web site says \$52 million a year in new profits and wages is being generated, equivalent to 0.6% of Kenya's GDP and 0.25% of Tanzania's (www.kickstart.org/home accessed 2007/10/22).

Sources: IWMI 2006: 34-35; www.kickstart.org.

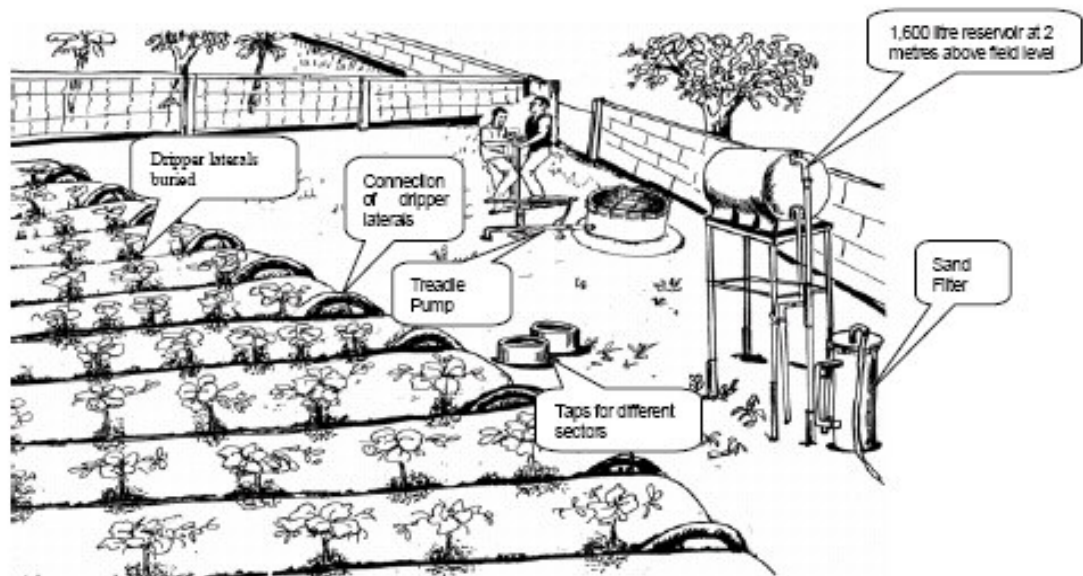
3.2 Drip irrigation kits

Drip irrigation enables the farmer to make productive use of limited amounts of water and fertilizer. It allows precise application of small amounts of water directly to the root zone, and reduces losses from evaporation, weeds, runoff and percolation. Drip irrigation is popularly viewed as one of the most water efficient types of irrigation, but in large areas in southern Africa the soils are not suitable for drip irrigation, notably coarse sands and severely crusting soils. Conventional drip irrigation systems typically cost US\$ 5,000–10,000 per hectare or more installed, in East and Southern Africa. There are cases of successful adoption in South Africa, Lesotho, Swaziland, and elsewhere by commercial farmers (IWMI 2006).

Recent advances have introduced some adaptations that make drip irrigation accessible to small-scale farmers. Simple drip irrigation systems are now available which would cost a farmer US\$ 15 to cover 15 m², or US\$ 200–400 for a bigger system covering 500 m² (Sijali, 2001; Sijali and Okumu 2002, 2003). Low-cost bucket and drum drip kits are designed specifically for poor farmers. The reader is referred to Sijali's excellent

handbook (2001), with diagrams of layouts and functions of virtually every type of bucket and drum drip kit available in Eastern and Southern Africa. Figure 3 illustrates a drum and drip kit linked to a treadle pump.

Figure 3. Layout of small-scale drum and drip irrigation system



Source: van Leeuwen (2002: figure 1).

While there are numerous individual farmers in Africa who have benefited from low-cost bucket and drum drip kits, IWMI (2006) found no evidence of successful implementation on a larger scale in southern Africa. This is in contrast to South Asia, where there has been considerable success, both in terms of market-driven systems aimed at relatively better-off farmers, and in some limited cases, in terms of targeting poor farmers. According to recent assessments, IDE's drip irrigation programs in India have tended to benefit better-off farmers, but in Nepal, poor women farmers have been the major beneficiaries (Namara et al. 2005; Shah and Keller 2002). As discussed in the next section, the literature on Zimbabwe's experiences with drip irrigation kits does not paint a very positive picture.

4. Drip Irrigation Kits in Zimbabwe

4.1 Review of literature

Zimbabwe's experiences with drip irrigation kits, especially those distributed as part of drought relief programs, are relatively well documented (for example ITC et al. 2003; Maisiri et al. 2005; Moyo et al. 2006; Rohrbach et al. 2006; IWMI 2006). A technical comparison of the performance of low-cost drip irrigation compared to conventional

surface irrigation of English giant rape (*Brassica napus*) showed that while drip irrigation did achieve water saving of over 50%, there were no yield differences or labor advantages as farmers were manually filling the drip drums—a finding confirmed by Rohrbach et al. (2006) (this problem can be addressed by combining drum and drip kits with treadle pumps). Further, since the water pricing policy was in terms of area irrigated not water consumption, the water savings brought no direct benefit to the farmers (Maisiri et al. 2005). Moyo et al. (2006) assessed drip kit programs implemented by several NGOs and also concluded they are under-performing because a number of pre-conditions were not met – most importantly, reliable access to a water source. They found poor targeting of vulnerable households, and lower intensity of use than expected. While 86% of households produced at least two harvests and 51% three harvests, only 2% produced the planned five harvests over two years. Their main finding was that low-cost drip irrigation kits distributed as part of short term relief programs are not sustainable. ITC et al. (2003) evaluated bucket and drum drip irrigation kits in a study that included eastern and western India as well as Zimbabwe, and concluded that in the present macro-economic conditions in Zimbabwe, farmers’ benefits tend to be minimal while costs are beyond their means.

In 2006, ICRISAT and the University of Zimbabwe carried out the most comprehensive assessment of relief-oriented drip irrigation kit programs in Zimbabwe to date (Rohrbach et al. 2006). They reported that about 70,000 kits had been distributed by various NGOs and other entities, supported by several different donors. The core of the study was based on interviews and observations of 232 beneficiaries and 135 non-beneficiary neighbors using alternative watering technologies (mostly watering cans). They found that while NGOs attempted to target the most vulnerable households, and most beneficiary households were indeed ‘vulnerable’ by various criteria, the same was also true for the non-beneficiaries. The key finding was that the use of drip irrigation kits was not sustained: the kits were often tried and used for a season or so but were abandoned as time progressed. For example, after two years only 25% and after three years only 8% were using the kits. There was no variation in rates of use between ‘dry’ and ‘wet’ regions. A finding that was not anticipated was that most farmers were supplementing the drip irrigation of crops with hand-watering, defeating the main technical advantage of drip irrigation. Insufficient training and lack of continuing technical backup were important reasons for the ‘failure.’ Supporting Moyo et al. (2006), the main conclusion was that drip irrigation kits distributed as part of short-term relief programs have no significant impact on households’ viability and food security. Rohrbach et al. (2006:61, bold in original) conclude that

“the promotion of drip irrigation is generally not suitable as a component of humanitarian assistance programs. If the primary aim is to improve household nutrition, higher returns may be obtained from efforts to improve the productivity of vegetable production per se, for example, with improved seeds and fertilizer. Where water is most limiting, investments are warranted in developing supplies for the wide range of household uses.”

4.2 The OFDA-supported drip irrigation program

From 2003 to 2005, USAID/OFDA supported two related drip irrigation programs as part of a larger effort to respond to a drought-induced food security crisis. The major drip kit investment was through an American consulting firm, DAI, which dispersed USAID funds through its on-going program, *Linkages for the Economic Advancement of the Disadvantaged* (LEAD) *Household Nutrition Garden* (HNG). LEAD is now an indigenous NGO registered as a trust in Zimbabwe, and using other funds has apparently continued its work on household gardens and introduction of drip irrigation kits for irrigating vegetables. DAI (2004) reports that over 23,000 drip kits were distributed during the period under review (16,000 funded by OFDA). LEAD distributed the 16,000 drip kits funded by OFDA through some 40 different NGOs as part of an intensive household garden project. The final report says that the HNG program exceeded most of its targets (in part because it attracted other funding to complement that provided by OFDA), in terms of number of kits distributed, average annual household vegetable production and income, and capacity building (DAI 2004). It acknowledges that water savings were difficult to measure as there was no adequate baseline, but claims many households mentioned labor saving as a result of drip irrigation. The report also claims that LEAD's success "has put the small-drip garden squarely into the agro-recovery agenda of Zimbabwe" (p.7) as other donors picked this approach up. However, the research reports cited in the previous sub-section suggest this may not have been as positive a development as LEAD had hoped.

The other program using an OFDA grant was managed by Catholic Relief Services Zimbabwe (CRS-Z): the Emergency Nutrition and Drought Recovery Assistance (ENDRA) Project. This Project operated in two phases from 2002 to 2004 to feed malnourished people, and manage a seed fair and voucher program as a way of providing agricultural production inputs to poor farmers. Phase II rehabilitated 20 hospital vegetable gardens—benefiting 200 needy HIV/AIDS-affected households as well as hospital patients—using drip irrigation on a total of 22,067 m² and another 2,000 m² in local communities (CRS-Z 2005). Eighteen hospital gardens were rehabilitated and functioning well. LEAD provided technical advice to this program.

4.3 Findings from qualitative assessment

4.3.1 DAI/LEAD/ORAP Program

The qualitative assessment focused largely on Gweru District where the Organization of Rural Associations for Progress (ORAP), an indigenous NGO, distributed 618 drip kits under the LEAD HNG program (Sullivan 2008a). ORAP is a membership-based indigenous NGO with a hierarchical structure. Its criteria for selecting beneficiary households of the program were clear and well-known, though not always followed to the letter: beneficiaries had to be members of ORAP (as demonstrated by payment of a one-time membership fee of about Z\$ 60,000 at the time of the program, as well as payment of a monthly subscription, reported by Mugabe et al. [2008] to be Z\$ 6000), had to have water available, an able-bodied person, a history of gardening, and some provision for including vulnerable populations, though how this was operationalized is not clear. Sullivan reports a number of technical issues arose though these were apparently not serious; but a fundamental issue also reported by Rohrbach et al. (2006) is over-watering

as farmers were not convinced drip irrigation provides sufficient water. The ORAP Association Secretary estimates that only 40 out of the 400 kits distributed in her area are still in use three to four years after distribution, a similar finding to Rohrbach et al. (2006) and Moyo et al. (2006). Mugabe et al. (2008) point out this may to some extent reflect the useful life of these kits.

Based on interviews with people who had been involved in the OFDA-funded program, the following issues emerged:

- Administration problems and serious delays as a result of staff turnover and reduction at the USAID/Zimbabwe Mission and long periods required to negotiate contracts with partners;
- Because of the political situation in Zimbabwe, the program took a short-term perspective in which drip kit distribution became an end in itself rather than a means to achieving sustainable development;
- According to the agreed measures of success (e.g., number of kits distributed, average production, average income, training), the project was a “success.” However, there are questions as to whether these measure impacts in a meaningful manner, and some farmers and ORAP members suggested that distribution of free kits with no contribution by the recipients sets a bad precedent (this in an area where years of donor-funded NGO programs have led to high expectations for free aid);
- There are questions regarding the appropriateness of the technology, as it is not simple and requires a reasonable level of technical competence and understanding by users—a level that may often exceed the capacity of stressed households. At a minimum, drip kits need to be matched with households who have the capacity to take advantage of them. Further, respondents stressed the need to assist farmers with other aspects of garden production including soil fertility, crop husbandry, marketing etc. – a major conclusion reached by the ICRISAT study as well (Rohrbach et al. 2006). Several respondents also questioned the appropriateness of the vegetable seed packets distributed with the kits;
- Targeting emerges as a difficult issue. On the one hand, it is clear that ORAP’s prerequisites, such as payment of membership dues, exclude the really poor and needy households. Indeed, Rohrbach et al. (2006) and Moyo et al. (2006) also found that NGOs were generally not successful at reaching the target households intended by donors. On the other hand, it is doubtful whether the truly poor and needy households can make good use of drip irrigation kits. They may not have the technical competence needed, and as other studies have found, may not have sufficient labor: lifting cans of water to fill the elevated central drum may be beyond the capacity of the very young and very old, and the sick. There is an underlying “one-size-fits-all” assumption that is not valid—not all rural households have the water availability, capacity, interest, etc. required to make good use of drip irrigation kits. Finally, there is no evidence that implementing agencies made an effort to target women, either as household heads, or as members of households headed by males where they play a key role in gardening (see below for further discussion).

4.3.2 CRS/LEAD hospital gardens

LEAD provided technical support to Catholic Relief Services (CRS) for rehabilitation of about 20 hospital “institutional” gardens through drip irrigation, using OFDA funding. CRS reported at the end of the project that 20 hospitals had functional vegetable gardens using drip irrigation, covering a total area of 22,067 m², and another 2,000 m² was under drip irrigation in surrounding communities. HIV/AIDS-affected households as well as hospital staff and patients were benefiting and some hospitals were selling vegetables for income. Although we were unable to verify the results systematically, this model has important advantages and seems worth supporting.

4.4 Adoption and impact of drip irrigation kits: Findings from quantitative survey

4.4.1 Approach

The MSU/Gweru team interviewed 105 households in each of two districts, Gweru and Bikita, where 618 and 400 drip kits, respectively, had been distributed (Mugabe et al. 2008). Of these, in each district the team drew a sample of about 35 drip kit adopters, 35 who never received a drip kit (“non-adopters”), and 35 who had received one but stopped using it (“dis-adopters”). While ORAP was the implementing agency under contract with LEAD in Gweru, an NGO called Family Aids Counseling Trust (FACT) was the implementing agency in Bikita. The two NGOs used different beneficiary selection criteria and different approaches to extension and training. ORAP’s beneficiaries were paying members, but FACT insisted on choosing households with able-bodied people and having a reliable water source. In Gweru, extension and training followed a farmer-to-farmer approach with limited agency involvement; in Bikita, FACT provided more direct technical support. Gweru District is 1255 m above sea level and mean annual rainfall is 852 mm; Bikita is at 986 m and mean annual rainfall is lower at 750 mm. The analysis focused on returns from sale and consumption of vegetables and costs incurred in the garden, termed Net Garden Income (NGI). The cost of the drip kit was not included as these were donated and for comparison of adopters and non-adopters the cost of the bucket—used by both categories—was also excluded. Profitability was also assessed using NGI on a per hectare basis to enable comparison. Assessment of impact of drip kits on poverty and household well-being was done using the head count index, depth of poverty, poverty severity index, and relative risk of poverty. These methodologies are briefly explained in Appendix 2. Further details are provided by Mugabe et al. (2008); the next section summarizes the most salient findings.

4.4.2 Main results

It is notable that although some interesting patterns emerge, for much of the descriptive statistics, no statistically significant differences were found among adopters, non-adopters, and dis-adopters, or between the two districts. Households formally headed by women constituted 34-42% of households under the three categories, but less information was captured on who within households was using the kits. Mugabe et al. (2008) claim that decisions on the use of drip kits are in any case made largely by the male household head and not the woman (wife). This is said to have a cultural basis, where the patriarchal set up favors male authority. Even the extension workers’ and NGO officers’ lists were

such that they first approached males in the households. It was only when they discover that the males are absent that they then put women on the list. Therefore, it is only in the case of divorce, migrant husband or widowhood that the female becomes head of the household and is allocated a drip irrigation kit where she could then make decisions regarding its use. Otherwise, in the full presence of the male head, it is not possible for the woman to be allocated a drip kit and then go on making decisions pertaining to its use—a pattern Mugabe et al. (2008) attribute in part to males wishing to maintain control over household interactions with the outside world⁶.

Approximately 70-84% of all household heads interviewed in both districts could read and write the local language. Hardly any household heads rated themselves as “very poor,” perhaps understandably (just 1 respondent in Bikita claimed to be very poor), while over 60% of adopters, dis-adopters and non-adopters rated their living standard as “medium” and just a few claimed to be “rich.” The balance claimed to be “poor”—nearly 35% of non-adopters but only 24.5% of dis-adopters and 29% of adopters (these differences are not significant statistically).

Both ORAP and FACT provided training covering aspects of drip kit installation and maintenance as well as soil fertility management, low-cost crop protection, and basic record keeping. ORAP trained all drip kit recipients and farmer leaders who in turn were to train and provide technical support to other farmers, while FACT apparently provided more direct training and support. Nearly all adopters and dis-adopters found the training ‘very useful’ or ‘useful’ with no statistical differences between the two categories. Although the OFDA-LEAD support ran for only 6-12 months, both NGOs continued to provide technical support after the funding ended; the researchers suggest this is why the dis-adoption rate is lower than reported in other districts⁷.

Three types of drip kit were distributed, Plastro, IDE, and Netafim. Although the IDE kit was dis-adopted more often than others, there are no statistically significant differences on this score. Why did some people stop using their drip kits? Table 1 provides an overview of the reasons given. The reasons vary among the three types; except for the observation that Netafim was the only type abandoned because of lack of spare parts, it is difficult to draw conclusions from the other reasons given regarding the three types of kit. Clearly, “lack of water” is the single most important reason given, suggesting that the two NGOs failed to apply the water availability criterion effectively – a finding of other studies as well (e.g., Rohrbach et al. 2006).

⁶ These points however do not fully capture the internal household dynamics, where one would expect considerable variation in terms of the roles of women in household garden management; and they do illustrate, unintentionally, the profoundly male-biased mind sets of government and NGO officials.

⁷ However, the sampling method used makes it difficult to specify the drop-out rate. The comment of the ORAP Association Secretary, above, suggests it is as high as elsewhere.

Table 1. Reasons for dis-adopters discontinuing drip irrigation for different types of kits in Gweru District

	Plastro (%)	IDE (%)	Netafim (%)
Lack of water	25	44	60
Labour shortages	0	0	0
Lack of inputs	25	0	20
Health problems	50	22.2	0
Drip kit eaten by rodents	0	11.1	0
Lack of spare parts	0	0	20
Old age	0	11.1	0

Source: Mugabe et al. (2008:Table 3.8).

Assessing the impacts, if any, of drip irrigation kits on food security has proven difficult in this study. All those included in the sample, whether adopters or not, have household gardens, and most have other sources of income or food (for example dry land fields) as well. Income from dry land agriculture is similar for both adopters and non-adopters in the two districts (Table 2), and dry land cultivation is contributing more income than garden irrigation for both adopters and non-adopters. For adopters, garden irrigation contributed 8% and 26% of the Net Farm Income (NFI) respectively in Gweru and Bikita Districts. Garden irrigation contributed 20% and 4% of the NFI for non-adopters in Gweru and Bikita respectively. Research carried out in Chivi shows that garden irrigation contributes about 20% of the NFI in the smallholder sector (Mugabe 2006). In Gweru District, non-adopters get a great deal more income from gardens than adopters (2.5 times as much), but in Bikita this is reversed—adopters get seven times as much income from gardens as non-adopters. This is because in Gweru non-adopters have gardens that are 14 times as large as adopters⁸ (making per ha productivity for adopters higher than for non-adopters); in Bikita, adopters’ gardens are twice as large as non-adopters’ but have far higher productivity, possibly at least in part because of the drip kits⁹.

Table 2. Comparison of income generation from dry land agriculture and irrigated gardens

District	Land type	Adopters	Non-adopters
Gweru	Dryland	Z\$10 939 267	Z\$11 378 976
	Irrigated	Z\$918 666	Z\$2 316 771
Bikita	Dryland	Z\$9 093 968	Z\$8 168 997
	Irrigated	Z\$2 369 530	Z\$321 950
Total	Dryland	Z\$10 029 256	Z\$9 839 945
	Irrigated	Z\$1 563 338	Z\$1 348 825

Source: Based on Mugabe et al. 2008: Table 3.13.

Twice as many adopters as dis-adopters and non-adopters claim they have seen “very great improvements” in their living standards—but the figures are small at 12% versus 5-

⁸ Although not stated, it is likely they also have adequate water supplies.

⁹ We did not anticipate this difference in size of holding; and the sample is not large enough to hold land size constant and obtain meaningful results.

7%, respectively. More dis-adopters (50%) perceive “some improvement” than adopters (44%) and non-adopters (38%); similarly fewer adopters feel their living standards are worse than is the case for the other categories—but none of these differences are statistically significant. Before the introduction of the drip irrigation program, more adopters (62%) than dis-adopters (48%) say they had enough food, but the differences are again not statistically significant.

The team asked adopters and dis-adopters about changes in their lives after the drip kit program; the results are shown in Table 3. Regarding the question on whether they “had enough food”, nearly 71% of adopters said yes compared to 46% of dis-adopters – this appears substantial but again the difference is not statistically significant. Twice as many dis-adopters (33%) as adopters (17%) said they are better able to pay fees now than before. This also looks substantial though counter-intuitive, but is not statistically significant. Twice as many Gweru adopters (83%) claim to have enough food now as is the case in Bikita (48%), suggesting they have benefited more—but again, the opposite pattern is found for ability to pay fees between the two districts. Further, nearly the same percentage of dis-adopters claim to have enough food as adopters in Bikita (46% compared to 48%). Both adopters and dis-adopters claim there has been improvement in their food security since before the drip irrigation program was introduced. In sum, we are unable to confirm any significant impact of drip irrigation kits on food security and well-being in our sample.

The study attempted to compare the mean net benefits accruing to the use of drip irrigation compared to use of buckets to irrigate gardens using Net Garden Income (NGI) and not Net Farm Income because the latter would include dry land agriculture and other sources, distorting the result (Table 4). But this analysis was confounded because in Gweru (but not Bikita) non-adopters had 14 times bigger garden sizes than adopters—a highly significant difference. Overall, mean NGI was also significantly higher among Gweru non-adopters but in Bikita, adopters’ income was significantly higher (both at 0.1). On a per hectare basis for the entire sample but not for either district individually, adopters had significantly (0.1) higher income than non-adopters—four times as high. Bikita adopters had higher returns than in Gweru. In sum, we cannot say conclusively that drip kits had a large impact on poverty, but at the least we can say the results demonstrate the potential impacts on productivity and income if other conditions (see Appendix 4) are in place.

Table 3. Changes brought in lives of adopters and dis-adopters by use of drip irrigation kits in Gweru and Bikita Districts

	Lower Gweru District			Bikita District			Total		
	Adopter	Dis-Adopter	*p-value	Adopter	Dis-adopter	*-p-value	Adopter	Dis-adopter	*-p-value
Have enough food	83.4	63.6	0.1093	48.0	46.2	0.4801	70.9	52.2	0.0594
Pay fees	11.1	22.7	0.3264	24.1	38.5	0.2611	16.7	32.6	0.1635
Can do other chores while irrigating	0.0	4.5	0.4168	0.0	0.0	0.5000	0.0	2.2	0.4404
Bought livestock	2.8	4.5	0.4721	16.7	3.8	0.3707	9.6	4.3	0.1357
More crops area grown	0	4.5	0.4168	2.8	0.0	0.4364	0.0	2.2	0.4404
Can hire and pay casual labor	2.4	0.0	0.4364	2.8	0.0	0.4364	0.0	0	0.5000
No change	0.0	0.0	0.5000	2.8	11.5	0.3974	1.4	6.5	0.4602
Bought household items	0.0	0.0	0.5000	2.8	0.0	0.4364	1.4	0.0	0.1210
Started own business	0.0	0.0	0.5000	2.8	0.0	0.4364	0.0	0.0	0.5000
Total	100	100		100	100		100	100	
N	36	22		36	26		72	48	

*If p-value is less than 1%, reject the null hypothesis (Edriss, 2003)

Source: Mugabe et al. 2008: Table 3.11.

No trend is observed either overall or for either district, for the poverty and well-being measures we used (Table 5). The head count index shows the percentage of people whose income falls below the consumption poverty line (270 kg/person/year)—no clear patterns emerge. The poverty gap measures how far a household is placed from the consumption poverty line (270 kg/person/year) and is nearly the same for adopters and non-adopters. But non-adopters are better off—indeed in Bikita, non-adopters have a surplus of food. The poverty severity index, which measures the extent of inequality among the poor by putting greater weight on the poorest, is considerably higher for adopters than dis-adopters and non-adopters. Mugabe et al. (2008) note this may be because of the relatively low contribution of gardening to household income in all cases.

Table 4. Mean net garden incomes of irrigation drip adopters and non-adopters in Gweru and Bikita Districts

	Gweru		Bikita		Total	
	Adopters	Non-adopters	Adopters	Non-adopters	Adopters	Non-adopters
Land area (ha)	0.015	0.218***	0.026	0.05	0.021	0.144***
Mean NGI Z\$ and (US\$)	918 666 (31)	2 316 771* (77)	2 369 530** (79)	321 950 (11)	1 722 222 (57)	1 458 496 (49)
Mean NGI/ha Z\$ and (US\$)	58 470 581 (1949)	46 470 581 (1549)	186 721 491 (6224)	16 717 386 (557)	129 501 854* (4317)	33 455 487 (1115)
<i>t</i> -land area	-2.92		-1.62		-3.07	
<i>t</i> -NGI	-1.57		2.07		0.90	
<i>t</i> -NGI / ha	0.33		1.65		3.23	

*** = significant at 0.01; ** = significant at 0.05; * = significant at 0.1

An average parallel market exchange rate for 2005 and 2006 of US\$1= Z\$30 000 has been used.

Source: Mugabe et al. 2008: Table 3.12.

Table 5. Poverty index by type of farmer in Gweru and Bikita Districts

District	Type of farmer	Head count	Poverty gap	Poverty severity
Gweru	Adopters	42.9	19.8	23.8
	Dis-adopters	51.6	19.4	8.8
	Non-adopters	35.1	6.6	9.7
Bikita	Adopters	51.7	12.4	11.9
	Dis-adopters	43.3	13.4	4.9
	Non-adopters	51.4	-5.7	7.0

Source: Mugabe et al. 2008: Table 3.14. See Appendix 2 for explanations of the indices.

Crop failure and ‘drought,’ i.e., insufficient water availability, are the two main reasons given by both adopters and non-adopters for drip irrigation not paying dividends. The percentages are higher for dis-adopters but not significantly so. Nevertheless, lack of water was the most commonly cited reason for discontinuation in both districts (45-54%). Similarly more dis-adopters complained about the design and operation of kits, including clogging (50% for both adopters and dis-adopters), servicing, breakdowns, drum too small, too labor intensive, and area covered is too small. The relatively high number of such critical responses among both adopters and dis-adopters suggests that there are serious drawbacks to the “one-size-fits-all” approach used by donor-funded NGOs; if farmers could choose the type and size of their drip kit and drum, these problems would be reduced. Old and ill beneficiaries are the ones most likely to complain about labor, perhaps because they cannot lift buckets of water to fill the drums. High percentages of both adopters and non-adopters (78% and 65% respectively) agreed that non-availability of spare parts is a big problem, attributed to hyperinflation.

The two most common arguments for drip irrigation are that it saves water and saves labor. Only about a third of respondents agreed drip irrigation saves water, but 40% of

adopters and 56% of non-adopters agreed it saves labor (differences not statistically significant).

4.5 Conclusions: Zimbabwe drip irrigation kit experiences

The results are broadly consistent with the findings of previous research on drip irrigation kits in Zimbabwe (Rohrbach et al. 2006; ITC et al. 2003; Maisiri et al. 2005; Moyo et al. 2006) though less conclusively. It is clear that as an investment in relief for drought-stricken households, drip irrigation kits have very little impact. There are too many variables that determine how effectively households can use them, and the necessary conditions are rarely met. Further, also consistent with Rohrbach et al. (2006) and Moyo et al. (2006), local indigenous NGOs are not very effective at targeting the type of beneficiary that OFDA has in mind—and indeed if they were, the results may be even less impressive because the poorest, most vulnerable households may have the least capacity to use drip irrigation kits. On the other hand, it is also clear that many households can indeed make good use of drip irrigation to improve their productivity and incomes, given the right conditions. These include having sufficient labor and competence, water availability, access to spare parts and technical support, good land and crop management, and access to output markets. This and other studies therefore confirm the conclusion in IWMI (2006) that drip irrigation kits are a promising technology for long-term development, but we also confirm the conclusion of the ICRISAT study that **“the promotion of drip irrigation is generally not suitable as a component of humanitarian assistance programs”** (Rohrbach et al. 2006:61, bold in original).

5. Treadle Pumps in Zambia

5.1 Review of literature

There seems to be little academic research on Zambia’s experiences with treadle pumps. In a survey carried out for IWMI, Daka (2006) reports a “belief” that about 5,000 treadle pumps¹⁰ had been sold in Zambia to date (2005) at prices ranging from US\$ 50-100; and he reports examples of very high returns for farmers. The Project Completion Report for the Smallholder Irrigation and Water Use Program (SIWUP PCR no date) reports that the promotion of ‘simple irrigation technologies’ including treadle pumps by FAO and IDE went better than other components of the project—but still rates this component “highly unsatisfactory.” However, a recent draft final program evaluation of the USAID’s Regional Center for Southern Africa-funded Smallholder Market Creation (SMC) Project by Mudenda and Hichaambwa (2006) for IDE is more positive¹¹.

5.2 The USAID-supported Smallholder Market Creation (SMC) Project

SMC was a two-year project implemented by International Development Enterprises (IDE) to assist 2,000 households to participate effectively in agricultural markets and

¹⁰ Simfukwe et al. (2008:1) suggest a figure of 2,000 pumps used by more than 5,000 households.

¹¹ The version we obtained is a draft, apparently never finalized or completed.

thereby earn additional income. It had several integrated components emphasizing not only provision of irrigation technologies, but linkages to input and output markets, training and capacity building, and provision of credit¹². The main irrigation technology was the treadle pump, but drip irrigation kits were apparently supplied in some cases. Based largely on qualitative and incomplete quantitative data, Mudenda and Hichaambwa (2006) suggest that overall the project has had a positive impact, not only in terms of promoting treadle pumps but more important, providing valuable training to farmers; helping them to establish output market linkages and gain access to credit, which in turn has resulted in higher incomes; and helping manufacturers (but see below for a more negative view). They report that even though women were not specifically targeted, they have benefited substantially, an observation echoed by Adeoti et al. (2007) for Ghana. As IWMI (2006) reports for Malawi and Tanzania, treadle pumps have many uses: not only for irrigation, but also for such purposes as domestic use, livestock watering, brick making, and even peri-urban car washes. Nevertheless, Mudenda and Hichaambwa also suggest that there were continuing weaknesses in terms of both the input supply market and farmers' ability to research and respond to output market opportunities. Among others, two issues are raised that are important for future sustainability: the potential for depletion of local water resources through over-pumping, especially in the dry season, which can lead to conflicts and crop failure; and recent large-scale imports of treadle pumps by the Zambian government which has undermined local manufacturing capacity¹³. Mudenda and Hichaambwa (2006:24-25) discuss the difficulties local manufacturers face in planning for a long term business because of lack of credit and uncertainty about the market, a view supported by Simfukwe et al. (2008; see below); but they also criticize IDE for importing pumps from India rather than encouraging local manufacture.

5.3 The OFDA-supported Small Scale Irrigation Food Security Program (FSP)

This program was funded by USAID/OFDA in 2003-2004, and implemented by the Cooperative League of the USA (CLUSA) and Washington State University (WSU) in southern Zambia (CLUSA and WSU 2004). They collaborated with a local NGO, Total Land Care (TLC), and IDE. Originally designed to be implemented in the 2003 dry season but extended to the following year, its goal was to “improve the short and long-term food security and nutrition amongst vulnerable households in the target areas.” The main objective was to increase adoption of improved small scale irrigation practices by food-insecure households. This was to be achieved by:

- Supporting 300 households grouped in irrigation clubs of 10-15 members each, to produce irrigated maize and vegetables on 45 ha (0.15 ha/household) of land during the 2003 dry-season; and
- Establishing a revolving fund for each irrigation club.

¹² This was apparently a forerunner to the current PROFIT (Mudenda and Hichaambwa 2006:30).

¹³ Mudenda and Hichaabwa (2006:27) note that although IDE had tried to engage Zambian policy makers, the government implemented a program involving imported treadle pumps without learning the lessons of SMC.

Participating farmers were trained in treadle pump maintenance and use as well as irrigation of vegetables, and groups were given training in management of groups and financial record keeping. Treadle pumps were issued on credit to individual farmers, who were to pay into a bank account managed by the group. Once 100% of the loans were repaid, the group could use the account as a revolving fund. The cost was subsidized: farmers repaid loans of \$56¹⁴ equivalent, but the total cost of the pump was \$220. The group also received an additional bonus payment for 100% repayment. Credit repayment was reported as excellent, in part because irrigation groups exerted strong peer pressure and even took back pumps from those who fell behind in payments.

The final report (CLUSA and WSU 2004) says that although food security, incomes and household assets did improve compared to non-beneficiaries, the differences were not statistically significant. Nevertheless, the report concludes that average household incomes increased substantially (about \$325) from sales of produce in one season, suggesting a positive overall impact.

5.4 OFDA support through C-SAFE

Sullivan (2008b) reports that when a national food emergency was declared in October 2005, OFDA responded with US\$ 1 million and 20,000 tons of food aid through a consortium of NGOs, “Consortium for Southern African Emergency” (C-SAFE). The advantage was that these organizations were already on the ground (implementing a water management and nutrition assessment program), and the emergency funds could be used to complement existing development programs. C-SAFE contracted with CLUSA and IDE to implement treadle pump irrigated agricultural production using their technical expertise and local knowledge, under the overall direction of CARE. Based on local level assessments, project sites and participants were selected. The criteria included water available at least 6-8 months per year, people needing assistance, and lead farmers who could be linked to families in need of technical support. Qualified participants were trained in land preparation, drip kit operation and set-up or treadle pump operation (depending on which one they received), and crop husbandry: CLUSA was responsible for crop husbandry training while IDE was responsible for water management. IDE provided the treadle pumps on credit with the balance to be paid into a revolving fund for the group’s future use; a total of 326 treadle pumps and over 200 drip kits, as well as seed starter packs were distributed.

5.5 Findings from qualitative assessment

5.5.1 Food Security Program (CLUSA/TLC/IDE)

The following points summarized from Sullivan (2008b) are based on stakeholder interviews and the final report by CLUSA and WSU (2004):

- Targeting was not always effective as some participants did not have adequate water or lacked the resources needed to fence their gardens. There is no evidence

¹⁴ Simfukwe et al. (2008) give a figure of \$70, but this probably reflects changes in exchange rates.

in project documents on gender or particularly targeting women as recipients and beneficiaries.

- IDE distributed at least three different makes of treadle pumps, some locally manufactured, which were not uniform in quality. Some recipients claimed operating the pumps was too laborious for anyone other than able-bodied males and did not always deliver adequate water, while some models were too high for women to use. Although imported pumps were generally lower cost and more consistent in terms of quality, some people noted imports took business away from local dealers¹⁵. Implementing partners appreciated the credit-based package coupled with intensive training and establishment of farmer-managed revolving funds.
- Training in group business skills and practical training in using the technology were crucial to success according to respondents. Some confusion arose among implementing partners and local authorities because communication of the project goals was insufficient.
- Some concern about sustainability was expressed: the technology is not seen as durable and replacement parts are not readily available. CLUSA provided the linkages between farmers and input and output markets by acting as a middleman in many cases, which left the farmers without these linkages when the project ended. Simfukwe et al. (2008) confirm this observation (see below). Nevertheless, CLUSA and WSU (2004:13) argue that the legacy of the program is “a skilled, experienced and well-resourced group of more than 300 irrigation farmers in Southern Province who are richer and better fed than at the start of the program.” Their report shows that participants did achieve improvements in income generation and food security which CLUSA and WSU believe will be sustained.

Simfukwe et al. (2008) interviewed several manufacturers and retailers on their experiences with treadle pumps. Retailers generally did not maintain supplies of pumps, and manufacturers complained about the lack of demand; therefore retailers often waited for IDE to supply pumps for sale, while manufacturers waited for IDE to order them. This means manufacturers and retailers are responding to NGO demand not to farmer demand. Several manufacturers indicated they have considerable capacity to manufacture them if there is demand, and the researchers also found that several had been introducing innovations to improve the performance and durability of the pumps.

5.5.2 C-SAFE (CLUSA/IDE/TLC)

The following points are summarized from Sullivan (2008b) and are based on interviews and a report by CARE:

- Coordination was complex and cumbersome among USAID/Washington, ODFA in Pretoria and the USAID Lusaka team, but the latter invested effort to make the

¹⁵ Simfukwe et al. (2008) report that smallholder farmers claimed to appreciate the local pumps more than the imported ones as they had been adapted to local conditions and “perform better”.

project a success. Lags in contracting and procurement were overcome through the existing C-SAFE network and relationships.

- Providing treadle pumps to individuals seems to be more sustainable than provision to groups created for the purpose, which often do not persist; though distribution through pre-existing groups did fare better. IDE's ability to deliver technologies based on agro-ecological assessments enabled it to provide drip kits to those with difficulties accessing water, and to give treadle pumps to people able to make good use of them. Building on C-SAFE's on-going activities – consortium members undertook the detailed assessments and identification of households – enabled more effective targeting of vulnerable households, providing treadle pumps to some and drip irrigation kits to others based on need. While 60% of trainees were reportedly women, there is no evidence on whether they constituted the majority of recipients or benefited significantly: apparently no effort was made to target women.
- The C-SAFE model of a network of partners with complementary administrative, financial, technical and human capacity for implementing multi-faceted programs combined with its relationships with state and local institutions greatly facilitated successful implementation. C-SAFE (including IDE) also learned and applied lessons from the Food Security Program.

5.6 Adoption and impact of treadle pumps: Findings from quantitative survey

5.6.1 Main characteristics of sample farmers

This section is based on Simfukwe et al. (2008), and the reader should refer to that report for more details on the methodology, sampling, and detailed findings. It is based on a sample of 200 households, 100 each from an agricultural block in Ndola Rural and another in Chongwe District. The selection of these locations was based on the level of concentration of the OFDA/CLUSA program but was influenced as well by the recent evaluation by Mudenda and Hichaambwa (2006). These two blocks represent different agro-ecological zones; Chongwe has relatively low annual rainfall (800-880 mm) and Ndola relatively high annual rainfall (1300 mm). All respondents had at least one irrigated garden; half in each block had adopted treadle pumps and half were using buckets or watering cans. As was the case for the Zimbabwe drip kit assessment, Simfukwe et al. (2008) assessed the impact of treadle pumps on poverty and household well-being using, among others, the head count index, depth of poverty, poverty severity index, and relative risk of poverty. These methodologies are briefly explained in Appendix 2.

There were no significant differences among the sub-samples in terms of education (72-85% could read and write and nearly all had been to school), marital status or labor availability; but adopters in Ndola and overall had significantly (0.01 and 0.05 respectively) more land. Over 77% of treadle pump respondents (i.e., formally “adopters”) are male, 23% female¹⁶. However, Simfukwe et al. (2008) report that based

¹⁶ CLUSA and WSU (2004: 4) report 39% of treadle pump recipients were women.

on focus group discussions and other data, 65% of treadle pump adopters in Chongwe were actually female, while in Ndola Rural the figure is 50%. Despite this observation, the actual use of the pumps (“treadling”) was mostly performed by young male household members. Simfukwe et al. (2008) attribute this pattern to concerns about the cultural appropriateness of women peddling pumps; the study found a few households where allocated pumps were rarely used because of the absence of young males. In terms of yields, production and equipment management, no differences were found between male and female users. Nevertheless, elsewhere, Simfukwe et al. (2008) report that adopters had serious complaints about the treadle pumps. By far the most common complaint in both districts (86-90%) was the physical effort required to operate the equipment¹⁷; this is likely a more salient reason for young males doing most of the treadling.

It is important to note that the sample of treadle pump users was not limited to those receiving pumps through the OFDA-supported program; over 21% had paid cash and over 14% had received their pump as a gift; over 60% took a loan (the mode used by the CLUSA-IDE program). On the other hand, only about 36% had paid the amount stated by CLUSA and WSU (2007) as the required loan repayment (\$56)—others had paid either less or more. Further, most respondents who had received their pump on a loan basis claimed they were paying interest (27% ‘less than 10%’ and 66%, a rate of 10-15%). It is likely that nearly all received pumps supported by USAID though not necessarily OFDA.

Table 6 indicates the sources of treadle pumps according to sample farmers. CLUSA and IDE together supplied just over half (over 60% in Chongwe, but fewer in Ndola Rural); the Ministry of Agriculture is overall the largest single supplier to farmers. In terms of pump ownership, Simfukwe et al. (2008: Table 14) claim that nearly two thirds are individually owned while nearly a third are group-owned. However, those classified as “group-owned” appear in fact to have been provided to individuals through the group credit scheme discussed above.

Table 6. Distribution of treadle pumps by type of supplier

Supplier	Chongwe %	Ndola Rural %	P-value	Total %
Ministry of Agriculture	11.3	38.1	0.1271	25.4
CLUSA	27.4	14.7	0.2546	23.2
Direct Purchase	14.7	9	0.3821	12.1
IDE	33	14.5	0.1635	22.7
Other	13.6	23.7	0.1379	16.6

Source: Simfukwe et al. 2008: Table 12.

Nearly three quarters of treadle pump adopters said they had received training in the use of the pumps, and three quarters of those trained said the Ministry of Agriculture had provided the training. Simfukwe et al. (2008) note that many NGOs sponsored training

¹⁷ Adeoti et al. (2007) observe this was the main complaint about the design of treadle pumps in Ghana as well.

through the Ministry and suggest this may enhance sustainability after the project is finished.

5.6.2 Main outcomes and impacts of treadle pump adoption

The study found that not only was the total land area higher among adopters than among non-adopters, but Net Farm Income (NFI) per hectare was also significantly higher (at 0.05) among adopters (Table 7). NFI per hectare of adopters was nearly three times that of non-adopters in Chongwe, and 2.4 times as high among Ndola Rural adopters. Among adopters, an average of 58% of total household NFI was produced through the use of treadle pumps (72% in Ndola Rural, 50% in Chongwe). These data suggest that treadle pumps have made major and important contributions to net farm income compared to the income of non-adopters. Given these data, it is not surprising that 80% of adopters rated the treadle pump as “very useful” and 16% as “useful.” The most important benefits cited were enhanced crop production (47%), increased income (37%) and time-saving (14%) (Simfukwe et al 2008: Tables 20-21).

Table 7. Mean Net Farm Incomes of smallholder treadle pump adopters and non-adopters

variable	Chongwe			Ndola Rural			Total		
	Adopter (%)	non-Adopter %	P-value	Adopter (%)	non-Adopter %	P-value	Adopter (%)	non-Adopter %	P-value
Land Area Owned	3.2	1.8	0.6165	2.8	1.6	0.2116	3.05	1.73	0.3150
Land Area Under Irrigation	1.1	0.32	0.0317	0.92	0.25	0.5319	1.01	0.285	0.0439
Mean NFI	ZMK 46,632,421	9,074,651	0.0174	27,151,198	6,499	0.02164	36,891,810	7,786,848	0.02912
	US\$ 11,806	2,297		6,874	1,645				
Mean NFI/HA	(ZMK) 14,572,632	5,041,473	0.0392	9,696,856	4,061,903	0.0423	12,134,781	4,532,581	0.0472
	(US\$) 3,689	1,276		2,455	1,028		3,072	1,147	
	t-value=1.98			t-value=4.01			t-value=5.31		

ZMK3,950 = US\$1.00. Source: Simfukwe et al. 2008: Table 18.

The study attempted to understand the impact of treadle pump adoption on household food security, defined as the household having sufficient food to last until the next harvest (approximately 270 kg maize per capita; see Mangisoni 2006). Over two thirds of adopters reported they had been food-insecure before they adopted the pump (65% in Chongwe, 71% in Ndola Rural). Table 8 shows the distribution of adopters’ and non-adopters’ food security status at the time of the study (July 2007). The percentage of adopters who had achieved food security is dramatically higher than the pre-adoption case (basically, doubled), and the proportion of adopters who are food secure is higher than is the case for non-adopters in both districts—though the differences are not statistically significant.

Table 8. Distribution of adopters and non-adopters by current food security status

Current Food Security Status	Chongwe			Ndola Rural			Total		
	Adopter (%)	non-Adopter %	p-value	Adopter (%)	non-Adopter %	P-value	Adopter (%)	non-Adopter %	P-value
Food Secure	67	56	0.1788	54	37	0.1423	60.5	46.5	0.0918
Food Insecure	33	44	0.2643	46	63	0.0968	39.5	53.5	0.1020
Total	100	100		100	100		100	100	
N	47	50		48	50		95	100	

Source: Simfukwe et al. 2008: Table 24.

The study found no significant difference between adopters and non-adopters in terms of household assets such as housing, livestock, radio, bicycle, etc. However, several measures of poverty did uncover significant differences between treadle pump adopters and non-adopters. As Table 9 shows, the head count poverty index shows that non-adopters in both districts had significantly higher (0.1) levels of poverty than adopters (but there remain very high overall levels of poverty). The poverty gap index measures households' distance below the consumption poverty line (set at 270 kg/year/per person of maize for the purpose of the study) and therefore indicates the comparative level of resources required to bring households to the consumption threshold. The results show that 1.5 times as many resources will be needed to lift the non-adopters to the poverty line compared to adopters. The poverty severity index is consistent with the other measures—treadle pump adoption seems to have reduced the incidence and severity of poverty as well as the poverty gap. Simfukwe et al. (2008: Table 27) also find that the Relative Risk (RR) of poverty, i.e., the probability of being poor, is consistently lower for adopters than non-adopters, though the differences are not statistically significant.

Table 9. Poverty index by type of farmer

Type of Farmer	Head Count Index	Poverty Gap	Poverty Severity
Chongwe Adopter	50	21.4	11.4
Chongwe Non-Adopter	78	36.1	16.4
	t-value=23.61	t-value=49.57	t-value=23.41
p-value	0.3127	0.3017	0.3658
Ndola Rural Adopter	54	24.8	13.2
Ndola Rural Non-adopter	78	34.5	19.5
	t-value=29.75	t-value=28.39	t-value=31.57
P-value	0.3217	0.3589	0.3561

Source: Simfukwe et al. 2008: Table 26.

Finally, the study attempted to understand the movements from being poor (baseline 2003) to being non-poor, or the opposite, for adopters and non-adopters in each district, as of 2006, using data from CLUSA, IDE and others. The results are not definitive, but in general adopters had a higher likelihood to move from poverty to non-poverty than non-adopters, and non-adopters showed less resilience, i.e., were more likely to fall back into poverty than non-adopters (Simfukwe et al. 2008: Table 28).

5.7 Conclusions: Zambia treadle pump experiences

In conclusion, there is clear evidence that treadle pumps in Zambia have led to positive impacts on household food security and well-being. Although less definitive this is

consistent with the findings for the impact of treadle pumps reported using a similar methodology in Malawi (Mangisoni 2006; see Box 2), as well as findings from Ghana and other West African countries (Adeoti et al. 2007). Evidently, where farmers have a source of water that can be tapped using treadle pumps, making such pumps available at a reasonable cost can have very positive impacts, especially if they are accompanied by training and assistance with market access.

However, there are important concerns regarding the longer-term sustainability on both the input and output market sides. With regard to output markets, CLUSA had to play an active role in linking smallholder producers to markets where they could sell their produce; at the end of the project, many farmers found their access to these markets to be limited. This is a critical long-term policy issue common to many countries in Africa.

Currently, there is no evidence that a commercial (or even non-commercial) treadle pump supply chain is being established and institutionalized in Zambia. Manufacturers complain about the lack of demand and unwillingness of retailers to stock pumps until they have a buyer; retailers complain about the lack of demand in a context where stocking equipment for long periods of time is costly. For some types of pumps at least, spare parts are difficult to obtain. Simfukwe et al. (2008) observe that nearly the entire production, marketing and distribution system is “donor driven” and suggest the participation of the private sector is “donor-coerced and not business-motivated.” At \$220, the cost of a treadle pump according to CLUSA and IDE (CLUSA and WSU 2004:10), they are beyond the reach of most smallholders unless they have access to credit or subsidies¹⁸. But NGO and government subsidies also undermine commercial channels for pumps that are not subsidized. This confusing policy environment is not conducive to building a long term production and supply chain, and limits the potential long term impacts of programs like those of CLUSA and IDE.

The study has also highlighted several other issues that need to be addressed in future, for example the appropriateness of the design of at least some treadle pumps, and the effectiveness of targeting, especially with reference to women. None of these issues however detract from the conclusion that low-cost treadle pumps are one effective technology for helping small farmers increase their productivity and incomes.

6. Lessons from Comparison of Zimbabwe Drip Kit and Zambia Treadle Pump Experiences

Although we used similar methodologies in the two countries, strictly speaking we cannot make direct comparisons; there are too many intervening variables. Nevertheless, the following are some lessons that emerge from comparing the two programs.

1. The Zambia treadle pump program has had a measurable impact in terms of improving food security and reducing poverty, while the Zimbabwe drip kit program has not had any statistically significant impact. This is consistent with other assessments of treadle pumps (e.g., in Malawi: Mangisoni 2006; and in Ghana:

¹⁸ Even at \$65-\$85, the price range in Tanzania, treadle pumps would be beyond the reach of many rural households.

Adeoti et al. 2007) and of drip kit experiences in Zimbabwe (e.g., Rohrbach et al. 2006; Moyo et al. 2006). Many recipients of drip kits have benefited, demonstrating the potential usefulness of this technology under the right conditions; but drip irrigation kits are not an effective way to reduce poverty and increase food security among very poor households under relief conditions.

2. There was a sharp contrast between the two programs in terms of the support provided by the local USAID mission. In Zimbabwe, the mission was not able to provide adequate support as it did not have a long-term development program and was being dismantled at the time of implementation. In Zambia on the other hand, the OFDA support was provided through existing development programs and contracts with NGOs, and the USAID mission played a key role in overcoming bureaucratic hurdles and ensuring the effectiveness of the aid.
3. An important issue in both cases is the trade-offs involved in local manufacture versus importing, and maintaining both quality and a supply chain of spare parts and replacement equipment. An important lesson is that simply importing or even sourcing locally such technologies for distribution on a “drop and go” basis will not lead to long-term development. Investing in setting up a local supply chain including retail outlets carrying equipment and spare parts, sources of advice and technical assistance, and some means for quality control, are critical. Evidence from East and West Africa suggests investment in ‘social marketing’ to raise awareness among potential customers can also make a big difference (e.g., Adeoti et al. 2007; www.kickstart.org). Whether to encourage local manufacture or imports—or both—is a more complex issue whose answer may depend on the circumstances in each country. However, encouraging local manufacture (or even joint ventures of foreign and local firms) over the long run may contribute more in terms of job creation and economic growth. Encouraging regional markets would lower costs and lead to more competition (see Merrey and Sally forthcoming, 2008).
4. Targeting has been a problem in both Zimbabwe and Zambia. First, in both countries but especially in the case of Zimbabwe drip kits, the criteria for selection of beneficiaries used locally were not always consistent with the expectations of USAID/OFDA: they were not necessarily the poorest and most vulnerable households. However, the poorest households did not necessarily have the necessary conditions (labor, water) to make best use of the technologies. Second, while all the evidence suggests that women produce much of the food, and certainly manage most household gardens, especially among the poorer households that were the intended beneficiaries, they were not effectively targeted in either program. Some female-headed households were selected, but these were a minority; but even in households nominally male-headed, women play a critical role in cultivating vegetable gardens. We suspect but cannot say for certain that even training programs probably benefited the official “recipient” but not necessarily the actual “user” in many cases. Especially in cases where the implementing agency has roots in local communities (as was the case in both programs), it should be possible to do a better job of targeting women gardeners.
5. In both country programs, there is evidence that the implementing agencies were learning from experience and adapting their strategies based on lessons learned.

However, the Zambia program seems to have been more effective than the Zimbabwe program on this score, and seems to have been particularly adept at assessing the local situation and conditions of households. Both had the advantage of adding short-term relief resources to longer-term programs, but in the Zambian case, the longer-term programs included water management whereas this seems less often the case in Zimbabwe.

6. Training, not only in the operation of the technology itself, but in improved crop husbandry, marketing, and business management, proved to be valuable in both cases. Beneficiaries by wide margins expressed appreciation for the training.
7. In Zambia, the Ministry of Agriculture was deliberately involved, to the extent that implementing agencies provided resources to government staff to carry out training. In Zimbabwe, the relationship with AREX seems to have varied, but often excluded AREX from playing an active role. Involvement of government field staff can contribute greatly to the longer term sustainability of such programs.
8. Both programs had interesting experiences with groups. In Zambia, groups were created as a mechanism to guarantee credit and manage revolving funds. This seemed to be very effective in the short run, but we are not certain about the sustainability of these groups after withdrawal of the implementing agency; using existing groups where they exist may be a more sustainable option. In Zimbabwe, the LEAD-CRS program worked with about twenty hospitals to improve their nutrition gardens, and these hospitals often engaged with local communities as well. We did not assess their sustainability separately but based on reports from the implementing agency, we believe it is likely this approach has a lot of merit. Further, ORAP's inclusion of lead farmers with links to poor and vulnerable households is an attractive approach, though we did not have the opportunity to evaluate this in the field. In their comments on an earlier draft of this report, both LEAD Trust and USAID/OFDA suggested "community targeting" may help raise overall food production and income at community level, and vulnerable groups who are not direct beneficiaries may benefit indirectly. We are not aware of much evidence on this hypothesis, but agree it is well worth further exploration.
9. In both cases, access to output markets where produce could be sold was very important, but did not receive sufficient attention in Zimbabwe—indeed because of the economic situation such opportunities are very limited in Zimbabwe. In Zambia, the implementing agency did seek to enhance farmers' access to output markets but found itself in the position of acting as a broker, which is not sustainable, and probably led to an exaggeration of benefits in the sense that upon withdrawal of the implementing agency, farmers' profits most likely were reduced.
10. For many rural households in Zimbabwe and to a lesser extent Zambia, dry land cultivation is a more important (but also risky) source of income than are household gardens. For example, in Zimbabwe gardens produced just 4-20% of total net farm income, limiting the potential impact of drip irrigation kits. In Zambia however, treadle pump adopters on average earned nearly 60% of their income through its use. This may reflect the greater versatility of the treadle pump: where necessary it can be used even for supplementary irrigation of dry land staple crops.

7. Major Conclusions and Lessons Learned

This section highlights the most important conclusions and lessons emerging from the study of the USAID/OFDA programs in Zambia and Zimbabwe. These conclusions and lessons provide the basis for the action recommendations given in the next section.

1. Treadle pumps, drip irrigation kits, and indeed many other small-scale low-cost individualized water management technologies have a great deal of potential for enabling poor rural households to improve their livelihoods and food security in southern Africa. However, for long term sustainability they require effective support systems, including continuing access to replacements and spare parts, training, and technical advice on the input side, and access to output markets as opportunities to earn an income from sale of produce.
2. Drip irrigation kits and treadle pumps are often not appropriate if the objective is to provide support to the “poorest of the poor,” i.e., those households with insufficient labor, land, access to water, technical competence, and access to output markets. This observation combined with the previous point regarding the need for effective support systems leads to the conclusion that these technologies are not appropriate as stand-alone “relief” investments. However, where the shorter-term relief investments can be integrated with longer term programs to improve households’ livelihoods through improved water and land management, as was the case for the Zambia treadle pump program, the results can still be very positive. Using “relief” in ways that contribute to long-term sustainable improvements in household food security is a very worthy objective, but this does not mean that investing in short-term versions of programs that require a long-term approach will be effective.
3. This conclusion begs the question, how can the most stressed, marginalized and vulnerable households be identified and assisted? This is a difficult question going beyond what this study could address. FANRPAN (2007) has recently published a book describing how to construct and use a “household vulnerability index” (HVI; see Box 4) Although developed in the context of supporting HIV/AIDS-affected households, it lends itself to identifying those households who are most at risk, and is also a tool that can be used to track impacts over time. Rohrbach et al. (2006) have suggested that assisting households to improve the productivity of their home gardens can have enormous benefits in Zimbabwe, as vegetables and fruits produced by women in their household garden can have major positive impacts on child nutrition. We have also highlighted, above, that community-based approaches may offer another avenue to providing benefits to the very poor. Finally, we reported on but were unable to assess the effectiveness of “institutional nutrition gardens” such as those promoted through hospitals in Zimbabwe. We believe this may be another effective mechanism for reaching vulnerable people and youth in surrounding communities, as is claimed by LEAD Trust and Catholic Relief Services.
4. Both programs demonstrate the complexity of “targeting” support to those most in need. First, the criteria used “on the ground” by some of the implementing agencies

appropriately included access to water, land and labor (otherwise the technology is useless to the household). However, these criteria effectively excluded the poorest and most vulnerable households who are USAID/OFDA's intended beneficiaries. One implementing agency in Zimbabwe (ORAP) tried to overcome this in part by including lead farmers who had clear links to vulnerable households. Further, none of the programs sought explicitly to target women. This refers not only to women-headed households (the traditional means to reach women), but those women who are often the actual gardeners in nominally male-headed households. There is considerable incidental data from both programs showing that women were often the users, but less often received the technology and the training directly.

5. A major drawback of both programs is that they focused on the use of a specific single technology as a means to provide support to households. This can lead to over-emphasis on the technology itself, possibly providing the technology to the wrong households (i.e., those not able to make best use of it), and using as a major measure of performance, the number of kits delivered. A "one-size-fits-all" approach ignores the high degree of diversity among households; for example a common complaint expressed about the drip irrigation kits is they were seen as too small by many respondents. Given the diversity of agro-ecologies and household characteristics, a better approach will be to offer a larger menu of technologies and practices, and assist farmers to choose and mix and match based on their needs. For example, it is clear that some households receiving drip kits in Zimbabwe could have overcome its largest drawback, the need to lift heavy buckets over a meter high to fill the drum, if they also had a treadle pump; and many may have benefited from interventions to improve water management on their rain fed fields.
6. Where households do not have good access to profitable output markets for sale of surplus produce, the usefulness of technologies like drip kits and treadle pumps is limited (though not zero). Access to output markets is critical for households to earn income and improve their wellbeing. While both the Zimbabwe and Zambian programs realized this, the Zambian program put more effort into linking farmers to markets—to the extent of becoming brokers, an unsustainable role. NGOs should get out of the business of being market intermediaries themselves—it is not sustainable.
7. Both cases, but especially the Zimbabwe case, demonstrate that the policy and macro-economic environment is critical to success. The hyperinflation in Zimbabwe undoubtedly reduced the impacts of the drip irrigation programs, by disrupting both the input side (e.g., availability of spare parts) and output side. Similarly, government off and on again subsidies and import policies undermined the Zambian program, though less dramatically.
8. The study has confirmed the value of broad-based training, i.e., training not only specific to the technology, but for improving crop husbandry, marketing, and management of accounts.
9. There is evidence from Zambia that working closely with government pays dividends in terms of government capacity building and ownership. In addition, from the perspective of FANRPAN, it increases the likelihood of influencing policy to make it more favorable for supporting the small-scale irrigation technology industry. One

important policy issue is the consistency of support to the business environment to scale up manufacturing and marketing of these technologies and provision of after-sales services including spare parts.

10. Finally, we note that there is no consistent reporting system used by the implementing agencies receiving support from USAID/OFDA. The implementing agencies therefore devised their own reporting formats using their own criteria and measures, designed, understandably enough, to put their results in the best possible light. This makes it impossible to track in a systematic and comparative manner the outcomes, short-term impacts, and potential long term impacts of OFDA investments.

Box 4. The Household Viability Index

This index was developed as part of an assessment of the impact of HIV/AIDS on agriculture and food security in southern Africa, commissioned by SADC. It basically involves quantifying key household dimensions based on the sustainable livelihoods framework: natural, social, human, physical and financial. The ability of households to cope with stress and shocks is a function of the range, quantity and quality of their various assets. The index is an empirical quantitative score of household vulnerability, which can be classified as non-vulnerable, coping, acute and emergency. The index can be used with reference to individual households or as a statistical assessment over time of the impact of a program on a particular population. To date, the index has been applied only to vulnerability of households to the impact of HIV/AIDS, but it can be adapted to assess vulnerability to other types of shock as well. Further details are available from FANRPAN 2007, or policy@fanrpan.org.

8. Action Recommendations

In this section, we provide specific recommendations derived largely from the findings of this study complemented by findings reported in other literature. Other recommendations are included in the previous sections as well; here we highlight what we believe are the most critical.

1. **Carry out needs assessments.** Careful needs assessment and targeting of those most in need are both complex but critically important for disaster assistance to be effective. *We recommend carrying out detailed local assessments as pre-requisites to providing assistance.* Needs assessments can be done through locally active NGOs, local governments and councils, and consultations with local communities, depending on the circumstances. It is important to gain an accurate local perspective on who will be the long-term users of the assistance—who may not be those first in line when NGOs arrive. The FANRPAN ‘household vulnerability index’ (HVI) also provides a tool for identifying the households most vulnerable and in need and can be adapted to identify opportunities as well; it can also be used to monitor impacts over time. For example, if the problem is malnutrition from lack of micro-nutrients, assistance to improve household nutrition gardens may be most appropriate, but if the problem is insufficient calories, short term food aid may be more useful. Similarly, households need minimum levels of human, natural and social capital to be able to make good use of water management technologies. Finally, using local knowledge to

identify groups or local institutions as conduits for assistance will pay dividends; for example, churches, mosques or other community groups can often be used; and provision of assistance through community-based hospitals is worth exploring.

2. **Serious gender targeting.** Women in most southern African rural areas play key roles in food production, especially gardening, and are also responsible for feeding children. They are also the least likely to be provided opportunities to receive training, access to technologies, and market access. Yet most relief as well as development programs still fail to reach women effectively. It is not enough to target female-headed households though this may be a part of the solution; within nominally male-headed households, women are often the actual gardeners and users of drip kits and treadle pumps. Giving training and technology to men simply delays access and productive use of the innovation. The first step is a proper needs assessment as described in the previous paragraph, which will include identifying who are the real users of the type of assistance on offer. *We recommend that USAID/OFDA require its partners in future to develop detailed plans and strategies for ensuring that a needs-based proportion of assistance is provided directly to women, and that they report their results on this basis.* This means, for example, if 90% of gardening is done by women, then 90% of drip kits should go to women. Implementing partners could also be supported—and required—to recruit gender specialists at a sufficiently senior level to enable more effective gender-balanced implementation programs. Possible strategies include: providing training to two persons per household (at least one of whom must be female); using female trainers; paying for child care while women attend training; and making use of women trainers and extension workers even if additional support is needed to recruit and train them. Training women and providing materials to enable them to train other women can lead to more rapid replication as well.
3. **Targeting the needy and testing community-based approaches.** Targeting of water management technologies emerged as a critical issue in both Zambia and Zimbabwe: how to balance “needs based criteria” with “ability based criteria.” Those households best able to use technologies like drip irrigation kits and treadle pumps because they have the minimum necessary labor, land and water resources, are not necessarily the most needy people. In reviewing an earlier draft of this report, both LEAD Trust and USAID/OFDA suggested a community-based strategy may work, by increasing the overall supply of food in a community and creating opportunities for sharing through transfers or labor opportunities. This hypothesis is well worth testing. *We recommend USAID/OFDA review past experiences for evidence regarding this community-based approach, and support pilot-testing in a sufficient variety of socio-economic circumstances to enable reasonable conclusions to be drawn to guide future relief and development programs.*
4. **Take advantage of programs on the ground.** The Zambia treadle pump program implemented through C-SAFE demonstrates the potential for using disaster assistance resources to supplement and enhance long-term development programs, and also demonstrates the efficacy of NGO consortia. In this case, USAID/OFDA funds were used to scale up and enhance work that was underway in any case, and that was well within the mandate and capacity of the implementing agencies. *Therefore, we*

recommend that USAID/OFDA take advantage of on-going programs where appropriate to create synergies and enhance development programs.

5. **Work with governments wherever possible.** The Zambia case also demonstrates the potential for higher sustainability and commitment by working through government, for example to provide training, where possible. This seems to have led to capacity strengthening of government, and also led to a higher level of commitment to supporting the program in the long term. *We recommend integrating USAID/OFDA programs with government wherever this is feasible.*
6. **Use of vouchers for targeting subsidies.** FANRPAN has a separate program (supported by USAID/RCSA) that is examining the use of vouchers (coupons) to target agricultural input subsidies to poor farmers. The advantage of vouchers over subsidies provided through other means (including direct distribution of drip kits and other technologies by NGOs) is that they can be used to strengthen and support commercial markets, make targeting more precise, and possibly reduce costs. *We recommend that USAID/OFDA and its implementing partners explore the possibility of using vouchers as a means to target and support needy households to purchase technologies that fit their needs through the commercial retail markets.*
1. **Use a consistent reporting format.** *We recommend that OFDA develop a user-friendly, practical and consistent format for implementing agencies to use for reporting on the outcomes and real as well as potential impacts of their programs.* Ideally, these should include preparation and use of participatory impact assessment pathways and network mapping (these are similar to logical frameworks but express the relationships graphically), but this will require a training program for implementing partners. The basic idea is to clearly specify how the proposed intervention solves a particular problem, and what short term outcomes and long term impacts are anticipated. The kinds of information we suggest be included are:
 - ◆ Innovation/technology disseminated (type, model, quantity, where procured)
 - ◆ Region and communities of distribution (mapped)
 - ◆ Names and contact information of all implementing partners
 - ◆ Criteria for selection of implementing partners
 - ◆ Other significant institutions affecting outcomes
 - ◆ Impacts of government policy
 - ◆ Stand alone or integrated within on-going initiative?
 - ◆ Names of recipients
 - ◆ Criteria for selection of recipients
 - ◆ Name, age, sex of person(s) trained in technology
 - ◆ Copies of any training materials
 - ◆ Feedback from trainees on the training and its usefulness
 - ◆ Documentation of outcomes (based on rapid surveys)
 - ◆ Qualitative risk assessment/likelihood of sustainability by implementing agencies, with reasons.
7. **Realism about potential development impacts of relief programs.** Short term disaster assistance or relief projects cannot substitute for long term development programs. Many relief projects, including those studied here, seek to achieve in a

year what decade-long programs struggle to achieve; but few have a sustainable impact. *We recommend providing immediate relief where it is needed and avoiding projects that are “relief projects masquerading as development”* as they are unlikely to put people on the road to long term sustainable development.

8. **Implementation check list.** USAID/OFDA has requested that this report include a checklist of key factors for success and major constraints. Because of the diversity of conditions and the danger of uncritical application of checklists, we hesitate to do this. Nevertheless, we do provide guidelines for introduction of treadle pumps and drip irrigation kits in Appendix 4.

9. Conclusion

This study consisted of a combined qualitative and quantitative analysis of the results, experiences and lessons to be learned from two USAID/OFDA-supported programs, one focused on provision of treadle pumps (and some drip irrigation kits) in Zambia, the other focused on provision of drip irrigation kits in Zimbabwe. These programs were intended to support poor households facing serious food security problems as a result of drought. This was not a typical “evaluation” of these programs, in the sense that we were not seeking to identify specific strengths and shortcomings of the implementing agencies. Rather, it was designed to take a broader view in order to identify lessons and recommendations for the future.

Our basic conclusion is that low-cost water management technologies such as treadle pumps and drip irrigation kits can be very important tools for households to improve their food security and incomes, and escape poverty. However, they are generally not appropriate as disaster assistance investments because of the short-term nature of the support. The exception is when they add value to on-going longer term development programs that already include provision of such technologies. We recommend that before disaster relief programs are launched, they be preceded by careful locally-based needs assessments as a basis for identifying the most appropriate interventions. Further, we recommend much greater attention to targeting those who are most in need, especially women; not only women-headed households, but women who are members of male-headed households having significant responsibility for food production. This will require assisting implementing agents to acquire new skills and capacities but we believe it will enhance the effectiveness and efficiency of disaster relief programs.

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Appendices

Appendix 1: Country Teams

In Zambia, the quantitative study was implemented through the Agricultural Consultative Forum (ACF), which is the national hosting node of FANRPAN. The study was led by Mr. Mwalimu Simfukwe, a private consultant who has done quite a few projects for FANRPAN, and was assisted by Mr. Masiye Nawiko of ACF, under the overall supervision of Dr. Hyde Haantube, head of ACF.

In Zimbabwe, the quantitative study was implemented by a team from Midlands State University (MSU) in Gweru, led by Professor Francis Mugabe, Executive Dean of the Faculty of Natural Resources and Agriculture. He was assisted by Mr. Joseph Chivizhe, Director of Agricultural Practice at MSU after many years of experience in extension, and Ms Chipu Hungwe, Lecturer in Social Science at MSU.

Appendix 2: Methodology for Poverty Impact Assessment

Assessment of poverty was done by calculating the well-being measurements of headcount index, depth of poverty and poverty severity index.

Headcount index is the share of the population, which does not reach a given threshold, defined as 270 kg of maize equivalents per capita. Headcount index (HI) was computed as follows:

$$HI = \frac{q}{N},$$

where q is the number of farmers below the 270 kg of maize equivalents per capita poverty line; and N is the number of all farmers in the category being analyzed.

Depth of poverty (DP) or poverty gap gives information on how far off a farmer is from the poverty line. This was computed as the average distance between population and the poverty line taking the distance of non-poor farmers to be zero. The following formula was used to calculate DP:

$$DP = \frac{\sum_{i=1}^{np_i} (PL - PP)}{np + nnp}$$

where np is number of poor farmers; nnp is the number of non-poor farmers; PL is consumption poverty line; and PP is the per capita consumption of poor people.

The poverty severity index (PSI) is used to add value to the above two indices. This index put more weight on individuals further from the poverty line to demonstrate the extent of extremely low levels of consumption in a population or inequality among the poor. PSI is the average squared consumption shortfall of the population as a proportion of the poverty line. The PSI was calculated as

$$PSI = \frac{1}{n} \sum_{i=1}^q \left(\frac{y_i - Z}{Z} \right)^2$$

where n is total number of farmers in category; q is the number of poor farmers; y_i is the quantity of maize equivalents consumed by the i th farmer; and Z is the consumption poverty line.

To strengthen the three indices above, *relative risk of poverty* and transition matrices were calculated. Relative Risk (RR) is the probability that members of a group will be poor in comparison with the probability of poverty for non-members of the group. RR is calculated by looking at the headcount index and the share of all poor in the group and these are compared with other groups as follows:

$$RR = 1 - [\text{Headcount of target group}] / [\text{Headcount of Reference Group}]$$

Movement in and out poverty helps to identify whether individuals in a group are getting better off or worse off. Calculation of the transition matrix entails having two profiles of the target population. During each profile, proportions of individuals above and below the poverty line are computed. Comparisons are then made between the two profiles to see if there are some individuals who were poor in the first profile but emerged as non-poor in the second profile and vice versa. An individual whose status has not changed is also noted.

Source: Mangisoni 2006, Simfukwe et al. 2008, and Mugabe et al. 2008. The original version is from Dr. Mangisoni.

Appendix 3: Terms of Reference Provided by USAID/OFDA

The evaluation will address the following series of questions.

Specific to the Zimbabwe Drip Irrigation Program

- Have there been any problems in the design or implementation of drip irrigation activities?
- What different types of drip irrigation were tried in Zimbabwe (including a description of tubing, valves, water supplies); what was most successful and why?
- What was the frequency and extent of technical assistance and extension provided by the implementing partner after provision of the drip irrigation systems?
- What are the major constraints to using drip irrigation, and how were they overcome in Zimbabwe?
- Both households and institutions (hospitals, schools, etc.) were targeted to receive drip irrigation equipment and training in Zimbabwe. Highlight the benefits and constraints to each approach. What criteria was used to select targeted households and institutions?
- What did farmers see as the major benefits to the system, and what were their most serious disappointments?
- Did farmers who were not part of the initial target group eventually find ways to adopt the technology, or is dissemination of the system dependent on NGO inputs?
- Have any small businesses/enterprises sprung up to provide alternate sources of equipment for drip irrigation?
- Are there any instances where drip irrigation activities did not pay dividends as expected?
- Has hyper inflation impacted farmers' ability to purchase spare parts and inputs?
- How has the operation of the drip irrigation systems been affected by the availability, access and cost of other agricultural inputs--from seeds, fertilizer, and water, to loans and labor?
- For households that received drip irrigation systems and training in 2003-2004, are they still using the systems? If not why not?

Specific to the Zambia Treadle Pump Program

- Have there been any problems in the design or implementation of treadle pump activities?
- What are the major constraints to using treadle pumps, and how were they overcome in Zimbabwe?
- What was the frequency and extent of technical assistance and extension provided by the implementing partner after provision of the drip irrigation systems?
- What did farmers see as the major benefits to the system, and what were their most serious disappointments?
- Did farmers who were not part of the initial target group eventually find ways to adopt the technology, or is dissemination of the system dependent on NGO inputs?
- Have any small businesses/enterprises sprung up to provide alternate sources of equipment or maintenance for treadle pump systems?

- Are there any instances where treadle pump activities did not pay dividends as expected?
- How has the operation of the treadle pump systems been affected by the availability, access and cost of other agricultural inputs--from seeds, fertilizer, and water, to loans and labor?
- For households that received drip irrigation systems and training in 2003-2004, are they still using the systems? If not why not?

For Both Programs

- How were beneficiary households selected to receive these systems? What criteria were used to determine whether the small-scale irrigation systems would be appropriate?
- Were the effects on crop productivity, and family economic/food security vulnerability as expected? To what extent?
- Are the “Lead Farmers” and/or early adopters which were trained to promote the technology post-program to other farmers still actively doing so? If not, why? In addition to small-scale irrigation, what are they promoting in their communities, based on the training they received?
- What are the most significant outcomes and impacts of each program? Did food production at the household level increase or decrease? Did cash to buy food and other items increase at the household level due to these interventions?
- What impact did rainfall (as opposed to the drip kit or treadle pump) have on food production levels? On available water sources to support these small-scale irrigation systems?
- Were there any negative impacts on water availability or issues around water use?
- What was the average plot size put under irrigation using the systems provided? What constraints prevented these plot sizes from being increased/expanded?
- Where cost recovery was part of the program, how long did it take participants to repay the cost of the system? Where cost recovery was not a feature, how long did it take participants to generate income equal to the cost of the system?
- Will the effects of OFDA-funded small-scale irrigation activities be sustainable without continued external financial input? What factors contribute to this possible sustainability?
- What additional inputs are important for these programs to work? What might contribute to further success?
- In what ways were OFDA-supported food security activities coordinated with the USAID Mission in Zimbabwe/Zambia?
- How many farmers expanded their areas with money earned from initial input through purchase of more kits?
- How many of the farmers diversified after the initial seed issuance? What were the key factors leading to diversification?
- What groundwork would need to be laid prior to introducing this technology to other areas of the world, especially given limited funding resources?

Appendix 4: Guidelines for Introducing Treadle Pumps and Low-Pressure Drip Irrigation Kits

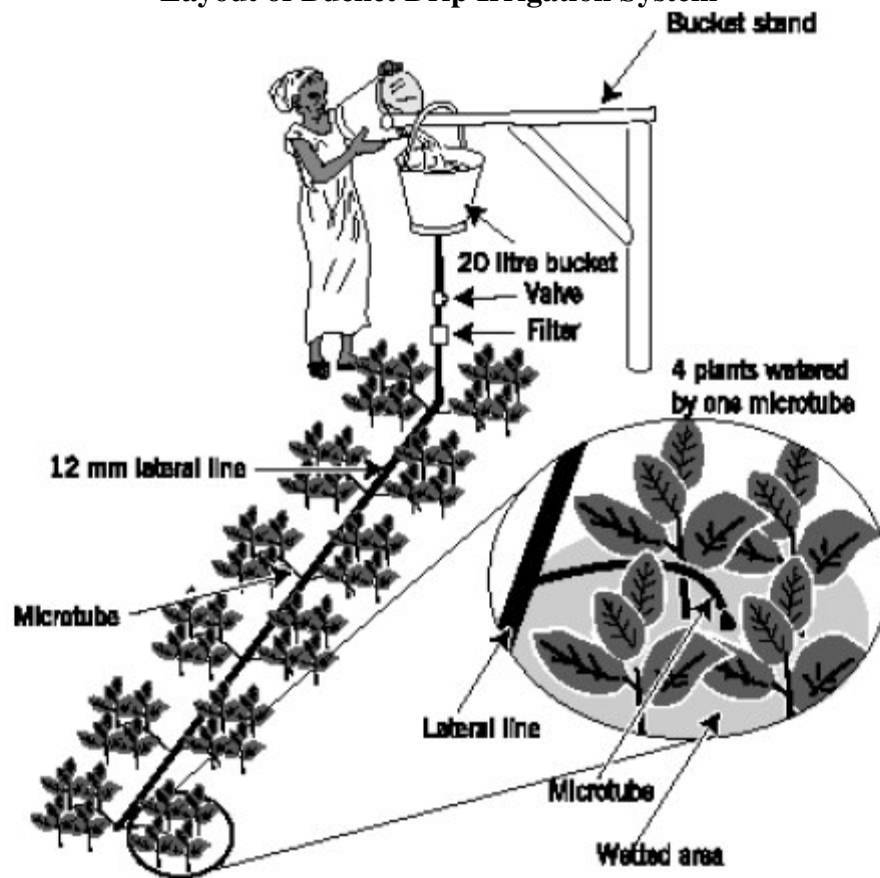
Treadle Pump Guidelines

Uses	<p>Pressure pump: pump water under pressure or lift water from deeper source (+/- 2-7 m) Suction pump: lift water from shallow source (<2 m) Multiple purposes where water pump is needed Agriculture: supplementary irrigation, irrigate high value crops</p>
Necessary conditions	<p>Water source close to where water will be used (<200 m) Adequate water supply (about 1 liter/second or more per pump) Availability of land (approximately .25-1 ha, depending on number of people pumping, pumping hours, pump capacity, crop water requirements, etc. This compares to water cans, one person irrigating 20 hours/week—0.03 ha.) Availability of labor for pumping and related activities Availability of spare parts and technical advice Output markets highly desirable to get full economic benefit</p>
Advantages	<p>Versatility—can be used for many purposes requiring a pump Low cost to purchase: affordable by many people Low cost to operate—no purchased fuel etc. Easy to maintain and maintenance requirements limited Less tiring to use than other manual technologies Less expensive to purchase and operate than motorized pumps Local manufacture is possible Portable—can be moved, kept at home Easy to share given portability Labor-saving over other manual ways to lift and carry water Increase labor productivity compared to other manual technologies (carrying buckets, etc.) Increased area can be irrigated compared to watering cans Full irrigation of gardens possible, reducing number of irrigations and increasing quality and quantity of produce Increased number of growing cycles as crops grow faster with full irrigation Therefore, increased family nutrition, income and employment on and off farm possible Can be used for supplemental irrigation of dry lands High economic returns if output markets available Can be targeted to poor, women, etc. Can be linked to efficient water application technologies such as sprinklers and drip irrigation kits Potential to create an agro-industry (manufacturing, marketing, maintenance, spare parts) thus promoting employment and economic growth</p>

Disadvantages	<p>Cultural issues, e.g., discomfort of women, reported in some places, especially on models whose seat is too high</p> <p>Some pressure pump models reported as difficult to use by women and children</p> <p>Relatively expensive in Africa—and in some countries very expensive compared to Asia</p> <p>Spare parts not easily available in some countries and for some models</p> <p>Potential to deplete limited water resources on small watersheds</p> <p>Insufficient policy and institutional support</p> <p>Potential to saturate market if large number of treadle pumps are installed in an area with limited market demand</p>
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Sources: Modified and adapted from IWMI 2006: Table 5; additional material from Kay and Brabben (2000), the most comprehensive technical guide currently available.

Layout of Bucket Drip Irrigation System



Source: Sijali 2001:33, Figure 4.3.

Low Cost Low-Pressure Drip Irrigation Guidelines

Uses	Precise application of irrigation water to plant root zones Used especially for vegetable gardens, and for permanent crops like fruit trees (not useful for staple grain crops)
Necessary conditions	Dry area or dry-season growing season, and relatively small amount of water available; perception of water scarcity Reliable source of clean water in close proximity Soils suitable for drip irrigation (for example not too coarsely sandy) Household labor available, and technical competence for managing drip irrigation Access to good output markets increases the returns [but can be used for own-use vegetables] Effective program for promotion and support: good technical and agronomic advice, training, spare parts Donor/NGO support over time to establish sustainable program (5 years or so), in collaboration with private sector
Advantages	Potentially raises productivity of water, land and labor; reduces loss of water In principle, very low cost, robust and simple Reduced fertilizer and chemical costs through greater precision Some versions – fertilizer can be combined with irrigation water Can be targeted to poor, women, disabled people Available in different sizes, from 10 m ² up, so can be adapted to land and water Higher yields, better quality crop, shorter maturity which should translate to higher profits under positive market conditions
Disadvantages	Currently no effective examples of programs targeted to poor farmers in SADC Insufficient local manufacturing capacity Relatively high management capacity required of farmer Distribution as component of emergency relief shows poor sustainability Dirty water can cause clogging Inadequate training and institutional and technical support to make good use of them in nearly all African countries Currently not attractive to private sector because of low volumes, high costs Restricted root zone increases vulnerability to drought if irrigation is stopped Risk of salt accumulation in root zone

Sources: Modified and adapted from IWMI 2006: Table 7; see also Sijali (2001), the most comprehensive technical guide available.

Protocol for Drip Irrigation Kits

For the program to be sustainable, it is important that the NGOs take on board relevant government organs from the inception of the program to the end so that by the time the NGOs conclude their work the program can be handed over to such government institutions.

1.Distance of water source

Objective: Ensure that the drip kit garden is close to the water source

Drip kit garden should be within 50m of the water source or

Provide wheelbarrow or simple water cart [or a treadle pump!] to assist with transport of water for distances up to 250 m

2.Reliability of water source

Objective: Ensure that the beneficiaries have a reliable water source

Before a kit is given, the NGOs in collaboration with relevant Government Departments should make an effort to determine the reliability of the potential water sources.

The potential water sources should be able to supply water for the kit all year round¹⁹.

3.Follow up visits

Objective: Ensure that the beneficiaries get prompt technical advisory service on the use of kit.

During the year of inception the NGO should make high frequency follow-up visits to beneficiaries, i.e., at least once every two weeks for the first crop, and then monthly.

During the second year follow-up visits should be made once every cropping season and then once every year thereafter.

4.Training

Objective: Adequate training of beneficiaries

The NGO in collaboration with Government Extension Services should undertake the training.

Training should be done in the following areas: Installation, repair and maintenance of drip kit

NB. Training on maintenance of the kit should take cognisance of quality of water available for the drip kit in different areas.

Cropping techniques including the cropping calendar and irrigation scheduling.

Pest control using cheaper traditional methods [or integrated pest management].

As a way of motivating the beneficiaries, field days and exchange visits by beneficiaries especially during the inception year.

5. Targeting

Objective: Beneficiaries are people who are able to work in their respective gardens

NGO should ensure that the beneficiaries are able bodied persons²⁰ who can work in their gardens

Provide water containers relevant to size and age of beneficiary – it is hard to lift a 20 litre bucket [again, a treadle pump can address this problem].

6.Spares

Objective: Beneficiaries are able to carry out repair work in time on their kit without compromising their crop production

NGO should identify a local trader willing to stock the necessary spares, so that the beneficiaries can purchase them when needed.

Source: Box 1 in Moyo et al. 2006 [with some editing]

¹⁹ A 30 m³ cistern can do this for a 100 m² garden in a 450 mm rainfall area (Marna de Lange, personal communication).

²⁰ “Able bodied” should not be taken as overly restrictive; since in principle these are labor-saving devices, it means people with handicaps should be able to use them.

