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Production Challenges and Sustainability of Smallholder Irrigation Schemes in Zimbabwe

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Abstract
Smallholder irrigation schemes in most developing countries, including Zimbabwe have proved to be unsustainable beyond external assistance. The history of smallholder irrigation schemes in Zimbabwe indicate these irrigation schemes suffered considerable neglect and were a mixture of success and failure during the post independence era. Their importance in the semi-arid regions cannot be over emphasized yet they the smallholder farmers do not seem to give them the value they deserve. This study was aimed at unravelling the factors influencing the production levels and the sustainability of smallholder irrigation schemes. Three smallholder irrigation schemes from the southern Eastern Low-veld of Zimbabwe were purposively selected for the study. A total of 130 farmers were interviewed using questionnaires, 11 key informant interviews and 3 Farmer Group Discussions (FGDs) with farmers were conducted in the 3 schemes. The study revealed that farmers had unsustainable sources of livelihood and poor asset base that compromised their capacity to make meaningful investments into the schemes. Production was unsustainably low due to limited access to agricultural inputs (only 40 – 67% of farmers had access to fertilizers and pesticides), inactivity in the input supply chain (the dominance of government and NGOs in the supply chain is biased towards specific farmer groups thus disadvantaging other groups), limited access to irrigation water (due to electricity load shedding and reduced discharge of the Save river in spring) and lack of credit facilities (0% farmers had access to bank loans and 17% accessed loans from input suppliers). The low application rates of fertilizers and the low value crops grown in the scheme showed that the farmers were still to graduate from subsistence to commercial or market oriented agriculture. Poor agricultural output markets prevented farmers from growing some high value crops and were a strong disincentive for commercialising the production in the schemes.
Keywords: production level, smallholder irrigation schemes, sustainability

1. Introduction

Irrigation development is a special case of agricultural development in which technology intervenes to provide control for the soil moisture regimes in the crop root zone to achieve a high standard of continuous cropping (Rukuni and Makadho, 1994). This knowledge enables humans to reduce the negative effects of natural rainfall and to grow crops in arid and semi-arid regions. Irrigated agriculture is the most viable means of reducing crop failure, hunger, and malnutrition in Africa, and an effective means for improving the competitiveness of smallholder farming in most parts of Africa (World Bank, 2008).

Globally, large investments in irrigation have been an essential element in increasing food production to sustain the ever-growing population. In order to meet food requirements by 2020 (when world population is estimated to reach 8 billion), FAO (1995), estimated that food production from irrigated areas needed to increase from 35% in 1995 to 45% in 2020. This indicates that access to water for irrigation will become an issue of global concern, especially in the arid and semi-arid regions of the world, and with the advent of climate variability and change. Climate variability in Southern Africa is a reality, evidenced by year to year rainfall variability ranging between 30 and 35% and the fact that rainfall for the region in the early 1990s was 20% lower than that of the 1970s. Significant droughts were recorded in the 1980s, early 1990s and 2000 (Perry, 1997; Svendsen *et al*, 2009), making irrigation farming obligatory.

Unfortunately, throughout Africa, there are hardly any cases of successful and sustainable farmer-managed smallholder irrigation schemes despite efforts by Governments, NGOs and private organisations (World Bank, 2008). The result has been low levels of production and rapid deterioration of the irrigation infrastructure that has required recurrent investments in rehabilitation, failing to generate returns commensurate with expectations and their design potential (Dittoh, 1991; Webb, 1991; SADC, 1992; Shah *et al*, 2002; Denison and Manona, 2007). The general understanding for Africa is that the costs outlay for smallholder irrigation schemes is too high relative to the benefits (Postel et. al. 2001; Shah and Keller, 2002). Yet several studies point to the fact that smallholder irrigation schemes offer a great potential to improve crop production, secure income source, create employment, stabilize agricultural production systems, assure food supply even in years with inadequate rainfall and thus poverty reduction (Manzungu and van der Zaag, 1996; Chancellor, 2004).

In Zimbabwe, over 80% of the rural population lives in Natural Regions III, IV and V where rainfall is erratic and unreliable, making dryland cultivation a risky venture (FAO, 1995; FAO, 2000). The success rate of rain-fed agriculture in Natural Regions IV and V is approximately one good harvest in every four to five years (FAO, 2000; Poulton *et al.*, 2002). The greatest food deficits in Zimbabwe occur among farmers practising rainfed agriculture in dryland areas of Natural Region V, with fewer farmers in irrigation schemes running out of food during the year (Meinzen-Dick *et al*, 1993). Yields attained on smallholder irrigation schemes were found to be higher than under rain-fed agriculture. Thus some smallholder irrigation schemes during the early 1990s were generally financially viable with gross margins significantly greater than for dryland farming (Rukuni, 1984; Meinzen-Dick *et al*, 1993; Ruigu and Rukuni 1990). Despite the apparent benefits that the country and farmers have enjoyed from irrigation schemes in Zimbabwe, smallholder irrigation schemes have proved to be unsustainable beyond external support. They have to date been characterized by low production and minimal direct contribution to the national economy (Manzungu and van der Zaag, 1996; Chancellor, 2004; Nhundu and Mushunje, 2010).

The development of smallholder irrigation systems has been promoted since the pre independence period as the strategic answer to food deficit and a lot of investment has been channelled to the development of irrigation infrastructure through Government and different NGOs. However, many of these schemes are facing sustainability challenges which have left some of them in a state of disrepair or operating below their design capacity despite the critical value for food security, stabilisation of agricultural production, employment creation and poverty alleviation. A number of researches have been carried out on small scale irrigation schemes but the focus has been mainly on analysis of the design options and water management, financial viability of different crops, identification of appropriate irrigation technologies and the socio- economic impacts of these schemes (Makadho, 2000; Makombe, Makadho and Sampath, 2004; Makombe and Sampath, 2010; Meinzen-Dick, 1993; Meinzen-Dick, Makombe and Sullins 1993; Mupawose, 1984; Ruigu and Rukuni, 1990; FAO, 2000 and Rukuni, 1984). Little has so far been done to holistically investigate sustainability challenges of smallholder irrigation schemes in Zimbabwe especially in the post inflation era. This research therefore, seeks to establish why rural farmers and their respective Government stakeholders are failing to sustain smallholder irrigation schemes after some huge capital investments in their setting up and their intrinsic interest in irrigation in the face of erratic and highly variable rainfall. This study therefore, seeks to unravel the subtle complexities underlying the sustainability of irrigation schemes in Zimbabwe which can be targeted for intervention.

2. Materials and methods

2.1 Study area

All the irrigation schemes targeted for the study were located in Natural Region V of the southeast lowveld. This Region is characterized by low rainfall, less than 450mm per annum, which is often erratic and not adequate for crop production (FAO, 2000). The type of soils range from typically sandy clay loamy soils to deep heavy black cracking clay soils derived from karoo basalt, interspaced by red silliatic clay soils (Mombeshora, 2003). The soils are highly productive under irrigation but are highly prone to erosion (FAO, 2000). The water for irrigation is drawn from Save perennial river as shown in Figure 1.

The three irrigation schemes were purposively selected, where two, (Tsovani and Dendere) are operating below capacity while the other, (Mtandahwe) has been operating at full capacity for the past three years. Factors affecting production and the sustainability of smallholder irrigation schemes were to be identified by comparing the three schemes. Their proximity to each other was ideal in controlling other confounding factors like micro-climate, known to influence the performance of schemes.

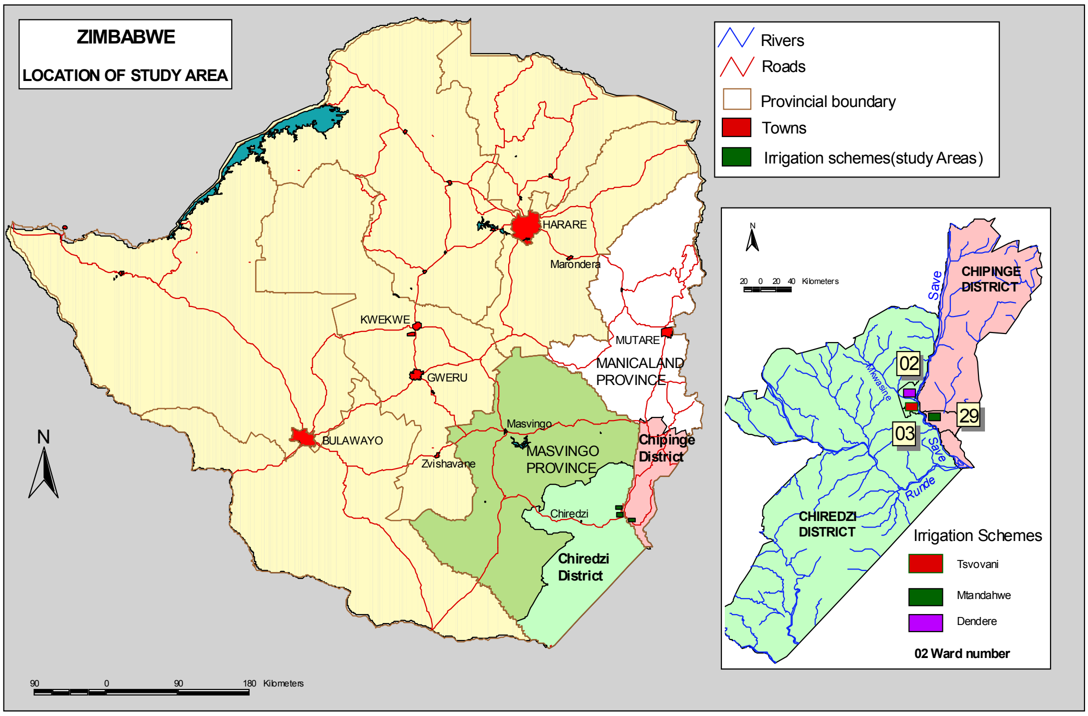

Figure 1: Location of the study area

2.2 Sample size, interviews and farmer group discussions

An exploratory case study method was adopted, in which both quantitative and qualitative research methods were employed. A questionnaire survey was used to collect both quantitative and qualitative data from the irrigation plot holders. Data obtained from the questionnaire survey was augmented by Focus Group Discussions (FGDs), key informant interviews and direct observations. A simple random sampling method was used for selecting participating farmers, representing 40% of the target population. Tsovani, Dendere and Mtandahwe irrigation schemes have a total membership of 120, 38 and 167 farmers respectively thus 130 farmers were interviewed. One FGD was conducted in each of the three schemes. FGD participants were selected from the farmers who had not participated in the questionnaire interviews. A total of 12 farmers participated in each FGDs, to give a total of 36 FGD participants, who were also gender balanced. The plot holders' behaviours and attitudes were observed and noted.

Key informants comprised of irrigation management committees and district heads of institutions involved in agriculture and/or irrigation schemes. Thus eight key informants were interviewed from Agricultural Technical and Extension Services (AGRITEX), Department of Irrigation (DOI), Zimbabwe Electricity Supply Authority (ZESA), Zimbabwe National Water Authority (ZINWA) and Rural District Councils and three from the Irrigation Management Committees (IMCs), giving a total of eleven. Field observations on some pertinent features which could suggest members' level of engagement to the scheme and the general state of the scheme's infrastructure, crop stand and quality were carried out using an observation checklist.

The data collected was quantified and inputted as nominal into the Statistical Package for Social Scientist (SPSS, Version 16) and results presented through simple descriptive statistics such as frequency tables and cross tabulations as well as advanced statistical analysis through regression analysis and analysis of variance (ANOVA).

3. Results and discussions

3.1 Demographic characteristics of the respondents

Table 1 summarises the distribution of the respondents by irrigation scheme and age. The majority of the respondents (72%) were between the ages of 30 and 59. Those below 30 averaged 9% and 19% were above 59 years of age. Fifty eight percent of all respondents were females, 72% were married, 21% widowed while 6%

and 3% were single and divorced respectively. The average household size for all interviewed households was 7 against the national average of 5 (ZimVac, 2012). The sex and age disaggregation of the farmers in the schemes confirmed Muparange's (2002) findings, that in smallholder irrigation schemes, most of the farmers were females and that the youth were generally not interested in agricultural production. This poses a potential threat to the future sustainability of these schemes as no institutional memory will be left after the current generation of farmers gets out of picture (Shah *et al*, 2002).

Table 1: Ages of the respondents in the different irrigation schemes

Age	Name of Scheme			Total no. of respondents
	Mtandahwe	**Dendere**	**Tsvovani**	
Below 20	1	1	0	2
20-29	3	1	6	10
30-39	7	2	13	22
40-49	18	4	13	35
50-59	20	5	11	36
60-69	11	2	3	16
70 and above	7	0	2	9
Total	67	15	48	130

The demographic characteristics of the respondents as highlighted above would seem normal and the expectations are that these farmers should be capable of producing at least enough for themselves. However, a closer investigation into the household compositions reveals other challenges which may hamper productivity. Figure 2 shows the vulnerability status of the households ranging from young children, chronically and terminally ill, disabled and mentally ill, orphans and the elderly. Sixty eight percent of the households had children less than 5 years of age with an average of 3 children under 5. About 37% of the households had orphans living with them while 20% had members who were chronically ill, 3% had terminally ill patients and 4% had at least a member who was disabled or mentally ill. These findings are in line with national estimates which revealed that for all the rural households, 30% had orphans, 8% had a chronically ill or a mentally or physically challenged member (ZimVac, 2012). This scenario depicts that the resources (labour, time, finances) that are needed for the successful running of an agricultural enterprise are divided to cater for all these other challenges. Once again it is the women that take care of the children, nurse the ill, assist the elderly, take care of the homes as well as the agricultural activities. These multi-faceted responsibilities can only mean that some or all of the activities will not be given adequate attention. The vulnerability status of the households has a direct negative bearing on the viability of irrigation schemes in that, all the vulnerability categories need to be looked after by women who usually provide labour in the schemes. Parker *et al* (2009) argued that shocks to households from diseases like HIV/AIDS can reverse developmental progress threatening economic sustainability of smallholder farming systems.

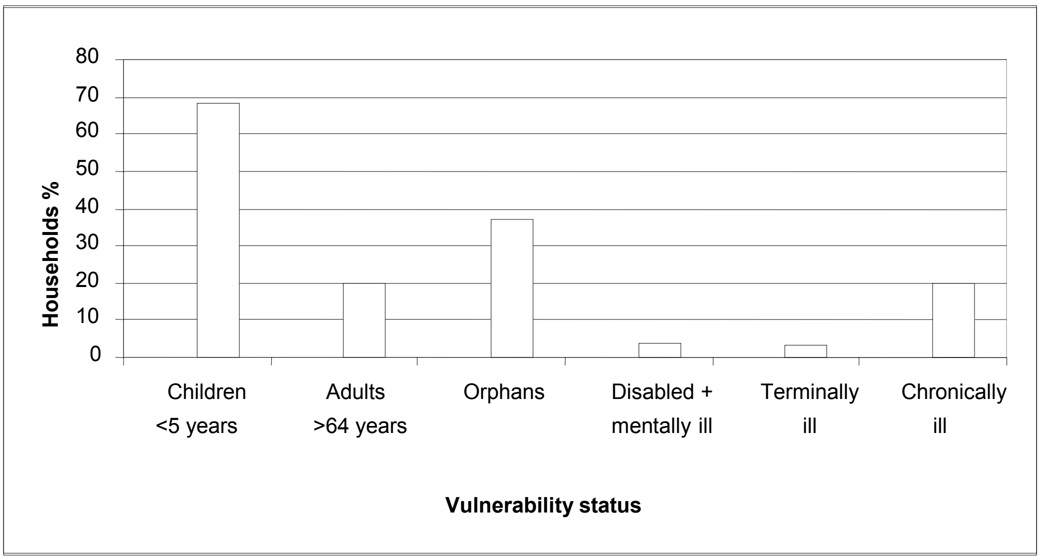

Figure 2: The vulnerability status of the interviewed households

3.2 Educational level of the farmers

The level of illiteracy was on average higher than the national average, with an average of 37% of the farmers having not attained any level of education against a national average of 18.7%. This was especially true for Dendere and Tsvovani whose illiteracy levels were 60% and 65% respectively, while at Mtandahwe only 12% of farmers had not attained any education at all (Table 2). Less than 2% of the respondents were educated beyond Ordinary Level against a national average of 3% (ZimVac, 2012). The differences in the level of education of members in the 3 irrigation schemes were found to be significant by one way ANOVA at $P< 0.005$, in favour of Mtandahwe irrigation scheme which had the least number of farmers that had not attained any level of education. In Dendere, the extension officers confirmed that due to the very low levels of literacy, farmers were not participating in training programmes that were aimed at improving the production level. The production of high value horticultural crops in irrigation schemes is usually knowledge intensive and the level of education of the farmer can be an important variable in the choice of crop and level of production. The sustainability of irrigation production at Mtandahwe could be attributed to higher levels of education, e.g. 70% of the farmers completed primary and ZJC levels compared to 40% and 16% at Dendere and Tsvovani respectively. In Sub Saharan Africa, low level of education has been blamed for limiting access to information and understanding of commercial farming concepts which are critical to sustain high production levels in irrigation schemes **(**Shah *et al.*, 2002).

Table 2: Highest level of education attained by farmers in the schemes

	Name of scheme			
Highest level of education attained	**Mtandahwe**	**Dendere**	**Tsvovani**	**Total**
None	12%	60%	65%	37%
Primary	46%	27%	6%	28%
ZJC	24%	13%	10%	18%
O' level	16%	0	17%	14%
A' level	2%	0	2%	2%
Total	100.00%	100.00%	100.00%	100%

3.3 Asset ownership

Livestock ownership in the 3 schemes was generally low, with the percentage of households that owned cattle being 69% for Mtandahwe, 73% for Dendere and 60% for Tsvovani and on average, each household owned <3 cattle in Mtandahwe and Tsvovani and 3 for Dendere. The percentage livestock ownership in the 3 schemes was higher than the national average, which was estimated at 58% during the same period (ZimVac, 2012). Goat ownership was 48% in Mtandahwe, 67% for Dendere and 77% for Tsvovani with each household owning an average of <2 goats for Mtandahwe, 4 for Dendere and 5 for Tsvovani. Cattle and goats are viewed as a symbol of wealth in rural areas, as these can be sold when the need for cash arises or slaughtered for meat to supplement the farmers' meat requirements (especially the goats) and cattle are also used for draft power. The survival threshold per household is >3 beasts (cattle) and >5 beasts (goats) (Chawatama, 2008). Thus 66% and 80% of the interviewed households were below the cattle and goat survival thresholds respectively.

As cattle are used as draft power for tilling and cultivating the fields, it was assumed that there would be a relationship between cattle ownership and full utilization of irrigation plots. The relationship was analyzed using linear regression. The output showed that there was a positive but very poor relationship between cattle ownership and land utilization ($R^2 = 0.20$). This weak relationship implies that there are other important factors that affect land utilization other than cattle ownership or simply that tillage can be hired out and paid for in cash or kind. Cattle are important as an investment or as a form of saving. The study revealed that farmers used carts to transport both inputs and outputs to and from their schemes and other non-farm enterprises and those without a scotch cart were at a significant disadvantage as they had difficulties in accessing markets and obtaining resources from common properties and individual fields. Lack of critical productive assets by the farmers ideally means high production costs as farmers are then forced to hire these at a cost, further compromising the profitability of their farming activities.

3.4 Production levels and generated income

The study identified limited access to agricultural inputs, credit, limited access to water and group cohesion as the major production challenges threatening the sustainability of the three small scale irrigation schemes. The farmers indicated the crops, yields and income they realised during the previous cropping cycle (Table 3). The level of production for the two schemes was very low. The area under maize was 0.1, 0.2 and 3ha for Mtandahwe, Dendere and Tsvovani respectively, 0.05ha under tomatoes across all schemes and sugar beans commanded 0.06ha at Mtandahwe and 0.1ha at Dendere and Tsvovani. Cotton was only grown in Tsvovani with each household cultivating about 1.4 ha and producing an average of 1505kg- realising $452. The relatively better yields at Mtandahwe could be attributed to the higher level of education resulting in a higher training in horticultural production (99%), compared to 62%, and 70% from Tsvovani and Dendere respectively. The difference in the number of farmers trained in horticultural production from the three schemes was found to be significant at $P< 0.037$.

Table 3: Crop production levels and income realised according to scheme.

Scheme	Maize			Beans			Tomatoes		
	Quantity (kg)	Yield (kg/ha)	Value US$	Quantity (kg)	Yield (kg/ha)	Value US$	Quantity (kg)	Yield (kg/ha)	Value US$
Mtandahwe	254kg	2540	64	103	1716	64	276	5520	94
Dendere	147kg	1235	11.80	95	950	40	60	1200	51.50
Tsvovani	916kg	916	94	88.5	885	44	73	1460	21.60

The low yields inhibit the farmers to reinvest into the schemes, like buying inputs for the next cropping cycle, considering that they would use the same proceeds to pay electricity and water bills. Moreso, the yields produced under maize can hardly meet household grain requirements. Conversely, before independence smallholder irrigation schemes were noted for enabling farmers to obtain a certain amount of wealth and reduced the need for drought relief grain from government by about 90 to 180 t/yr, as they were financially viable with significantly greater gross margins (Roder, 1965; Rukuni, 1984; Meinzen-Dick et al, 1993; Ruigu and Rukuni 1990; Makombe and Meinzen-Dick, 1993). The low yields in the 3 schemes confirmed the conclusion by some researchers that post Independence smallholder irrigation scheme have been characterised by low production and minimum contributions to the national economy and were not able to cover the costs of development and operations (SADC, 1992, Manzungu and van der Zaag, 1996; Chancellor, 2004). Therefore, low production level was one of the sustainability challenges of the irrigation schemes. Having displayed unsustainably poor production levels, farmers listed the production constraints in their respective schemes (Table 4).

Table 4: Production constraints of the farmers by scheme

Production constraints	Percentage of the respondents by scheme		
	Mtandahwe	**Dendere**	**Tsvovani**
Limited access to inputs	15%	53%	20%
Shortage of irrigation water	54%	73%	31%
Pests and diseases	10%	20%	21%
Problem animals	13%	0	0
Electricity charges	9%	20%	50%
Poor (earth) canals	1%	0	21%
Shortage of capital	18%	40%	29%
Lack of security on land	0	0	4%
Poor scheme management skills	0	0	27%
Poor output market	21%	47%	33%

3.5 Production challenges

3.5.1 Agricultural inputs' acquisition, sources and utilization

Limited access to agricultural inputs was one of the major production constraints faced by the farmers in the 3 irrigation schemes. The FGDs revealed that the shortage of agricultural inputs, comprising fertilizers and seeds for all crops, was the main reason for the farmers not to fully utilise the plots. In some instances the inputs were not available on the market, e.g. soya bean and wheat, while for other inputs the prices were too high. Fertilizers were not available from local shops, making their accessibility difficult as farmers had to buy them from the nearest town of Chiredzi, where availability was also erratic. If available, they would be over-priced. The acquisition of inputs from town also increased the prices due to transport costs. The FGDs also showed that the high cost of seed of some high value crop types like potatoes, sugar beans and bananas was preventing farmers from growing them for fear of failure after expending so much in buying them. In the previous cropping cycle 40%, 67% and 52% of the farmers had not used any insecticide/pesticides in Mtandahwe, Dendere and Tsovani respectively, due to their unavailability in the local market and the prohibitive high costs. All the farmers, regardless of the scheme, were not using the recommended and ideal high yielding seed varieties. For their maize crop in the previous season, 40% used the Seed Co 513 while 58% used the Pioneer 5 series varieties, which are medium yielding varieties and are mainly grown in rain-fed agriculture and 2% did not plant maize. The reasons for not using the recommended seeds were mainly the unavailability of the appropriate seed type and lack of knowledge.

Fifty seven percent of the respondents had purchased fertilizers, 21% had obtained them from GMB and 22% from NGOs. The input sources (NGOs and GMB) suggest that they were not sustainable sources of inputs. The subsidized inputs scheme by Government for the 2011/2012 season was said to have primarily targeted the communal farmers outside the irrigation schemes (Dendere and Tsvovani). Farmers from the irrigation schemes would then buy the fertilizers from these farmers, at a higher cost, as fertilizers in these areas are hardly used under rainfed agriculture. Government inputs distribution schemes for key agricultural inputs have been found to be poorly coordinated and prioritized (FAO, 2002). NGO participation in the input distribution was necessitated by the breakdown of the input supply chain following Zimbabwe's world record of hyperinflation in the 10 years preceding 2010 when both the Government and the private sector were failing to satisfy the input needs of farmers (World Bank, 2008). The participation of NGOs and Government in the input supply chain has a crowding out effect on the sustainable private sector participation in the input supply market. The input supply chain, therefore, still needs to be revitalized to sustainably unlock the production potential of the smallholder irrigation farmers.

All the farmers in Mtandahwe had used Ammonium Nitrate (AN) fertilizer in their farming operation as compared to 80% in Dendere and 92% in Tsvovani. The average application rates in Dendere and Tsvovani were far below the minimum expected for commercial production. AN (a top dressing fertilizer) and Compound D (a basal fertilizer) application rates for maize production were 290 and 262kg/ha, 150 and 157kg/ha as well as 72 and 73kg/ha for Mtandahwe, Dendere and Tsvovani respectively-against recommended commercial rates of at least 400kg per hectare for both AN and Compound D (Makombe and Sampath, 2010) The application rates used by the farmers showed that the farmers were still practicing subsistence agriculture and were not capable of breaking that cycle on their own. The farmers attributed the low application rates to the high cost of fertilizers and the unavailability of the commodities when they are most needed by the farmers.

Proper application of fertilizers increases yields, especially if water is not limited, as in the irrigation schemes. Correlating the two parameters showed that fertilizers were explaining 38.4% of yield variation for cotton, 55.6% for maize, 47.3% for beans and 53.4% for tomatoes. The positive linear relationship between quantity of fertilizers used and the yields attained, despite the low fertilizer rates used, suggest that the farmers were not fully utilizing the critical variable to boost and sustain yields. The importance of fertilizer use highlighted in the analysis was consistent with the findings in Kenya where it was noted that although yields were generally declining in smallholder irrigation schemes, yield increase was mainly due to increased chemical fertilizer use (Karugia, 2003).

3.5.2 Shortage of capital

All the farmers were not accessing loans from banks due to lack of collateral and only 17% received loans from input suppliers mainly from cotton companies. These are payable upon harvest but the fluctuations in the cotton prices were threatening the sustainability of such arrangements as the risk of price slumps was only borne by the farmers while the cotton companies recovered all the costs. Farmers used to receive loans before the year 2000, when their 99 year leases were still acceptable to Banks as collateral. This however, stopped following Zimbabwe's fast track land reform programme. Therefore, lack of credit facilities to procure inputs for the farmers was threatening the sustainability of the schemes. In trying to express the critical need for credit facilities, one farmer said "i*t is difficult for us to procure the necessary and adequate inputs, as the production costs are high, we need loans to improve our production".*

The farmers were operating below capacity due to limited access to credit facilities as FGDs revealed that, while the pumps may have the capacity to irrigate 4ha per farmer (Tsovani), some farmers were irrigating only 0.1 ha due to lack of inputs. It was observed that farmers did not realize the full benefits from irrigation schemes as their production levels remained below capacity yet the electricity charges remained high. Sentiments were that only loan provision could unlock the farmers' potential to enable them to invest in their farming business.

The lack of effective credit system highlighted by the farmers in the 3 schemes, is a universal problem in Sub Saharan Africa where it has been largely blamed for adversely affecting agricultural development in the region (Karugia, 2003). The only difference with the Zimbabwean situation was that, in other countries, the smallholder farmers have land as their collateral for institution based lending (Karugia, 2003) but in Zimbabwe, land has become worthless, in the eyes of the financiers, following the fast track land reform program and nationalisation of agricultural land.

3.5.3 Limited access to irrigation water

Another major factor threatening the sustainability of the schemes' production levels was limited access to irrigation water. Ninety two percent of the farmers had times during the year when they had limited access to irrigation water, due to electricity load shedding by ZESA (81%) as well as reduced discharge of the Save river, especially between September and November. Farmers indicated that during this period they were forced to create artificial ponds/wells from which a pump could be installed. Field observations confirmed this and the winter crop as well as planting of the summer crop were affected. Thus planting is usually delayed until the beginning of the rainy season, a scenario which makes the schemes resemble dry-land plots. This affirms Chidenga (2003) assertion that changes to the flow regimes may have significant negative impacts on downstream users in small-scale irrigation schemes.

Furthermore, pump breakdowns were frequent and sometimes lengthy periods of time elapsed before they were repaired, thus negatively affecting productivity. In Dendere the installed pumps did not have the capacity to service the whole scheme and thus were not able to fill the 10 000cm^3 night storage reservoir within 24 hours, thus further limiting irrigation water. However, in Tsvovani unequal distribution of water was the problem.

Fields that were further away from the main pumping unit received less water to such an extent that some sections of the scheme were managed more or less like dry-land fields. This resulted in conflicts which affected the development of the scheme as well as disputes in the payment of electricity bills.

3.5.4 Lack of knowledge in Operation and Maintenance

Generally, the farmers had little knowledge about the basic operation and maintenance of water pumps. Only twenty one percent of the farmers were trained in basic pump repair and maintenance with Mtandahwe having the greatest proportion of farmers (71%) with these skills. The differences in the number of farmers trained in the 3 schemes were found to be significant at $P< 0.018$. Such training was perceived critical in the preservation of institutional memory on basic skills instead of relying on outside assistance. This would reduce maintenance costs and enhance pump longevity thus prove to be sustainable in the long run. Experiences with community managed irrigation schemes in Northern Ghana also showed that many schemes severely deteriorated or broke down completely in the past 2 decades due to insufficient maintenance (Webb, 1991). In Zimbabwe, Chidenga (2003), argued that lack of information and lack of understanding of operation and maintenance of irrigation infrastructure imposes limitations to irrigation development

3.6 Typical farmer livelihoods and coping mechanisms

Contrary to general belief that all rural folk are farmers and that their livelihoods are defined by farming activities, this study shows that farming forms but a part of their livelihoods and that there are some activities which are deemed important and may override farming depending on individual farmer circumstances. Such activities as casual labour, art and craft activities (basket and mat weaving, wood and stone carving) as well as carpentry form an integral part of the community services. It must be understood that some people in these areas do not view themselves as farmers but for this study, the target population can be defined as 'farmers' as they were selected from and are members of irrigation schemes.

The target group of farmers were also engaged in casual labour, locally termed "magau" which involves weeding, cutting cotton straws, picking cotton and watering gardens for other people in order to supplement their production. Twenty six percent of the farmers in Tsvovani, 19% from Dendere and 13% from Mtandahwe were engaged in casual labour. Other activities although also important were practiced by a smaller percentage of farmers as they require a certain level of skill and/or talent and thus cannot be mastered by all.

The variety of livelihood activities employed by the farmers in the three irrigation schemes may act as disincentive for serious commitment to the schemes by the farmers (Bodibe 2006). Casual labour activities were characterised by very low wage-rates and were frequently paid for in-kind (usually maize and other types of food). These traded goods were then sold, often at poor or seasonally variable local rates, to generate cash needed for school fees or milling fees. Involvement in casual labour was also blamed for keeping household members away from their own fields, resulting in the depression of productivity, threatening the sustainability of the schemes. This finding confirms the conclusion by Pocock (2004) that in Africa, casual work is not only poorly paid but leaches commitment to work at the scheme and affects productivity.

The monthly income of the respondents was found to be generally low with 51% of the households earning less than \$100 per month from all livelihood activities, 26% earned between \$100 and \$199 and 15 % earned over \$300 as shown in Table 4.

Table 4. Average monthly income for the month of July 2012 by scheme

Average income earned	**Name of Scheme**			**Total number of respondents**
	Mtandahwe	Dendere	Tsvovani	
Below \$100	25	15	26	66
\$100-\$199	29	0	5	34
\$200-\$299	5	0	6	11
\$300-\$399	4	0	3	7
\$400-\$499	1	0	4	5
\$500 and above	3	0	4	7
Total	67	15	48	130

The average monthly income for all the farmers was \$106 and 66% of the interviewed households in the 3 schemes earned less than the national average monthly income of \$85 (ZimVac, 2012). Mtandahwe farmers had better income as 61% earned at least \$100 per month compared to 46% for Tsvovani and 0% in Dendere. The differences in monthly incomes between the schemes were significant at $P <0.008$, reflecting the relatively better production level at Mtandahwe irrigation scheme. The low income level of the farmers suggests that the farmers may not be able to make meaningful investments into their schemes to boost their productivity neither can they be able to absorb any natural or economic shock that may affect the scheme.

4. Conclusion

The study showed that the sustainability of small-holder irrigation schemes in Zimbabwe was affected by a complex interaction of different factors among them, limited access to agricultural inputs, educational level and/or training in appropriate farming skills, lack of collateral which enables farmers to access loans or working capital, erratic irrigation water supply.

In all schemes production was affected by the fact that most farmers were females, who are burdened by other multifaceted responsibilities like caring for the children, the terminally ill and the disabled thus devoting limited time to farming. The youth were only involved to a lesser extent further jeopardizing the sustainability of the schemes. Limited access to inputs (accessibility and high costs) led to limited fertilizer use, inappropriate varieties, sometimes eliminating some viable cash crops resulting in poor yields. While a positive linear relationship between quantity of fertilizer used and yields attained was found, farmers could not fully utilize this variable. Lack of collateral and thus no access to credit facilities resulted in poor investment into the schemes and sometimes farmers could not fully utilize all the land allocated to them. Erratic irrigation water supply, even for short periods of time affects yields drastically.

Mtandahwe irrigation scheme, which is fully operational differed from the other schemes in that the farmers showed a higher level of education and could thus be trained in different farming methods as well as scheme operation and maintenance. Water management was better as farmers could operate and maintain pumps. They thus realized higher yields, more income and had less conflicts emanating from payment of bills or general issues pertaining to scheme operation. Low production, characteristic of the schemes that were operating below capacity, was caused partly caused by a lower level of education, lack of training, poor servicing and maintenance of pumps, disputes over access to irrigation water and payment of electricity bills as well as devoting more time in casual labour activities rather than in the fields. The variety of coping mechanisms employed by farmers suggests that irrigation farming alone does not fully meet the farmers' needs.

There are therefore some social issues that communities should be able to solve, given the right attitudes and leadership. However, some of the problems are beyond the scope of the farmers and would need the Government to intervene, especially on the issues of land ownership and input distribution. The participation of NGO and Government in the input distribution process tends to crowd out the participation of the private sector, making the input supply system unsustainable. Contract farming could be encouraged so as to guarantee affordable and timeous input supply.

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