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Climate Change Adaptability: The economic efficacy of investing in irrigation in Chivi Rural District, Zimbabwe

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Abstract

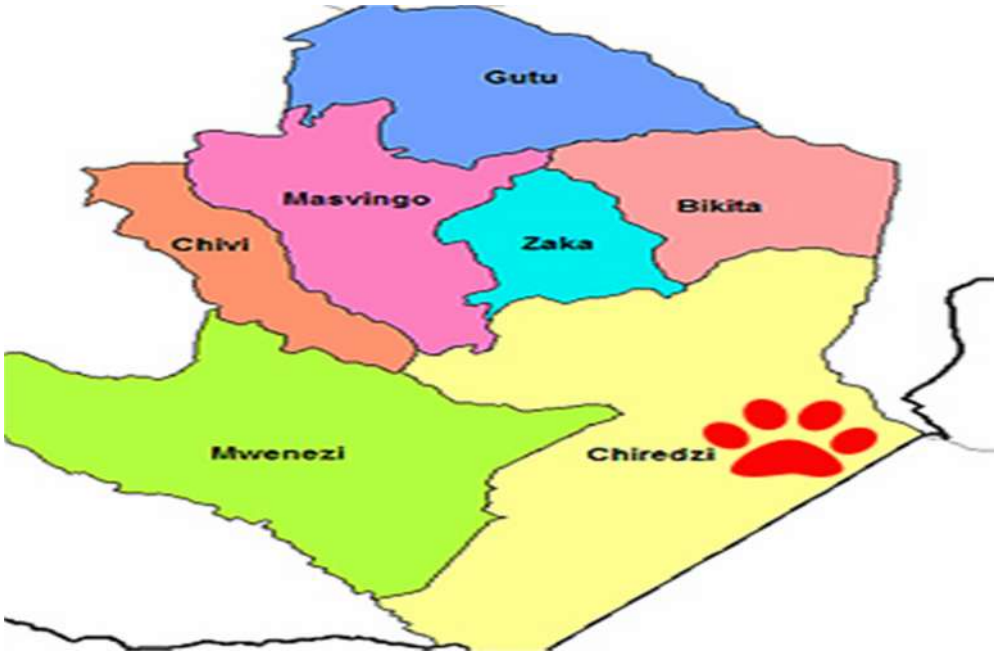
In Zimbabwe, food insecurity is linked to factors ranging from climate-change, low capitalisation of the agriculture sectorand weak landholding rights. In the country,irrigation is generally regarded as a sustainable climate change adaptability strategy especially for semi-arid regions. While there is consensus on the notion that irrigation is the solution to social development ills at community level (World Bank 2008), there is no consensus on economic benefits of investing in small irrigation in dry areas. The study collected data from 30 farmers drawn from two communal irrigation schemes (CRD1 and CRD2) in Chivi District. Scheme CRD1 is located in an area that receives 400ml - 450mlof rainfall per year while CRD2 receives >300ml of rainfall per year. The District has a population of 166 049 people of which 111 944 are females (ZimStat 2012). The study established that farmers in the District know the effects of climate change on food security but they (farmers) differed on what causes climate change.This suggests that dealing with climate change requires a multi-faceted approach. By using the Cost Benefit Analysis (CBA) and the Net Present Value (NPV) tests, the study established that irrigation has the highest economic return on investment made in CRD1 compared to the returns on investment in CRD2. The study concluded that irrigation does not always bring about positive economic returns on investment.

Key Words: Climate change, Communal Irrigation, Economic Investment, Chivi Rural District

1.0 Background

In Zimbabwe about 80% of the agricultural landis not only rain fedthey are alsovulnerable to climate variability.Rainfall intensity has been gravitating more from mean in a negative way with an increased magnitude since 1980 (Simba 2012b). In the country, temporal rainfall variation islinked to food insecurity. For instance, the 1992 drought caused a decline in the country's maize production byabout75% (World Bank 2003). Food insecurity meanslimited accessto nutritionally adequate food. According to World Bank (2008), investing in irrigation is one of the climate change adaptability strategies. In 2005 Zimbabwehad 206 000 ha of developed irrigable area. The irrigable area was composed of 30.7% large private company estates, 29.3% model A2, 14.7% model A1 and old resettlement areas, 8.3% Agriculture and Rural Development Authority (ARDA) estates, 8.3% communal areas,and 9.7% wetland cultivation (Hungwe and Matondi 2006). Growth in communal irrigation schemes wasin post 1980 when the ZANU PF-led government adopted pro-poor development policies. Some of the communal irrigation schemes which were established wereChikwara-kwara, Mushandike,Bhuka, and Mteyo (Kadzombe 2003). Communal irrigation contributeenormously to social development (World Bank 2004). Notwithstanding their contribution to social development, one wonders if investing in such schemes has an economic benefit. This research examined the perception of farmers on climate change and food security as well asthe economic benefit of investing in communal irrigation schemes in Chivi Rural District in Masvingo Province. The District is located in Natural Ecological Region V which receives >450ml rainfall per year.

Figure 1: Location of Chivi Rural district in Relation to other Districts in Masvingo Province



Source: www.googlemaps.com

The District has a population of 166 049 people of which 111 944 are females (ZimStat 2012) andmany residents survive on food aid from the donor community.

The study focused on two small scale community irrigationschemes; CRD1 and CRD2. In the schemes, each farmer holds 0.5 haunder which to plant peas, beans, vegetables and maize. The establishment of the irrigation schemes was a joint operation by Government of Zimbabwe (GoZ), the local communitiesand some private development partners. In the two schemes, traditional methods of diverting water were used. The major difference between the two schemes was temporal rainfall intensity; CRD1 receives 400ml - 450ml per year while CRD2 is located inan area that receives >300ml per year. The Null Hypothesis (Ho) of the study were; **Ho 1**: Farmers in the District are aware of the effects of climate change on food security. **Ho 2:** Investment in irrigation in CRD2yields higher economic return on investment.

1.1 Literature Review

The evolution of the irrigation sector in Zimbabwe passed through fivephases. The first phase was the colonial era (1890 – 1980). During this period, the minority colonial masters (4% of the population) refused to share the land equitably with the black majority (96% of the population) most of whom lived in abject poverty in the tribal trust lands (MAMID

2013).Seemingly, the regime's marginalisation of the blacks is reflected in Hirschman's 'Rhetoric of Reaction' which states that purveyors of timid ignorance (colonisers) rely on three types of arguments; jeopardy (changes will cost a lot and endanger previous gains),perversity (reforms will harm the people they are meant to benefit), and futility (the problems are so big that there is nothing we can do about them).

The post-colonial phase is classified intofour distinct phases. First, between 1980 and 1990 Zimbabwe was in the Growth with Equity smallholder agricultural revolution.The National Farm Irrigation Fund of 1985 and the Rural District Council Act of 1988policies promoted irrigation development in the country. More specifically, the policies were meant to support sustainable rural development in Zimbabwe (Chenje1999).The second phase in the evolution of irrigation in the country (1991-1999) wasdominated by the economic structural adjustment programme (ESAP), which itself was crafted and imposed on Zimbabwe by the World Bank and the International Monetary Fund. The ESAP was necessitated by Zimbabwe's failure to services its debt. Instead of promoting irrigation development in the country, this epoch scaled down government expenditureto the irrigation sector.

The third phase was the land reform policy of 2000 to 2008. The policy was highly successful in terms of availing arable land to the land hungry black men and women in Zimbabwe. However, the phase resulted in de-investment in the sector as many white farmers vandalised irrigation infrastructure before vacating designated irrigation schemes. Seemingly, most of the new farmers who took over the schemes did not have the capital to resuscitate the sector. According to Matunhu (2014), lack of a clear land holding rights is one of the factors which discouraged farmers from investing in the newly acquired land.

Currently, Zimbabwe is in the economic recoveryphase (2009 to date). Cluster 1 of the Zimbabwe Agenda for Sustainable Socio-economic Transformation (Zim-Asset) aims to achieve food security in the country by 2018. However, the implementation of the ZIMASSET is heavily affected by poor funding.

Zimbabwe has several types of irrigation schemes; in individually run schemes individual farmers are responsible for all their farm operations. In communal irrigation schemes a group of farmers share the same irrigation infrastructure like water source, water pump and delivery line. In the scheme each farmer is entitled to about 0.5 ha of land, which could be too big for ill-funded farmers. According to the World Bank (2008), community irrigation schemes are contributing significantly to localfood security and poverty reduction.Large scale irrigation

schemes are usually private investments where farmers can share the same water delivery system. The area covered by these schemes is about 50 ha, and may have blocks that average 20 ha (Hungwe and Matondi 2006). In these schemes, complex irrigation infrastructure that includes large canals, computerised centre pivots, night storage reservoirs, multiple stages pumping, or multiple boreholes are utilised. Investments on these farms have mainly been from (Chitsiko 1999) farmers with state assistance in the provision of subsidised credit fund such as the 1995 National Farm Irrigation Fund. Included in the list of these large irrigation schemes is ARDA which runs state-owned estates.

1.2 Research Design

This mixed methods research design collected data using a questionnaire which was administered to 30 farmers who were selected using a convenience sampling technique. The irrigation schemes themselves were selected purposively. The schemes were homogenous in terms of land size,soil type, pesticides and fertiliser use, composition of farmers and cropping. In the study, the respondents were household heads or their appointees. Data were also collected from key informants who included officials from Zimbabwe National Water Authority (ZINWA), the Department of Irrigation Development,the resident Extension Offices, and the District Agritex office. In the study social network platforms like the Twitter, Facebook and the WhatsApp werealso used. The study used bean production in the two irrigation schemes.

The collected data were subjected to cost benefit analysis (CBA) and the net present value (NPV) appraisal techniques. In this type of project analysis, the project's total cost and total benefits are compared to gauge the benefits of investing in a project. The World Bank uses this approach to evaluate the costs and benefits of implementing public projects (World Bank 2003). The decision rule in CBA is to accept projects with a positive profit at shadow prices.

The NPV is a discounted cash flow technique which relies on the concept of opportunity cost in evaluating investment projects. Opportunity cost is the calculation of what is sacrificed or foregone as a result of a particular investment decision. Present value is the cash equivalent now of a sum receivable at a later date. In this study the NPV was calculated using a discount rate (0.03); the rate is equivalent to the interest that would have been received on streams of inflows, had these inflows been saved in a savings account with a commercial bank.The formulaused is;

$$NPV = -C_0 + \frac{C_1}{1+r} + \frac{C_2}{(1+r)^2} + ... + \frac{C_T}{(1+r)^T}$$

$-C_0 = Initial\ Investment$
$C = Cash\ Flow$
$r = Discount\ Rate$
$T = Time$

or

NPV = $[R_1/(1+i)^1+R_2/(1+i)^2+R_3/(1+i)^3…..]$-Initial Investment/Investment a Time Zero.

Where:

i is the target rate of return per period or discount rate

R_1 is the net cash inflow during the first period

R_2 is the net cash inflow during the second period

R_3 is the net cash inflow during the third period and so on…

The decision rule of the NPV principle is **Accept**a project with a positive NPV and**Reject** projects with a negative NPV. When comparing two or more exclusive projects with positive NPVs, the evaluator should **Accept**a project with the highest positive NPV.

1.3 Research Ethics

The research was conducted with respect and concern for the dignity and welfare of the research participants in line with Flick's (2005) claim that researchers should endeavour to maximize benefits while reducing risks. The researcher was mindful of the fact that researchers should not invade the privacy of participants; and so interviews were conducted in places and times which were mutually agreed by the participants and the researcher. The researcher made sure that the purpose and activities of the research were clearly explained to the participants and that the respondents had the right to refuse or pull out of the study at any point during the life of the investigation. The researcher also observed the ethic that no human participants with diminishing autonomy should be involved in a study. The researcher protected the privacy and anonymity of the respondents during and after the study; in the

study, names of the irrigation schemes and identities of the respondents have not been disclosed; codes have been used.

1.4 Research Findings and Discussion

1.4.1Farmers' Perceptions toward Climate Change Variability

All the 30 farmers involved in the study indicated that their livelihoods were being affected by climate change. However, the degree of vulnerability to the effects of climate change varied depending on the location of the irrigation scheme. Farmers in CRD2 claimed to be more affected by climate variability than their counterparts. More so,the farmers differed in what causes climate; 15 farmers were scientific; they believed climate change is a result of human action on the natural habitat, 7 farmers believed the spiritual world (God and ancestors) was responsible, and 8 farmers believed that a combination of the spiritual world and human activities on the ecosystem was responsible. The first category of respondents mentioned that cutting down trees and irresponsible emission of high levels of carbon dioxide into the air where the main causes of climate change. Indeed industrial revolution (Matunhu 2014) is largely responsible for producing carbon dioxide and other waste chemicals that are injurious to the ecosystem.

The views of farmers who believed that the spiritual world causes climate change are summarised by Respondent 13 as;

> ‘Everything on earth is determined by God. He decides when to create and when to destroy. During the time of Noah, water was used to destroy the world and during the time of Lot, fire was used . . . It is now that God is about to destroy the world and climate change is a sign of the time. Some of us believe that ancestors get authority from God to punish disobeying nations and climate change is a way of punishing people.

In his Squawk or Go, Albert Hirschman argues that as long as nature is in charge of mishaps like floods and droughts, they are acts of God.

All the 30 respondents cited the major negative effects of climate change as increased run off which results in loss of top soil, increased leaching of nutrients, shorter rain season resulting in crops failing to reach maturity. The net effects of all these factors were cited as poor quality of farm produce,low yields and food insecurity.Due to climate change, livestock in

the District (goats, sheep and cattle) are becoming smaller and smaller with time. Small livestock adapt better to the effects of climate change, however the livestock have a lower value on the beef market; thus poor people have multiple challenges to deal with.

Smallholder farmers in CRD2 rated the effects of climate change more harshly than their counterparts in CRD1. One of the farmers in CRD1 gave the following narrative of the evidence of climate change in thearea;

> I hold about 0.5ha of land in the irrigation scheme. I water the crops about once a week. The advantage that we have here is that the irrigation scheme is located in a valley and the place receives more rainfall than some parts of the District. Climate change affected and continues to affect our livelihoods . . . 60 years agowe never needed to irrigate our crops, and our neighbourhood was swampy all year round. The advent of climate change has changed our livelihoods in this locality . . . . Our neighbourhood is getting drier and drier with time . . . the need for us to consider investing in irrigation.

The respondents mentioned that in the 1940s their community received more than 450ml of rainfall yearly and people could produce enough food for household use and a little surplus for trading. Their livestock were bigger than they have now. According to Respondent 2, their livelihoods aregradually being affected by climate variability. The farmer gave the following account;

> Irrigation came as an adaptability approach to food security in this area. . . We water our crops almost every day because of the scotching heat. It appears to me that the amount of water required in our irrigation scheme is increasing yearly since the opening of the irrigation scheme about 21 years ago. This is because rains are erratic, temperatures are increasing and evapo-transpiration is on the rise. Because of climate change, we now require more water and more labour to maintain the production levels in terms of quality and quantity.The greatest challenge is that our water source is affected in cases where we experience a prolonged drought like that of 2002-2003 agricultural seasons.

The above finding confirmsthe notion that farming operations in drier parts of Zimbabwe are hardest hit by climate change. Most of the respondents claimed that climate change is associated with increased drought incidences and delays in onset of rain seasons. Small holder farmers in CRD2 are hardest hit because less rainfall results in their water reservoir not filling up and hence less water for irrigation activities. The above narrative suggests that the cost of running CRD2 higher than the cost of running CRD1.

1.4.2 Appraisal of the Two Irrigation Schemes

The CBA test was used to determine the economic soundness of investing in the two schemes. In a way, the study tested the view that productivity returns are highest in irrigated lands. The test revealed that it is economically wiser to invest irrigation infrastructure in CRD1. Notably, investing in low potential lands might have a greater impact on households living in those areas but investing in high potential areas will give higher returns for the nation at large than low potential areas. Investing in high potential areas will generate more output at lower cost than low potential areas (World Bank 2003). This will lead to higher economic growth and higher wages nationally. Increase in agricultural output will result in lower food prices because supply will be more than demand and those people living in less favoured areas (CRD2) will benefit from employment opportunities and lower food prices. In a similar study in China, the results showed that highest returns were achieved in high potential areas but had minimal impact on poverty reduction and environmental issues. Thus, it is of higher economic worth to invest in irrigation infrastructure in CRD1.

Table 1: Viability of the CRD1 and CRD2 Irrigation Schemes

Parameter	**CRD1**	**CRD2**
Total Benefits	36 982.06	10 462.54
Total Costs	19 837.16	12 209.05
Total Net Benefits	17 144.90	-1746. 51
Net Present Value	17 144.91	-1 746.51
Benefit Cost Ratio	1.86	0.86
Discount Rate	0.03	

Source: Research Survey 2014

The Cost Benefit Ratio(CBR)was established using the formula(Total Discounted Benefits/Total Discounted Costs).The results show that there are more benefits received on irrigation scheme CRD1 than in CRD2. The cost of investing in CRD2 outweighs the benefits accrued from such an investment as the CBR is 0.86. This means that for every dollar invested a return of 0.86 cents will be realised hence failing even to break even by 0.14 cents. These results reject the Ho which states that higher irrigation investment returns are found in drier (less than 300ml per year) ecological areas. The CBR of the scheme CRD1 was 1.86 which means the benefits are far more than the cost of investment in the irrigation scheme.

Put differently, returns on irrigation schemes in relatively humid areas are better compared to those obtained in the drier areas of the District.

The above finding confirms Chitsiko's (1999) assertion economic analysis of agricultural activities argued that drier parts of Zimbabwe are best suited for livestock rather thancropping even under communal irrigation. The claim above opposes Chazovachii's(2012) claim that irrigation gives more economic returns in drier areas (receiving > 300ml of rainfall per year). The findings of this study also dismiss the belief that irrigation facilities are an added advantage but not a necessity in wetter regions (World Bank 2008). Perhaps the World Bank needed to quantify wetness. Faced with no quantification of moisture content, the above claim by the Bank remains controversial and contestable. In terms of the net benefit, the study revealed that CRD2 is drier which might accelerate the rate of evapo-transpiration, which itself demands more water and a higher frequency of irrigation when compared to that of CRD2. The cost of water and labour is also relative to amount of water required and the frequency of watering crops. In the area, the higher the irrigation frequency, the higher the cost of water and labour and these have a direct effect on the net economic benefits of irrigation.

The NPV (17 144.91) for CRD1 is positive, which demonstrates that communal irrigations schemes benefit those in high potential (wetter) areas than in low potential (drier) areas in the District. Since the NPV (-1 746.51) of CRD2 is negative, the decision rule is that investors should not consider investing in CRD2 for there is no economic prudence in undertaking such an exercise. Based on NPV results for the two irrigation schemes, the Ho which state that it is economically worth to invest in irrigation in dry areas is rejected.In drier areas (>300ml), irrigation schemes are for social and political benefits more than for economic benefits. This finding is in sharp contrast with investments in large scale commercial irrigation schemes like TongaatHulletwhere despite being in very dry areas, the economic return on investment is high. Large scale commercial irrigation has also transformed desert areas in the United Arab Emirates, Namibia, and Egypt.

Both the CBA and NPV tests of the CRD2 scheme were negative suggesting that investing in small scale irrigation should not be considered for communities in areas that receive less than 300ml of rainfall annually. A probe into why GoZ invests such schemes revealed that Government may invest in projects which may not necessarily have positive economic returns but their impact in terms of poverty alleviation, local employment, promote local

industrialisation (eg Growth Points) may have spin offs which will promote economic development. Government may also invest in such areas for political expedience.

1.5 Conclusions

The study results showed that climate change does affect farmers in both small communal irrigation schemes in the District. However, farmers were divided on what causes climate change; while some respondents used scientific methods to describe the causes of climate change other use traditional methods.The implication of this finding is that strategies meant to deal with climate change should appeal to different ideological persuasions of the residents of Chivi Rural District. It also emerged from this study that the farmers concur on effects of climate change on the livelihoods of the residents of CRD1 and CRD2. However, the level at which the schemes are affected is different;smallholder farmers in CRD2 are more affected than the farmers in CRD1. The study recommends further investigation into the sustainability of introducing/investing in off-farm livelihoods for the community around the CRD2 irrigation scheme. It is also advisable to carry out an econometric analysis of the influence of other variables on agricultural productivity of small holder farmers across all the ecological regions of Zimbabwe.

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