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Will Adaptation Carry the Future? Questioning the Long-term Capacity of Smallholder Farmers' Adaptation Strategies against Climate Change in Gwanda District, Zimbabwe

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ABSTRACT Globally, smallholder farmers are adapting to the negative effects of climate change. This paper uses sustainability lenses to interrogate the capacity of current adaptation strategies used by smallholder farmers in Gwanda District, Zimbabwe. In-depth interviews and focus group discussions were held with smallholder farmers, non-governmental organisation representatives, and Agriculture and Extension Services Department (AGRITEX) personnel to understand current adaptation methods used by smallholder farmers and the potential of those strategies to continue delivering positive results into the future. The study found out that most adaptation methods currently being promoted such as conservation agriculture and small grains have various implementation challenges which threaten their sustainability as long-term adaptation methods. Among other recommendations, this paper proposes that more research should be directed at understanding low-cost, labour friendly technologies and strategies for use with current adaptation methods in order to reduce the labour strain on ageing rural populations.

INTRODUCTION

Anthropogenic climate change will continue to occur for the foreseeable future (Belay et al. 2017; Eriksen et al. 2011; Padgham 2009). Even if strong mitigation measures to reduce greenhouse emissions were instituted, the benefits of such mitigation would take a long time to be realised (Nyong et al. 2007; Hassan and Nhemachena 2008; Morrison and Pickering 2013). Climate change is occurring more quickly than previously anticipated, hence adaptation and mitigation strategies must outpace the rate of climate change impact in order to protect and preserve livelihoods (Agbebi and Omoniyi 2011). This means that the world is locked up in an inevitable trap of continued global warming for several more decades to come even if we assume that mitigation measures work a miracle (Cooper et al. 2008). Consequently, adaptation is now being proffered as a critical component of responses to the negative impact of climate change as it enables communities to survive the harsh reality of climate change (Belay et al. 2017; Hopkin 2014; Vincent et al. 2013).

It has been argued that 'the extent to which natural ecosystems, global food supplies and sustainable development are 'in danger' depends partly on the nature of climate change and partly on the ability of the impacted systems to adapt' (Smit et al. 1999: 201). Wall and Smit (2005: 116) have indicated that the availability (or lack) of skills to adapt to climate change is a critical determinant of the ability of communities to withstand climate change induced shocks.

Adaptation therefore has immense power to reduce or even reverse the impact of climate change if successfully implemented. Fraser et al. (2011) point out that many forecasts on the possible impacts of climate change on socio-economic systems have been proven wrong because the mathematical modelling of the impact of climate change often considers biophysical relations and overlooks the human responses to the phenomenon in the form of adaptation.

Globally, studies show that communities are adapting to climate change using a plethora of strategies that include changing planting times, planting short term seed varieties, increasing insurance premiums against climate change related hazards, participating in first aid trainings and emergency simulations, planting trees, drinking more water on hot days and taking a swim, sharing water with neighbours and taking shorter showers (Wamsler and Brink 2015; Howden et al. 2007). This study focusses on agriculture related adaptation strategies in Zimbabwe. The need to understand adaptation strategies at the local level is explained by Howden et al. (2007) who argue that agricultural adaptation research assists decision makers who include farmers, policy makers, and agro-businesses to make both long-term and short-term strategic plans in agriculture.

In general, there is a dearth of evidence on how adaptation is unfolding in developing countries including Zimbabwe (Vincent et al. 2013). A study conducted by Mutekwa (2009) in Zimbabwe in the Midlands province, in Murohwa Ward, established that local smallholder farmers employed a number of strategies to adapt to reduced precipitation in the area. Some of the main strategies used included a switch to short season maize varieties and the adoption of drought resistant small grain crops such as sorghum and millet. Smallholder farmers also employed crop diversification as a strategy. In this case farmers would mix both short season (low yielding crops) with long season (high yielding) crops to minimise losses. Livelihood diversification was also actively pursued by local smallholder farmers (Mutekwa 2009). This involved people engaging in illegal gold panning and migrating to cities as far as Johannesburg in South Africa or Gaborone in Botswana in search of employment. Studies such as the one by Mutekwa (2009) have merely documented but not interrogated the sustainability of the adaptation methods being used.

In spite of the popularity of adaptation as the magic pill to climate change problems in developing countries, evidence shows that the adaptation process does have its own challenges (Eriksen and Brown 2011; Stringer et al. 2009; IPCC 2007). In particular literature raises questions about two different but related concepts that determine the ability of adaptation strategies to deliver results in the long term. These concepts are 'limits of adaptation' and 'sustainability' (Eriksen et al. 2011; IPCC 2007). The two concepts point to the need to not accept adaptation strategies at face value but to interrogate their possible negative side effects and failures in the long term. This paper uses the lens of the two concepts to scrutinize the future of adaptation strategies used by smallholder farmers in Gwanda District, Zimbabwe.

Limits of Adaptation

The concept of 'limits of adaptation' partly determine the capacity of adaptation methods to continue yielding results in the long term. According to Moser and Ekstrom (2010: 22026) limits are defined as:

… obstacles that tend to be absolute in a real sense; they constitute thresholds beyond which existing activities, land uses, ecosystems, species, sustenance, or system states cannot be maintained, not even in a modified fashion.

The IPCC (2007: 733), points out that climate change adaptation would not make climate change impacts necessarily negligible, and that not all climate change adaptation strategies get used because of several factors. There are several limits to climate change adaptation which make it useful but of limited value in terms of responding to climate change. Four categories of limitations are highlighted by researchers and these are (i) biophysical limits, (ii) economic limits, (iii) technological limits and, (iv) social limits (Morrison and Pickering 2013; Smit and Pilisofova 2001).

Ecological and biophysical limits exist where adaptation strategies simply fail to prevent the negative impacts of climate change (Morrison and Pickering 2013). An example is that of coral bleaching caused by a rise in sea temperature. It is unlikely that any kind of technological adaptation could stop the phenomenon (Morrison and Pickering 2013). Economic limits to adaptation are said to exist when the cost of adaptation strategies exceeds the cost of climate change impact making it unreasonable to adapt (IPCC 2007). In most instances, adaptation may simply not occur because the relevant stakeholders cannot meet the resource requirements for climate change adaptation (IPCC 2007). It was estimated by the World Bank (2006) that the global total cost of adaptation was between (USD) $10

billion and (USD) $40 billion per year (IPCC 2007: 734).

Technological limits are said to exist where available technology is inadequate to prevent climate change impacts (Morrison and Pickering 2013). For example, a study in Australia showed that some tourism business operators were coping with warming by making artificial snow for skiing. However, increasing temperatures might eventually make this impossible in the near future. Social limits of adaption entail limits imposed by social values about what is acceptable as adaptation strategies (Morrison and Pickering 2013). For example, some crop types may be culturally unknown and unacceptable in the short term. An appreciation of the limits of climate change adaptation is thus critical for decision making as it can be determined from such an analysis that which strategies are feasible for adoption, and how long the strategies can remain effective in the context of changing climate (Morrison and Pickering 2013: 11-12).

Sustainable Adaptation

Besides the notion of 'adaptation limits', consensus is now building that adaptation should adopt sustainable pathways. Eriksen and Brown (2011) have argued that what might seem to be obvious successes in adaptation strategies might in fact undermine other objectives associated with sustainable development. In their words, '…adaptation can have unintended negative effects both on people and on the environment' (Eriksen et al. 2011: 8). Adaptation strategies that appear to improve livelihoods for a particular group might increase the exposure to negative impacts for other groups (Stringer et al. 2009: 749). Adaptation might appear to be reducing risk in the short term, when it is actually increasing vulnerability in the long term (Martin and Watson 2016; Stringer et al. 2009). It has been argued that it is often the case that most current adaptation strategies lead to long term vulnerability and may even result in 'maladaptation' (Brown 2011).

The notion of sustainable adaptation has steadily gained currency in the adaptation discourse (Brown 2011). The concept arises from the simple view that adaptation does not happen in a vacuum. As it takes place, it will have both positive and negative impacts (intended and unintended) and trade-offs have to be made (Eriksen et al. 2011: 16). Sustainable adaptation is defined as:

…..…adaptation that contributes to socially and environmentally sustainable development pathways, including both social justice and environmental integrity (Eriksen et al. 2011: 8).

Sustainable adaptation essentially requires that adaptation becomes conscious of and takes care of both 'intra- and intergenerational equity' (Brown 2011: 29). In general, therefore, an environmentally sustainable adaptation strategy must maintain a stable resource base and avoid land degradation, depletion of water sources, and over-exploitation of (natural-vegetation) resources and maintain biodiversity and other ecosystem functions (Eriksen and O'Brien 2007 cited in Barnett and O'Neill 2010). With regards to social sustainability, a socially sustainable adaptation strategy must not disturb adequate provision of social services such as education, gender equity and participation of community members in other development activities (Eriksen and O'Brien 2007 cited in Barnett and O'Neill 2010).

This paper thus contributes to the widening of climate change adaptation knowledge by questioning the sustainability of adaptation strategies currently applied by smallholder farmers in a semi-arid area in southern Zimbabwe. The paper argues that both notions of 'sustainable adaptation' and 'adaptation limits' address the capacity of climate change adaptation strategies to continue delivering benefits to communities into the future. The paper uses these two notions as analytical frameworks in this assessment.

Objectives of the Study

The main objective of this study is to investigate the sustainability of climate change strategies being utilised by smallholder farmers in Gwanda District in Zimbabwe. In order to achieve this, the study begins by investigating the variety of adaptation methods used in both crops and livestock farming.

In view of the foregoing discussion, this study is guided by the following research questions:

1. What are the main climate change adaptation methods used by smallholder farmers in Gwanda District?

2. How long can these adaptation strategies continue to deliver positive adaptation results into the future?
3. What are the main factors determining the capacity of the methods used to deliver positive results into the future?

RESEARCH METHODOLOGY

This study primarily adopted a qualitative approach. Focus group discussions, structured observation and in-depth semi-structured key informant interviews were utilized for data collection. Fifteen (15) key informant interviews were administered to various respondents including local leaders like councilors and chiefs because of their strategic role in community development issues. Other key informants that were interviewed were officers from local NGOs that address issues of food security as well as the Department of Agriculture and Extension Services (AGRITEX). Observations were used to gain information on adaptation strategies used by farmers by physically observing their fields (for example, viewing contour ridges and effects of adaptation strategies on environment). The study further utilized six focus group discussions constituted by farmers from local villages, namely Fumukwe, Gohole, Mnyabezi. In each village, two focus group discussions were held, one for men, and another for women. Each focus group discussion had between eight and ten farmers. Separation according to sex was done to ensure gender balance in all cases. The purpose of these focus groups was to discuss farmers' experiences with climate change adaptation methods that they were using.

Study Site

The study uses Southern Zimbabwe as a case study. The Southern part of Zimbabwe is drought prone and it is classified under agro-ecological regions 4 and 5 of Zimbabwe's climatic regions. For example, Gwanda district falls within natural regions IV and V which are characterised by low, erratic rainfall patterns and droughts. The mean annual rainfall is 300 mm (Mzingwane Catchment Council 2010 cited in Dube 2012). As a result of these geographical characteristics, Gwanda District is one of the most severely affected district by climate change in Zimbabwe. The temperatures are already relatively high and precipitation is relatively lower compared to other regions in the country.

RESULTS

The study established that smallholder farmers in the study area predominantly practiced subsistence agriculture in the form of cattle rearing and crop farming. Climate change affected both animals and crops in different ways. Farmers broadly lamented the deterioration of grazing lands and the decline in crop yields due to negative climate related changes. They noted that reduced precipitation levels were leading to grazing lands in the area failing to mature the grass for pasture in several consecutive seasons. This depreciation of grazing pastures was leading to an increase in the incidence of cows that were dying from drought induced hunger in the area. In order to adapt to these changes, communities employed a variety of adaptation mechanisms explained in this paper.

Using Drought Resistant and Heat Tolerant Crops

The impact of climate change on local livelihoods was also particularly noted by farmers on their crops. It was indicated that the wilting of crops due to excessive heat and limited rainfall was a common phenomenon in the area. In order to stand a meaningful chance to harvest, farmers often had to plant twice or thrice in a season. In view of this problem, many farmers pointed out that they were now shifting to small grains such as millet and sorghum which were being promoted by government and local NGOs as a climate change adaptation strategy. The small grains were said to be more adaptable to climate change as they required less precipitation to mature. While the use of drought resistant crops such as small grains as an adaption strategy was found to be a beneficial strategy, studies elsewhere have argued that these crops pose an environmental challenge because the use of drought resistant crops as an adaptation strategy sacrifices the benefits of crop rotation as they are repeated over the years (Mutekwa 2009). It would thus be necessary to identify new crops that withstand heat and can be used for rotational purposes with these small grains. Furthermore, farmers complained that shifting to the use of small grains had worsened their already

acute demand for labour agricultural activities. Small grains demanded more labour as they attracted pest birds. Farmers and their children had to spend time in the fields chasing the birds from the crops. As was noted in one focus group discussion:

These pest birds are a huge problem. If you send children to watch over the fields, they sometimes end up spending the whole day in the fields wading off the birds. This disturbs their performance at school. You need clever children who will take their books to the fields. Sometimes you can plant these small grains and harvest nothing because of the birds (Fumukwe Focus Group Discussion 1, Participant C).

After school children go to the fields because the qeulea birds are more active during sun rise and sun set. Due to quelea birds, children do not find enough time to rest and to do their homework……. they spend almost the whole of April holiday scaring birds in the fields (Focus Group Discussion, Gohole village, 22 April 2016).

The process of harvesting, storing and milling small grains was noted to be more demanding than that of maize.

Construction of Contour Ridges

It emerged from the focus group discussions that one of the major adaptation methods used by local smallholder farmers against climate change with regards to cropping were contour ridges. These ridges are built across the slope of the fields. The design of the ridges is such that they are used for water harvesting and for the reduction of runoff to minimize the loss of soil nutrients through runoff. Mupangwa (cited in Gukurume 2010) notes that contour ridges have been successfully applied in Masvingo as a rainwater harvesting technique following frequent droughts that were experienced. While this method is generally low cost and easy to apply, smallholder farmers noted that the construction and maintenance of contour ridges requires a physically strong labor force and more human labor as it was a demanding exercise. The elderly people particularly noted that this adaptation strategy was largely out of reach for them as they could not afford to dig long and deep trenches. One elderly lady indicated in a focus group discussion that;

Yes, we were taught by these NGOs to use contour ridges to harvest water and prevent water runoff. They are very useful indeed in harvesting water and keeping the fields with some moisture when there is limited rain. However, by the time you complete the digging of the contours, you will be having a serious back ache. We all suffer from back aches from these things. This is hard especially for old people like us (Mnyabezi Focus Group Discussion, Participant 3, 24 April 2016).

Therefore, the sustainability of this particular strategy was dependent on age groups and financial capacity at household level. Those who could not afford to dig were able to hire casual labour for the purpose if resources were available.

Runoff Rainwater Harvesting

A similar strategy to contour ridges is called runoff rainwater harvesting. This is done through the construction of water ponds which are used to limit runoff by collecting water and allowing infiltration into the soil to take place so as to raise the water table. Runoff rain water harvesting technique is constructed adjacent to water sources such as wells and boreholes so as to recharge water tables for boreholes and wells. Boreholes provide water for livestock.

A lot of water is lost as surface runoff. We receive large amounts of rainfall in a very short time, and most of the rain will run off into streams rather than infiltrate into the ground, within that short period of time, rivers will be overflowing. What was amazing is that boreholes were drying despite heavy rains and the overflowing of rivers. Therefore, the adaptation strategy is a solution to reduce the drying of boreholes because water is given opportunity to infiltrate (Focus Group Discussion, Gohole village, 22 April 2016).

Zero Tillage Farming Method

Conservation farming (also known as "zero tillage") was another method found to be widely used by farmers in the study site. The method was widely introduced in Gwanda district by NGOs such as CARE International and ORAP under the name *Gantshompo* (literally "dig and jump" in the local Ndebele language). Officials that were interviewed from the NGOs that were promoting conservation farming noted that zero

tillage improves the storage of rainwater in the soil and thus facilitating for longer crop growth periods even if the rains are limited. A study carried out by Gukurume (2010) in Bikita revealed that zero tillage is a useful option for improving the storage of rainwater in the soil and can help mitigate agricultural drought and the strategy improved crop production in marginal rainfall regions.

In all focus group discussions, respondents argued that many smallholder farmers in Gwanda have abandoned zero tillage (Gantshompo) because the strategy is labour intensive. One participant in a FGD held in Fumukwe highlighted that,

Gantshompo is good …. the challenge is that it is labor intensive and some of us are aged….it causes back pain…when you practice Gantshompo, what you reap is far less than the effort applied during the activity (Fumukwe Focus Group Discussion, Participant 5, 21 April 2016).

Irrigation

The study also found out that communities in the study site were adapting to climate change through irrigation schemes. In particular, in Gohole the Senior Kraal Head indicated that there was a small irrigation scheme which was introduced by the Agriculture and Water Supplies Committee. However, pump machines had broken down and they had not been repaired leading to the collapse of the irrigation scheme. Available technology was inadequate for the sustenance of irrigation as an adaptation strategy. Therefore, it is critical to consider the level of technology before implementing climate change adaptation strategies. As one Focus Group Participant indicated:

….no one here possesses the skills to repair irrigation….we need money to hire skilled people…. Irrigation schemes are causing a lot of financial burden to us. As you see, no one here between us has a fixed source of income. We depend largely on migrants and they tell us where, when and how to use the money. Therefore, this is the reason why even the irrigation project adjacent to Sihawulane dam collapsed (Gohole Focus Group Discussion, Participant 3, 22 April 2016).

Stream Bank Crop Cultivation

Stream bank crop cultivation was noted to be a significant adaptation strategy for local farmers because water could be accessed easily from the rivers. River mouths and buffer zones had outstanding moisture content and fertile soils. Extensive stream bank cultivation took place in these areas. However, when vegetation along rivers was removed, the soils became more exposed to effects of denudation forces. The Zimbabwe Stream Bank Protection Act of 1952 which prohibits cultivation within 30m of streams was not observed in Ward 17. Smallholder farmers were taking advantage of the stream banks by establishing small fields to cultivate crops such as maize which is easily susceptible to low moisture availability in the soil. This can be summarized by the words of smallholder farmer during FGD who highlighted that,

Soils along Mnyabezi river have greater soil moisture, better water holding capacity. They are also more fertile than the land that we used to cultivate in our original fields before stream bank cultivation. We know that it is not good to cultivate close to the river, but what can we do? It's the only way we can survive (Mnyabezi Men Focus Group Discussion, Participant 6, 22 April 2016).

Participants argued that sometimes they cultivate maize crops twice a year when rains are good and stream bank ensures food security. As another key informant also indicated, stream bank cultivation had very clear benefits:

When your practice stream bank cultivation, you won't spend money buying food during drought because of the previous surplus (Key Informant interview with a local farmer, Mnyabezi village, 22 April 2016).

Every-one in the village, including the Kraal head have ventured into stream bank crop cultivation, how can he report us (Focus Group Discussion, Mnyabezi village, 22 April 2016).

Stream bank cultivation also led to deforestation and exposed the soil to denudation forces such as water and wind which causes soil erosion. Due to cutting down of trees the indirect impact of stream bank crop cultivation exacerbated soil erosion leading to the siltation of the local Mnyabezi dam. The researchers observed that farmers generally ignored the regulation that cultivation should not take place closer than 30 meters to the river. As such, siltation affects the continuity and effectiveness of dams as adaptation strategy to climate change effects such as shortage of water for livestock production and irrigation. Hence, stream bank crop cul-

tivation as an adaptation strategy employed by smallholder farmers in Gwanda is maladaptive as it leads to more serious economic consequences economic cost because it influences erosion and siltation. The researchers note that adapting to climate change through stream bank cultivation makes a bad situation even worse by causing the siltation of dams which are a major water source for both livestock and human beings during the dry season.

Transhumance

Smallholder farmers move cattle to faraway places such as to Esigodini, Tuli river and UMzingwane rivers. The areas were noted by smallholder farmers as having good grazing lands and water. The flipside of the adaptation strategy is highlighted by Agritex official in the department of livestock based at Manama in Gwanda district as she revealed that employing transhumance as an adaptation strategy in areas such as in Mzingwane and Tuli due to shortage of pasture and water in Southern Zimbabwe brings domestic and wild animals close together and this may result in the transmission of pathogens leading to outbreak of diseases such as foot and mouth and anthrax to cattle. These pathogens were reportedly emanating from buffaloes. In a related activity farmers were noted to be often moving livestock to better pastures within the ward or to nearby wards. In this case smallholder farmers do not build shelter instead they commute from their homes on a daily basis with livestock or leave them in grazing areas for a week on these new grazing areas.

This type of adaptation strategy causes conflict with other people where they graze their livestock due to competition for scarce grazing lands and due to people-animal conflicts in fields. Some local communities were opting to transfer their cattle during the dry season to other distant communities where there were better grazing lands. This observation is similar to what Dube and Phiri (2013) observed in Matobo District in Zimbabwe where local farmers were moving their cattle several hundred kilometers away from home in order to get pastures for them. It was noted at the study cite in Gwanda, as was the case in Matobo that this movement of cattle was always at a cost to the farmer. In particular, as one woman noted in a focus group discussion,

In this area, not everyone who got a farm under the land resettlement program got it. The ones who got farms are not forthcoming in helping those that did not get farms. The farms under the land reform program have fresh and vibrant pastures. So we ask farmers in those areas to keep our animals when there is drought here. The problem we have is that when we ask those farmers to allow our cattle to feed in their farms, they require that we should leave a cow when we take back our cattle. So if you have two or three cows, what will you have left if you give that person one cow? (Fumukwe Focus Group Discussion, 23 April 2016).

Livestock farmers collected and stored crop residues including those from maize, sorghum, millet, and groundnuts for cattle feeding. This resonates with the study conducted by Mombeshora et al. (1985), in Mangwende and Chibi district. They argued that crop residues constitute a major source of feed for livestock in communal areas. It is critical to note that this strategy of harvesting crop residues is a disadvantage in the sense that crop residues are no longer used as organic manure to improve soil fertility.

Moving livestock to better grazing lands often leads to neighbouring villages fighting because people send their livestock in areas that belong to other smallholder farmers. Competition for scarce grazing lands often leads to conflicts where animals trespass into farms. The kraal head indicated that;

People in nearby wards and villages see our livestock as a threat to their crops, considering that people dump their livestock and come back home and return after a week. As such, live stocks are not controlled hence leading to people conflicts amongst people (Gohole Focus Group Discussion, 23 April 2016).

A few well-to-do farmers also resorted to supplementary livestock feeding at the height of drought. The study found out that access to stock feed in Gwanda was determined by the level of income of the farmer. Even though some non-governmental organisations were selling subsidized stock feed, most farmers still could not afford it. Smallholder farmers without formal sources of income faced challenges to access the subsidized stock feed. Councilor of Ward 17 highlighted that;

The subsidized price is good, but not all farmers are able to access stock feed, despite that it is 9 US dollars and the standard un-

subsidized price was 15-19 dollars (Key Informant interview with Councillor, 21 April 2016).

DISCUSSION

It is evident from the findings of this study that although many of the adaptation strategies currently being employed by smallholder farmers in Gwanda are effective in the short term, there are major questions about the ability of the adaptation strategies to last the fight against climate change for the next few decades. Most of these strategies do not meet basic sustainability requirements as explained by Eriksen et al. (2011).

In particular, it was observed that some adaptation strategies were leading to an extensive use of child labour in communities studied. Children were involved in implementing adaptation strategies as they were assisting parents in the construction of contour ridges, moving livestock to better pastures, preparing the ground for zero tillage, herding cattle during seasonal transhumance, and scarring *quelea* birds in the fields. The use of child labour disturbs the education of children. A socially sustainable adaptation strategy to climate change must maintain fairness and justice and should not disturb children's access to social services and education. Disturbing children's education means that these children might not pass their school examinations, and therefore, they would remain unemployable in the better paying formal sector jobs. This leaves them entangled in a poverty trap that also exacerbates the failure to acquire adaptation resources. Adapting to climate change through small grains will evidently affect the education of children which is broadly considered as a poverty escape route for many communities in developing countries. As some researchers have observed:

Owing to the close inter-relationship of many of the stresses, caution has been expressed over the need to ensure that adapting to any one stress does not inadvertently increase vulnerability to another (Vincent et al. 2013: 197).

There is need to look into strategies to ensure that this adaptation mechanism remains viable without affecting children's education which could hamper adaptation in the long-term if communities fail to break from the trap of rural poverty.

The long term effectiveness of some of the adaptation strategies used by communities was affected by the high demands for labour. Both adaptation strategies introduced by locals and those initiated by NGOs such as Care International and ORAP in Gwanda district rely largely on an intensive applications of human labour. As shown in the findings, the stock of human labour has largely been depleted by the scourge of HIV and AIDS and the migration of young and middle aged people to South Africa and Botswana. As was shown, the use of such adaptation strategies as conservation farming and the construction and maintenance of contour ridges requires a physically strong labor force and more human labor. Therefore, while these strategies have proven to be effective in many places across the globe, their sustainability is in question in Gwanda because of the labour dynamics. Most communities indicated that the methods were not usable by communities that have a predominantly aging population as the main labour force.

In general, it would appear that most climate change adaptation strategies are imposing new labour requirements in communities that are making an effort to adapt. These new labour requirements making adaptation strategies are generally detestable for adapting communities. In another study conducted Dube et al. (2017), in Matobo District in Zimbabwe, it was shown that most adaptation strategies result in increasing labour demands for both men and women. This leads to communities being reluctant to adopt certain adaptation strategies including conservation farming and construction of contour ridges.

While some strategies, as indicated above, face resistance in terms of adoption, other strategies were more easily adopted but posed environmental hazards. Stream bank cultivation was a strategy that was reportedly widely used by local communities. However, as Eriksen et al. (2011) have shown, some adaptation strategies are environmentally unsustainable and could result in negative coutcomes in the long-term. Stream bank cultivation leads to such effects as increased soil erosion and dam siltation. In the long-term, the siltation of dams would lead to the failure of other important adaptation strategies such as irrigation because dams would have a reduced water carrying capacity. It has been argued that the main challenge in the implemen-

tation of successful adaptation strategies will be the ability of individuals and communities to navigate the complex labyrinth of limits and barriers that are encountered in the execution of adaptation (Biesbroek et al. 2013). As shown by this example some adaptation strategies are self-defeating when examined from a different perspective.

The ability of some of the strategies to be used in the long term was affected by economic considerations. In particular, the costs associated with some adaptation mechanisms made them intermittent rather than permanent adaptations to climate change. Stock feeding was regarded as one such adaptation strategy that farmers could only utilise occasionally. The cost of stock feed was beyond the reach of many rural farmers. Although it was indicated that a bag of stock feed was subsidised to as low as $7 (United States Dollars) from the market cost of $19 (United States Dollars), many farmers still could not afford the stock feed. This was made worse by the fact that livestock prices also tumbled in drought years, thus making it difficult to sell livestock to buy stock feed. Vincent et al. (2013) have argued that the strategies that some of these communities in fact apply are coping strategies rather than adaptation strategies. They argue that adaptation strategies are by nature permanent to semi-permanent while coping strategies are generally temporary usually being employed for one season and perhaps not the next one. Cost was observed as a major influence on the longevity of these methods in adaptation. Other adaptation methods such as the sale of cattle to buy stock feed were also not successful because of deep seated societal beliefs about the value of cattle and the hope that seasons would turn out different from what was forecasted. This is in line with the observation by Adger et al. (2009) who argue that individuals and the societies that they come from have their actions shaped partly by deep seated and embedded cultural and social norms.

CONCLUSION

In conclusion, this study found out that smallholder farmers in Gwanda District employ a variety of methods to adapt to climate change in agriculture. Adaptation methods were being applied both in livestock rearing and in crop farming. With regards to crops, the main methods used to adapt to climate change included contour ridges, conservation farming, shift to small grains, stream bank cultivation and irrigation. The study noted that while most of these strategies have been useful in increasing yields in the short term, they posed major problems for the future, thus bringing into question the sustainability of these methods as climate change adaptation strategies into the next decades. The main challenges posed by the methods included excessive labour requirements for an ageing population depleted by outward migration to South Africa and Botswana. Furthermore, environmental degradation was noted to be a major challenge deriving from such methods as stream bank cultivation. Irrigation farming posed major financial constraints with regards to the pumping of water, procurement of pump fuel and the servicing of the pumps. As a result, the local irrigation scheme was failing. The methods used in climate change adaptation for livestock farming were also noted to be effective although their sustainability was also in question. Two major methods of adaption were noted, which were transhumance and stock feed supplements. Transhumance was noted to be causing human conflicts as villagers with more yielding pastures defended their territories. The use of stock feeds was found to be too expensive for most local farmers although stock feed was often sold at subsidized prices.

RECOMMENDATIONS

The study makes several recommendations with regards to improving the sustained use of adaptation methods cited in this study. Firstly, the government of Zimbabwe and other development actors should investigate the possibility of assisting households with ageing populations with machinery for labour demanding work such as contour ridge digging and conservation agriculture. Secondly, development agents (individuals, government and NGOs) should develop a coherent systematic effort to collect, develop and distribute cheaper stock food in areas where climate change induced drought has become a norm in order to save livestock. This stock feed may be developed from locally available products. Thirdly, development planners in the agricultural sector should ensure that irrigation equipment used for community projects adopts less sophisticated equipment that is easy

to maintain and repair. Local people should be trained for regular repairs and maintenance of any machinery. Fourthly, the researchers recommend research into pest birds control in small grains farming. There may be a possibility of crops that are not palatable to the pest birds or perhaps some technology to be used against the birds. Finally, a stricter enforcement of environmental regulations in communal areas is recommended in order to ensure adherence to laws that protect the environment from harmful maladaptation such as stream bank cultivation.

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