# Local Knowledge Adaptation Measures in Responding to Climate Change, for Sustainable Development, in Southern Africa

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***Abstract*:-The study sought to examine local knowledge adaptation measures in response to climate change in Southern Africa, with specific reference to Chivi District in Zimbabwe. A qualitative approach, informed by the interpretative paradigm was adopted. Data was collected using focus group discussions comprised of elderly community members. This was augmented by interviews that included Meteorological Officers and Environmental Management Agency Officer and observations made by the researcher. The results revealed that adaptation measures were adopted for crop farming, livestock agriculture and other livelihood adaptations. Crop farming adaptation included use of infiltration pits, crop diversification, staggering planting dates, mulching, rain-making ceremonies, collective farming and *Zunde RaMambo.* Livestock adaptations include livestock diversification, relocation, food preservation and alternative water sources. Other methods of adapting to climate change include food diversification, selling wild fruits and establishment of woodlots. Some of the adaptation measures were now losing relevance, for instance, rain making ceremonies as people shifted from the traditional regard of spiritual matters. This has adversely impacted on the adaptation measures to contribute towards the community's sustainable development. Poverty and hunger in the Chivi community continues to be a humanitarian issue worth of consideration by the government.**

***Keywords:*** **Local knowledge; Adaptation measures; Climate change; Rural agriculture; Sustainable development.**

## I. INTRODUCTION

Local knowledge adaptation measures refer to ways integrated into a community's philosophies, understandings and skills. These measures are developed by societies over a long period in response to changes in their environment, including climate change. Local knowledge informs decision-making about fundamental aspects of day-to- day life for rural and indigenous people. It is a unique way of knowing crucial tenets of the world's cultural diversity, and provide a foundation for locally- appropriate sustainable development (Rurinda, 2014).

Local knowledge has three important features. It is local as it is rooted to specific sets of experience, and developed by individuals residing in a particular place. Transferring the local knowledge to another place may result in local knowledge dislocation; hence it becomes irrelevant to that other place. Local knowledge is transmitted via oral means, imitations and demonstrations, hence reducing it to writing may distort some of its essential qualities. Local knowledge is said to emanate from a community's practical engagement in daily living. Therefore, it is reinforced by experience and through trial and error over long periods and transmitted from one generation to another (Sacks, Deryn, Foley & Ramankutty, 2010). This study focusses on local knowledge adaptation measures by Chivi District communities in response to climate change.

The world is experiencing significant changes due to changes in climatic conditions and Southern Africa has not been spared. Changes have been experienced in the soil, rainfall patterns, weather conditions which in turn affected agriculture, forestry and energy sources. Barry and Chorley, 2009) records that climate changes have been recognised from 1840s upon the discovery of former Ice Ages. These have been a result of plate tectonics movements and natural oscillation of the earth. This has been augmented by anthropogenic causes as human activities and industrialisation increased emission of carbon dioxide and greenhouse gases (Gupta, 2012; Christopherson, 2012; Malachin, 2013).

Changes in climate adversely impact the agricultural activities. The effect can be so overwhelming for rural communities who often lack requisite scientific knowledge and resources to counter such adverse impacts (Masika, 2002). Given that the effects of climate change are unavoidable, there is need to develop ways for surviving in affected environments, hence the development of adaptation measures. Climate change adaptation was advocated for by the IPCC (2001) which observed the importance of adaptation which may produce immediate ancillary benefits in reducing effects of climate change, though the approach does not prevent all damages. This is crucial for rural communities in Southern Africa and other developing countries which are basically agrarian based.

Brisman, South and Walters (2018) proffer that climate change impacts increase inequalities between the poor and the rich thereby leading to 'climate apartheid'. The rich will thus use their capital to live 'comfortable' whilst the incapacitated

developing countries are bearing the harsh impacts of climate change. The role of IKS in climate change adaptation for sustainable community development has been a subject of research. Prior studies have highlighted that scientists concur that IKS is useful in climate change adaptation as it relies on locally available skills and materials which makes it a cost-effective method for rural communities (Tanyanyiwa & Chikwanha, 2011; Mawere, 2014). This was confirmed by Chikaire and Nnandi (2011) who highlighted that climate experts are now integrating indigenous African Knowledge into their approaches as they endeavour to salvage agriculture from the devastating effects of climate change. More importantly local knowledge is well adapted to the culture and environment where it is applied, unlike modern technology which is foreign and might not work for the concerned people.

Indigenous African people have immense local knowledge which helps them in sustaining their livelihoods. A study by Chikaire and Nnandi (2011) suggests that farmers in Africa can predict and interpret weather patterns which are useful in their cropping decisions and assessing potential vulnerabilities. Ajani et al. (2013) found that in sub-Saharan Africa, farmers make use of indigenous knowledge to reduce their vulnerability to climate change. Common measures include intercropping, use of short season seed varieties, crop diversification and changing type of domestic animals reared. Similar strategies were noted by the UNFCC (2007) which found that farmers in Western Sudan shifted from goat rearing to sheep keeping as a mode of adapting to climatic events. Such approaches were found to be affordable as less financial resources and technical knowledge is required.

Kpadonou, Adegbola and Tovignan (2012) acknowledged the importance of using local knowledge in adapting to climate change in Oueme Valley in Benin. Households sought to extend their farming season by growing crow crops on the dyke of the finger-ponds (*kanfli*) during the dry season. This helped to increase food availability even when they experience flooding during the rainy season. In another study Chengula and Nyambo (2016) conducted a study in Kenya on the significance of indigenous weather forecast knowledge and practices under climate change. The study found that local farmers trust and use their traditional practices to predict weather. Common approaches include observing of behaviour of birds, insects, animals, plant phenology and environmental changes on mountains to forecast rainfall patterns. The Malachile sunbird's (*ndelerefa*) was integral as its singing after a prolonged drought in January and February meant nearness of a wet season, hence farmers should commence preparations as this is indicative of a good rains.

Shoko and Shoko (2013) established the usefulness of farmers Indigenous Weather Forecast systems in Mberengwa, Zimbabwe. Farmers relied on abiotic body indicators such as the presence of halo around the sun which they allege to indicate heavy rains, a moon with tilted orientation indicates drought and the presents of a prevailing easterly wind which shows an imminent drought.

Several studies have also been conducted in the Pacific Islands, an area vulnerable to disasters such as intensified cyclones, droughts, soil and groundwater salinization as well as increase in both land and sea temperatures due to movements in sea level (Bettencourt et al., 2003; Mimura et al., 2007; Hall, 2008). Common adaptation strategies for the communities in these Islands include house construction, food preservation and management of their natural resources (Lane & McNaught, 2009). Similarly, Anderson (2002) investigated adaptation strategies for people on the Island of Yap. The study revealed that women applied their local knowledge about the hydrology of the area to obtain drinkable water by digging wells deep enough to reach freshwater.

The studies reviewed above suggest variations in adaptation measures followed from one community to another. Local adaptations were determined by the nature of changes being experienced. Therefore, local adaptation was applicable to a particular area as changes brought by climate change differed from one community to another. It is important therefore for people to draw from their field experiences and understand the link between their communities and their natural resources. Given that climate change adaptation measures cannot be generalised amongst communities, this study sought to explore the adaptation measures being utilised in Cihivi District in Zimbabwe.

## II. METHODOLOGY

The study employed the interpretive paradigm in line with Cohen et al. (2013) to explore complex social construction of meanings, values and lived experiences in relation to adaptation to climate change. Through this paradigm, inductive procedures were pursued, shaped by the researcher's experience in collecting and analysing the data. By so doing, the qualitative multi-case approach was adopted in order to gain insight on the nature of the local knowledge used by Chivi inhabitants in adapting to climate change. The approach to view the issue of climate change adaptation from the viewpoint of the target population was desirable as the issue of local knowledge is contextual in nature, hence the need to study the people in their natural settings.

Chivi District was divided into three regions with different distinct soils and rainfall patterns, Chivi North, Chivi South and Chivi Central. The sample comprised of twenty four (24) elderly people, aged 50 years and above who were born and bred in the district with requisite information on climate change in the area. These individuals participated in focus group discussions of six participants in each group. Two focus group discussions in the three regions of Chivi were carried out separately The other group comprised of an Environmental Management Official for Chivi District and two (2) Meteorological officers, who brought into the study technical knowledge on farming practices, environmental practices and information on climatic data in the area, respectively. These individuals participated in the interviews conducted. The focus group discussions and interviews

augmented by information from observations conducted by the researcher.

## III. RESULTS AND DISCUSSION

The adaptation options examined were in relation to (1) Crop farming adaptation, (2) Livestock, Water and Vegetation Resource Adaptations and (3) Other livelihoods adaptations.

### *3.1 Crop Farming Adaptation*

Climate change in the form of extreme weather events such as high temperatures and rainfall variability were found to have adverse impacts on crop production. As a result, Chivi residents have resorted to numerous ways for adapting to such changes including measures shown in Table 1. The table shows the adaptation option and how the choice contributes to sustainable development.

Table 1: Crop Farming Adaptations

| **Adaptation option** | **Contribution towards sustainable development** |
|---|---|
| Infiltration pits | • Water retention in the fields<br>• Reduces water loss by evapotranspiration<br>• To manage soil fertility<br>• To ensure productivity on smaller areas<br>• Reduces runoff and protect rivers from siltation |
| Crop diversification e.g. growing small grains | • To plant crops that are nutritious, requiring low rainfall and low storage loss<br>• To improve on sources of food |
| Staggering of planting dates | • To counter risks associated with rainfall variability |
| Mulching | • Water retention in the fields<br>• Reduces water loss by evapotranspiration<br>• To manage soil fertility<br>• To ensure productivity on smaller areas |
| Rain making ceremonies (mitoro) | • To ask for adequate rains from ancestors<br>• To ask for bumper harvests from ancestors |
| Zunde raMambo | • To coordinate efforts towards a social safety net for the community |
| Collective farming (*Humwe*) | • To provide assistance to the underprivileged members |
| IKS weather forecasting | • To forecast the nearness of rain fall<br>• For planning the nature and type of crops<br>• Planning survival strategies in line with possible quantities of rainfall |

*Infiltration pits*

All the FGD participants confirmed that the use of water harvesting techniques was a long standing adaptation option used in their area. This was also confirmed by the AREX and EMA officers interviewed. Farmers were given training and guidance on the use of infiltration pits as a water harvesting technique. It was noted, from observations, that farmers dug infiltration pits to a depth of 1 to 2 metres within trenches along the fields, with a spacing at 5 metre intervals. A typical infiltration pit seen during observations of the farms is show in Figure 1.

Figure 1. Infiltration pit in a field with organic manure

The farmers agreed that the use of infiltration pits would enhance crop yields as the farmers utilising this adaptation option would have better yields. Comparison of two adjacent farmers whereby one used infiltration pits and the other without such infiltration pits suggested that infiltration pits would enhance yields by 100%. The farmer who used infiltration pits harvested 2 tonnes of sorghum over a 2 hectare piece of land Figure 2(a) whilst the other farmer did not harvest anything from his maize field over the same size land. It can be observed that the use of infiltration can enhance farmers' yields. Therefore, the results suggests that, within the Chivi area, infiltration pits are an adaptation measure worth of consideration as they may contribute towards the community's sustainable development through poverty reduction. However, the use of infiltration pits was declining as the farmers cited its requirement for labour intensive in the face of an ageing population in Chivi area. There was an increasing shortage of the active population which was migrating to towns and neighbouring countries in search of other sources of income.

*Crop diversification*

Chivi residents were now resorting to crop diversification to mitigate losses associated with a growing a particular crop. All the participants indicated their usage of crop diversification, a sentiment confirmed by AREX officers who were educating the farmers on the need for diversifying their crops to maintain yields. While the common crops included maize, the farmers were now embracing the growing of small grains (finger millet and sorghum). Photo Figure 2 is an illustration of the sorghum yields despite low rainfall in the area.

Figure 2(a) Field of sorghum

Figure 2(b)

As depicted in Figure 2, diversifying crops by also engaging in small grains farming can increase yields, despite low rainfall. Farmers who engaged in small grains farming confirmed having more food resources, while other community members highlighted limited food availability as their favourite, maize, could not withstand the low rainfall received. Further, small grains are desirable as they have longer storage time, spanning more than a year yet maize storage time spans 8 to 9 months (Mertz et al., 2010). Also, the small grains were touted to be drought resistant as they do not require more rainfall compared to maize (Lobell et al., 2008). As crop diversification helps to mitigate the risk of food unavailability, it is an adaptation measure that may help to reduce poverty in the area. As such, crop diversification is a move worth of consideration as the country seeks to meet the sustainable development goals on the issue of poverty reduction.

However, the growing of small grains was less common as the Chivi residents perceived production of small grains to be labour intensive. Also, the younger generation was having challenges embracing small grains which they found unpalatable when compared to maize. Consequently, mostly elderly people were prepared to diversify towards growing small grains, crops they claimed were common several years ago.

*Staggering of planting dates*

All the participants indicated that changes in the rainfall patterns now require them to shift from the traditional planting cycles. Rain is now being received later than previous years thereby delaying the planting season. In some cases delaying planting would result in crops affected by lack of rainfall as rains stop earlier than anticipated. In line with the AREX and EMA officials' claim, there is no longer an ideal time for planting as either delaying or planting earlier was not a guarantee for better yields. As such, the farmers were now staggering their planting dates so that they have both early and late crops to spread their risk. Evidently, this imply that in one way or the other, farmers were bound to lose some of their crops due to erratic rainfalls Prediction of planting dates is now complex in these times of climate change (Sacks, Deryn, Foley & Ramankutty, 2010).

The staggering of planting dates was difficult in some cases due to lack of the requisite inputs. Only those farmers with access to inputs were better placed to stagger their planting dates. Similarly, Rurinda (2014) found that, in the Southern Africa, if the rains start very late especially in December, staggering dates as an option becomes unbeneficial. This is particularly true because the growing season becomes shorter and therefore staggering of planting dates becomes ineffective in such cases.

Basing on the results, there is no doubt that staggering planting dates may help to reduce farmers' vulnerability to climate changes and enhance the community sustainable development. Losses in one batch of crops will be mitigated by better yields in another slot. However, the success of the method towards enhancing farmers' yields is hinged on inputs availability on time. In part, it also depends on the farmers' ability to forecast rainfall patterns. This makes it imperative for the farmers to integrate this approach with other adaptation measures for forecasting rainfall patterns such as studying behaviour patterns of animals [discussed in section 3.2 below]. Failure to make use of IKS on rainfall patterns would

leave the farmers with no option but to rely on scientific methods such as weather forecasts by the meteorological department.

*Mulching*

Mulching is also another recognised crop farming adaptation to climate change in Chivi. This was practiced in order to moderate temperatures and retain moisture in the soil. Tree leaves were spread in the fields during or before raining so that the moisture is trapped within the soil while also barring the sun from directly impacting on the soils. The farmers confirmed that mulching can increase crop yields by 100% as the crops are helped to withstand prolonged dry spells. However, only 30% of the participants confirmed their usage of mulching in their fields. Also, those practicing mulching were only doing so for smaller portions of their fields. Mulching was predominantly reserved for gardens and smaller portions in the fields. This was due to the labour intensive nature of the process (Bhardwaj, 2013). Coupled with that was the lack of tress leaves for the process as most of the trees were cut to meet the increasing demand for agriculture land in the community.

The evidence points towards the potential of mulching to enhance sustainable development within the community through poverty reduction. However, the initiative may also compromise other aspects of sustainable development due to the inclination towards deforestation. As the farmers require more vegetation and tree leaves which are needed for mulching, they are likely to engage in environmentally unfriendly methods like rampant tree cutting. By so doing, more harm is done to the environment with adverse consequences in future.

*Rain making ceremonies*

Rain making ceremonies were also cited as a means through which the community requests for rains from the ancestors through spirit mediums. On specified dates as we near the rainy season, the community elders would gather and share ideas regarding the conducting of rain making ceremonies to ensure the community receives adequate rains for a bumper harvest. There were strict procedures that were to be followed, without which inadequate rains or no rains would be received at all (Machoko, 2013). Beer for the ceremony was brewed by unmarried elderly widowed women who were no longer sexually active with the help of young virgin girls who deemed pure. The ceremony was done under certain trees such as *muonde* (Fig tree) which the participants believed was associated with water (Mawere, 2013). In addition to brewing and drinking beer, the ceremony involved singing, dancing and eating roasted meat. Elderly men were sent to *Matonjeni* to perform sacred ceremonies there and upon their return, rains would fall.

However, the current 'younger generation' was said to be less fond of communicating with their ancestors as they now believe rains are received due to scientific processes and as an act of God apart from ancestors. The ancestors were also said to be angry with such views and the violations of some of the procedures for rain making ceremonies, hence less rains were being received despite conducting such ceremonies. Such views regarded less rainfalls as a spiritual issue more than climate change or other scientific explanations. Basing on the results, there are limited chances for rain making ceremonies to enhance sustainable community development due to declining usage and effectiveness of the method.

*Zunde raMambo*

The results suggested that they make use of *Zunde raMambo* in a bid to lessen the effects of poverty induced by changes in climate conditions. This is a traditional social safety net concept whereby traditional leaders keep grain reserves to distribute to the needy during distress calls. The chiefs would reserve a portion of land in which community members were called upon to till and plant crops which would be harvested by the community members. Storage facilities and distribution of food will be directed by the Chief who identifies those in need of food assistance. The *Zunde raMambo* initiative was noble idea chiefs were better placed to coordinate efforts towards the common purpose and were better placed to identify those people in need.

However, this initiative was noted to be declining in usage as the farmers could not remember when they last participated in the Chief's field. Rather, they opted to pay a certain amount purported to be for paying individuals who work in the field on behalf of the residents (Gwaka, 2017). Consequently, there were fewer activities in the *Zunde raMambo* and less food was being generated. Rurinda (2014) also reported that social safety nets were under risk as a result of poor recognition Chiefs' roles. The Chiefs roles were undermined by the perceived corruption tendencies cited by the participants.

It is worth noting that the *Zunde raMambo* concept has potential to contribute towards achievement of the sustainable development goals. This concept addresses cooperation towards tacking the issue of poverty. Such combination of community efforts are bound to realise more benefits as distinct from individual efforts. What is required is the revitalisation of the concept to remove the barriers relating corrupt tendencies by those administering the initiative and effective coordination of community members' efforts.

*Collective farming*

Collective farming or *humwe* is another initiative identified by the Chivi residents as useful in coordinating community efforts towards assisting underprivileged members of the society in their farming endeavours. A specific day is set when several households gather and work in the field of an underprivileged household who is expected to provide the labourers with food. This was useful in ensuring that all community members had a chance to plough their fields in time thereby increasing chances of better yields. However, the idea was no longer as effective as it used to be as most of the

community members prefer to maximise their effort in their own fields. Fewer participants testified to their preparedness to work in another person's field for free as they argue that such effort could be channelled towards enhancing their own yields. Basing on the results, there is potential of collective farming concept to contribute towards poverty alleviation. It is of paramount importance to reduce individualism by conscientising community members on the importance of collective efforts towards poverty reduction.

*IKS weather forecasting*

IKS weather forecasting was also adopted and developed by the Chivi community. Sixty percent (60%) of the participants used this adaptation option and they agreed that climate and weather forecasting by the meteorological office was no longer reliable and trusted their indigenous ways of forecasting weather. Commenting on official forecasts, the Meteorological Officer highlighted that official forecasts covered wide spatial area. This made them more general, hence there were chances for variations between different areas (Aguado & Burt, 2010; Lutgen & Tarbuck, 2010). Such a gap would be covered by the IKS which the Chivi residents found to be specific to their area hence can be relied on. Some of the IKS and weather forecasting measures used by the people of Chivi are shown in Table 2.

Table 2: IKS and weather forecasting

| IKS Indicator Description | Indicator meaning |
|---|---|
| • Singing of *hwaya* (rain cuckoo bird)<br>• Extreme high temperatures between August and October<br>• Occurrence of a whirlwind<br>• Abundance of wild fruits such as *chakata* (Purinari caratellifolia) and *misekesa* (Bauhinia thonningii)<br>• Presence of *shuramurove* (stock birds)<br>• Singing of *nyenze* (cicada) insects<br>• Presence of full moon | • Rains are near<br>• Signals the coming of a good rain season<br>• Onset of rains<br>• Imminent drought<br><br>• Onset of rains<br>• Onset of rains<br>• No rainfall |

The IKS information was useful for the Chivi residents as they applied the forecasts in determining crop mixture, when there is going to be enough rainfall, more maize will be desirable while forecasts for less rainfall would necessitate small grains and other drought resistant crops. As the IKS are focussed on the particular locality, there are chances of the approach to contribute towards sustainable development as people make use of what is within their reach. However, it is imperative to integrate the method with other adaptation measures for better results.

*3.2 Livestock, Water and Vegetation Resource Adaptations*

Initiatives for livestock agriculture in Chivi was influenced by changes in weather patterns, rainfall patterns and levels of rainfall. This resulted in drastic reduction in livestock kept by households with those remaining being subject to climate change adaptation. Typical adaptation measures in relation to livestock rearing in Chivi area are shown in Table 3.

Table 3: Livestock adaptation

| **Adaptation option** | **Contribution towards sustainable development** |
|---|---|
| Livestock diversification | Diversifying risk of loss |
| Livestock relocation | Reducing loss of livestock<br>Preserving draught power |
| Livestock food preservation | Reducing loss of livestock<br>Preserving draught power |
| Alternative water sources | Reducing loss of livestock<br>Preserving draught power |

*Livestock diversification*

Chivi community traditionally highly regarded cattle rearing as a source of wealth and draught power. Cattle were preferable as they can be used for domestic chores, can be used as a source of proteins when killed for beef (Tavirimirwa, Mwembe, Ngulube, Banana, Nyamushamba, Ncube, Nkoboni, 2013). Cattle may also fetch more money from the market when sold. Therefore, the multiple uses for cattle made them an integral part of household agricultural activities. However, unfavourable weather conditions and erratic rainfalls rendered it difficult to effectively rear cattle as they succumbed to prolonged dry spells. As a result, all households were diversifying their livestock by keeping domestic animals such as donkeys.

Livestock diversification has the potential to enhance sustainable development through preservation of household wealth and draught power. Donkeys were used as draught power during farming, for transporting wood fuel and for fetching water for household use from distant areas. Their desirability stems from their potential to survive prolonged dry spells (Seo & Mendelhson, 2008). Increasing keeping of donkeys was also due to the households selling their cattle and purchase donkeys which cost a lot less than cattle. The extra amount was then used to fetch food for the families. What this implied is a downgrading in terms of household wealth but retaining draught power as donkeys could do similar tasks which used to be done by cattle except being a source of proteins.

*Livestock relocation*

The households also resorted to livestock relocation from areas that are hard hit by dry spells to less affected areas. All of the participants from Chivi North and Central revealed that

they relocated their cattle to Chivi South when the pastures were affected by long dry spells and drought. Chivi North households took advantage of their relatives and friends residing in Chivi South where they relocated their cattle for safekeeping and in wards 24 and 31 (in Chivi South). Several herdsmen camped in Chivi South until pastures in their areas had recovered. Cattle relocation was confirmed by the EMA Officer who highlighted that wards 29 and 31 in Chivi South were left vacant after people were relocated to other areas during the construction of Tokwe-Mukosi dam. Therefore, the area was being used as a pastureland by farmers from Chivi North and Central. By relocating their livestock, households were able to preserve their wealth and maintain draught power. Through this approach, it was possible for households to engage in farming on time rather than relying on labour intensive approaches such as, *diga ufe* as their livestock would provide the requisite draught power.

*Livestock food preservation*

Households were resorting to preserving food for their livestock to enhance food provision during summer and winter. This practice was useful for all the farmers from the three regions as they gathered maize stalk after harvesting which they fed the livestock during winter times. However, maize stalks could be inadequate as these depend on the nature of yields, prompting for alternative sources. A few of the participants (33%) added that, in such cases, they fed their livestock with *musekesa* (Bauhinia thonningii) pods during dry seasons so that the animals survive. Household members would gather *musekesa* which are found near rivers and in river beds using sacks. The task was so involving and labour intensive, hence its usage by a few of the participants (McCarthy, Canziani, Leary, Dokken and White, 2001). However, there is evidence to suggest that livestock food preservation is crucial in sustainable development as it would assist in preserving households' livestock. By so doing, their wealth is preserved during unfavourable conditions, thereby contributing towards sustainable development of the community.

*Alternative water sources*

Households were compelled to look for alternative water sources for their livestock as dams and rivers dry up. All of the participants from FGDs agreed that they used dug out wells (*mifuku)* in dry river beds to source household water. The participants agreed that the wells did not belong to individuals but the whole community to safeguard the water from poisoning if it was an individual property. The participants alleged that water from *mufuku* is clean and palatable when compared to borehole water which is salty. Therefore, the water was used for both livestock consumption and human consumption and household chores. A typical *mufuku* from the observations conducted is shown in Figure 3.

Figure 3: A woman collecting water for household use from a *mufuku*

The concept of *mifuku* would enhance water availability for both livestock and households consumption, which is crucial for daily living. However, there are chances of disease outbreak as water is drawn from unsecure places like the river. This threatens community members' health, an integral issue in sustainable development. It becomes imperative to practice hygiene by boiling the water and the use of water treatment methods to avoid compromising community health.

### *3.3 Other Livelihoods Adaptations*

Other livelihood adaptation measures by Chivi residents were identified. These are shown in Table 5.

Table 5: Other Livelihoods Adaptations

| **Adaptation option** | **Contribution towards sustainable development** |
|---|---|
| Food diversification | Nutritional purposes<br>Reducing food unavailability<br>Income generation |
| Selling wild fruits | Income generation |
| Establishment of woodlots | Improving woodlands<br>Increasing food availability |

*Food diversification*

Food diversification was identified as another adaptation measure meant to enhance Chivi residents' livelihoods. Traditional food basically comprised of maize products, especially sadza and other food provisions for a balanced diet.

Sadza, being the staple food, was not often missed and the community defined hunger in terms of the family's inability to secure sadza provision. Given the declining sources of maize for sadza due to inadequate harvests, households were compelled to look for alternative sources of food. Such sources include the use of '*chakata'* fruit (from Parinari curatellifolia tree) to make biscuits for human consumption. Households also roasted '*hwaka'* (black monkey orange) fruit seeds and made butter and soda from marula fruits. In some cases, individuals brew '*mukumbi'*, an alcoholic drink made from *marula* (Sclerocarya birrea) fruits for selling.

Alternative food sources also provided opportunities for income generation. For instance, a Marula company in Zimbabwe which specializes in marula products, partnered with people from Chivi South and empowered them with skills to make butter, soda, nuts and brew *mukumbi* (beer). These products were consumed by the participants and sold locally. They also exported *chifandichimuka* herbal tea (Myrothamnus flabellifolius) and generated income for their households.

Food diversification may contribute towards sustainable development as it improves nutrition in the community, despite unfavourable climatic conditions. Having a variety of food types and sources is an issue recommended for good health. Through diversification, households' risk of food unavailability is reduced as they do not rely on a single food provision. Also, embracing a variety of food sources opened avenues for exporting some locally available food. By so doing, income is generated and which may be used to provide for other household needs. This assists in reducing dependency syndrome as families can cater for their own household requirements.

*Selling wild fruits*

The participants indicated that they gather wild fruits when they are in abundance in order to provide for food sources when the fruits become scarce. These fruits were also sold in return for incomes to supplement household income. Eighty percent of the participants pointed out that some of their family members especially children gathered wild fruits and sold them to passersby along roads in order to feed and support their families. Common fruits that earned income for the households includes *nyii* (Berchanmia discolor), *matohwe* (Anzania garckena), *matamba* (strychnos spinosa), *hwaka* (strychnos madagascariensis) and *tsubvu* (smelly-berry finger). Motorists who came from areas far from Chivi were most of the customers who were prepared to pay for the wild fruits, contributing towards household income. However, the practice was common after harvest and in winter when there is less agricultural activities. During the rainy season, the practice would interfere with routine family chores in the fields.

*Establishment of woodlots*

Chivi residents engaged in establishing woodlots as part of vegetation resources adaptation. Most of the participants (54%) were involved in the establishment of woodlots, individually and collectively. Collectively woodlots were being established in partnership with EMA. The EMA Officer explained that the establishment of woodlots was meant to improve on the declining woodlands in Chivi District. Both indigenous and exotic trees were being grown. Woodlots have been established in Chivi North (Nyevedzanai in ward 8) with mango plantations; Chivi Central (Mavhundusi and Gwatiringa villages and in wards 11 and 15) with gum plantations and indigenous trees respectively. In Chivi South woodlots have been established in Sungai Village (gum trees), ward 17 (indigenous trees), Mbeva village (gum plantations) and Nyimai village (gum plantations). In contrast there were more woodlots established in Chivi South than in North and Central.

## IV. CONCLUSION

Several adaptation measures to climate change by Chivi residents have been identified. Adaptation measures identified relates to those for crop farming, livestock agriculture and other livelihood adaptations. The results suggest that some of the adaptation measures, e.g. rain making ceremonies, have existed since times immemorial within the community. They developed from the spiritual orientation of the community and are validated overtime.. Others have been imparted to the community, infiltration pits, through education and awareness by the government and other partners. These have their roots from scientific knowledge. The use of adaptation measures was influenced by the extent of labour required as labour intensive methods were not commonly used despite their potential to yield positive results. Several adaptation measures were found to have potential to contribute towards sustainable development within the Chivi area. It was observed that sustainable development could be attained if the farmers combine several adaptation measures as distinct from relying on a single measure.

Basing on the results of the study, it was recommended that Chivi community members should integrate and combine several adaptation measures as reliance on a single measure would yield less results. For instance, embracing crop diversification and staggering of planting dates. There is also need for education and awareness on the need to embrace climate change adaptation measures within the community's reach. For instance, embracing the farming of small grains, farmers are able to produce food enough for their families. Community empowerment is also crucial so that they can be self sustainable, without the need to look up to the government for food provision which would create donor syndrome.

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