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Enhancing disaster risk reduction through adoption of climate smart initiatives in marginal communities of southern Zimbabwe

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ABSTRACT

Climate change and variability are exacerbating communities' vulnerability and exposure to climate induced disasters and risks. The paper examines the contribution of climate smart initiatives in enhancing disaster risk reduction in vulnerable and exposed communities of Chiredzi District. The research adopted a mixed research design of both qualitative and quantitative methods where questionnaires, interviews and observations were used. Questionnaire administration was done to randomly selected households using the Kobo collect software. Interviews were conducted with purposively selected key informants from CARE, PLAN international, the Department of Agricultural Technical and Extension Services (AGRITEX), The Veterinary Services Department, Rural District Council and the District Development Co-ordinator's office. Findings revealed that climate change manifested through increased occurrence of hazards such as floods, drought and dry spells which were significantly compromising food security status that is availability, utilisation and access to the communities of Chiredzi District. Several climate smart initiatives were being implemented in the study area to reduce the impacts of climate-induced risks on the major livelihood sources, crop and livestock production as well as those that directly threatened human lives. Adoption of climate smart initiatives was significantly contributing to strengthening of community capacities to withstand climate induced risks and disasters. Development actors and government must increase the number of beneficiary wards and design more initiatives so as to increase communities' capacities to withstand future shocks as climate change is projected to continue to change in the next decades.

1. Introduction

Most disasters that strike countries across the world occur due to natural hazards and climate-related hazards constitute a significant proportion. Development is often negatively impacted on by natural-hazard-induced disasters (United Nations Office for Disaster Risk Reduction (United Nations Office for Disaster Risk Reduction 2015) as these disasters destroy assets and undo development gains. As such, any sustainable development plans should include strategies that reduce impacts of natural hazards (Thomalla et al., 2018). In Africa natural hazards such as droughts have had huge impacts on national economies; for example, in Zimbabwe the 1991/92 drought contributed significantly to the 52.3% reduction in GDP from 13.55 recorded in 1991(World Bank. 2020). In addition, recurring disasters have resulted in persistence of poverty in most African countries. Africa is particularly vulnerable to natural hazard induced disasters and according to United Nations Office for Disaster Risk Reduction (UNDRR) (2011) both the private and public sectors have shown great commitment to reduce impacts of these disasters. Disaster Risk Reduction (DRR) strategies are essential for reducing natural hazard -related disasters / risks and setting the strategic direction for enhancing resilience at various levels; district, country and regional levels (Peters et al., 2019). Of concern is the fact that the occurrence of climate-related hazards such as floods, heat waves and droughts is increasing in frequency and that these extreme weather events are increasing in intensity under climate change (IPCC 2014). Thus, the impact of these events on development has become more intensified over the decades.

Agriculture is the most exposed and vulnerable developmental sector to extreme weather events in Africa and developing countries in other parts of the world (FAO 2018). The sector plays a pivotal role in national economies contributing 15–23% of GDP on average and employing more than half of the total labour force in Sub-Saharan Africa (Goede, Ooko-Ombaka, and Pais, 2019, OECD/FAO 2016). In Zimbabwe, contribution of the agricultural sector to GDP has been fluctuating over the years, depending on, among other factors, prevailing economic policies and re-

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forms as well as the nature of the cropping season (World Bank. 2020). As an example, between the period 1970 and 2018, the share of agriculture in GDP was lowest during 1992 (a severe drought year) being about 6.8% and it was highest in 2007, at 21.2% (World Bank. 2020).

As a result of climate change, yields of staple crops are declining, new pests arising, soils degrading and water availability and quality are being compromised (Middendorf et al., 2020, Nwaerema, 2020, Pareek et al., 2020, Yan et al., 2020). This has a direct effect on food security, at household and community levels, particularly for countries which rely mostly on Agriculture. This provides the rationale for adapting agriculture to climate change. Several organizations in the private and public sectors, in a bid to ensure food security and reduce poverty in the face of climate change, are pushing for Climate Smart Agriculture (CSA) at various levels (household, community, district, country and regional). CSA aims to transform agricultural development in the face of climate change (Lipper et al., 2014, FAO 2017). FAO (2017) identifies three pillars of CSA namely: i) Sustainable increase in agricultural productivity and incomes; ii) Adapting and building resilience to climate change and iii) Decreasing and / or removing greenhouse gas emissions where possible. Although most of the initiatives are not really new to communities, their improvement and adoption have now become more critical than before, given the increased intensification of climate-related disasters and associated risks. There is therefore need to accelerate adoption of proven and appropriate CSA technologies.

The current study was conducted in Chiredzi District of Zimbabwe which lies to the south-eastern part of the country, in Masvingo Province. The district is in Agro-ecological Region V which is characterized by low and erratic rainfall (Vincent and Thomas, 1960, Manatsa et al., 2020). Annual rainfall is generally below 600 mm with annual evaporation exceeding 1600 mm (Gavera, 2012). Chiredzi is a semi - arid to arid area, marginal for production of crops and suitable for extensive livestock production and game farming. Most rural communities in the district derive their livelihoods from agriculture, where both animal rearing and crop production are practised.

Specific objectives of this study were: to establish the major climate induced hazards and risks faced by communities in Chiredzi District; identify the climate smart initiatives being implemented by these communities and the extent to which the initiatives have enhanced Disaster Risk Reduction (DRR); derive lessons for possible application to other geographical areas and communities experiencing similar hazards and risks and under similar economic and social conditions.

2. Materials and methods

The research adopted a mixed methods design incorporating both qualitative and quantitative methods (Collis and Hussey, 2009). This enabled data gathering based on people's views and experiences on climate change-induced hazards and effectiveness of implemented climate smart initiatives. The qualitative paradigm used depended on interviews, focus group discussions, observations and open-ended questions while the quantitative paradigm depended on close -ended questions and statistical tests for relationships between variables used to curb climate induced shocks and stressors and successes yielded. The research targeted all 1307 households in Chiredzi District, Ward 3. Chiredzi District is in the dry zone of Zimbabwe in Masvingo Province and borders with South Africa and Mozambique on the Southern side. The climatic conditions make Chiredzi district more vulnerable to climate disasters. The research targeted stakeholders operating in Chiredzi District whose mission was to enhance disaster risk reduction through initiating climate smart initiatives and the intended beneficiaries, the smallholder farmers. For this study and in answer to the research objectives, the offices of the District Development Coordinator (DDC), the Rural District Council (RDC) the Departments of AGRITEX and the Veterinary Services, Non-Governmental Organisations (Plan International and CARE) were targeted.

Convenience sampling was adopted to select Ward 3 which was the easiest ward to access. A 10% sample was calculated from the total ward population. A 10% sampling frame produces reliable results and it saves time and resources for data collection (Fowler, 2009). With this sampling frame, simple random sampling was used to select 130 households for administration of a pre-tested questionnaire. Purposive sampling was adopted to select key informant interviewees and six were selected each from DDCs Office, RDC, Department of AGRITEX, Department of Veterinary Services, Plan International and CARE International. These were consulted to identify climate induced disasters manifestation in the district and justify the effectiveness of the implemented climate smart initiatives.

Focus Group Discussions (FGDs) were used to obtain data on manifestation of shocks and stressors in the study area. Two FGDs were conducted in the ward and groups were disaggregated by gender and age. Each group had 10 people (Mishra, 2016) and each discussion lasted approximately one hour. To enhance validity of data collected through semi-structured interviews, questionnaire and FGDs, direct field observations were made guided by an observation checklist. Images were captured to enhance observation data. The study was conducted mid-season (January–February, 2020) of the 2019/20 agricultural season.

Quantitative data gathered were coded, cleaned and analysed in SPSS version 20.0. The data were analysed for frequency distribution and hypothesis testing. Chi-square tests were performed to affirm effectiveness of implemented initiatives on selected output variables. Qualitative data from interviews, open ended questions and FGDs were analyzed using content analysis which included identifying trends and describing experiences and opinions of respondents on climate change-induced hazards and climate smart initiatives existing in the study area. Tables, graphs and narration were used to present information generated from the analyses.

3. Results and discussion

3.1. Forms and types of climate induced hazards

Various forms of hazards were identified in this study and these significantly affected individuals, households and communities at large. The hazards identified were categorized into three main classes namely, those affecting crop production; livestock production and human beings (Table 1). Research findings revealed that climate change induced hazards that affected crops were the most (41%) followed by those affecting livestock (33%) and then those directly affecting human beings (26%).

3.2. Climate change induced crop production hazards

Climate change was further aggravating yield reduction in crop production due to changes in climatic variables from normal to abnormal conditions. Erratic, low to no rainfall and late rainfall onsets with prolonged periods of extreme temperatures were the major causes of crop failure in Ward 3 and the District, at large (Interview with the District Crop and Livestock specialist, January 2020). High temperatures and low rainfall were significantly causing crop wilting and eventually crop failure (Plate 1). In some cases, excessive rains over a short period of time caused flash floods especially in low lying areas. These often destroyed crop fields and submerged crops in water. The ultimate outcome was reduction in crop yields.

Climate change has caused shifting in planting dates. During data collection (mid – to third week of January of 2020) some farmers had not yet done land preparation (and yet in a normal season, January is mid- cropping season) due to late rainfall onset. A few (6%) whose plots were closer to wetlands had planted. However, the crops failed due to insufficient soil moisture. The District Crop and Livestock specialist highlighted that average rainfall was received during the second dekad of January which was very late when compared to previous seasons when farmers used to receive the same amount during late October.

Table 1
Forms and types of hazards affecting households and communities in Chiredzi District.

Crop production hazards	Livestock production hazards	Human being hazards
• Fall army worm (affecting mainly cereal crops) • Witchweed (Striga spp) • Excessive rains due to flash floods leading to: √ Water logging √ Crop flooding √ Leaching √ Soil erosion • High temperatures causing: √ Crop wilting √ Crop failure √ Poor yields • Drought causing: √ crop failure	• Poultry diseases: √ New castle √ Coccidiosis √ Infectious coryza These have caused high deaths of indigenous and broiler chickens • Cattle diseases √ Foot and mouth √ Heart water √ Anthrax √ Foot rot • Goat diseases √ Chihudha √ Foot rot • Drought causing: √ Shortage of clean, safe drinking water for livestock √ Shortage of pastures √ Livestock poverty deaths	• Drowning of people in flooded rivers • Water borne diseases. √ Cholera √ Bilharzia √ Malaria • Severe headaches due to high temperatures • Food shortages due to crop failure • Forced illegal cross border migration • School dropouts • Human / Wildlife conflicts.

Plate 1. Maize crop affected by moisture stress and high temperatures at early flowering stage.

The average weather conditions being experienced due to climate change had affectedmany farmers' choice of crops to grow. Although farmers were gradually adopting drought tolerant small grain crops like sorghum and pearl millet these crops were being damaged by the Fall Armyworm (*Spodoptera frugiperda).*

3.3. Climate change induced livestock production disasters

Considering the climatic conditions of Chiredzi district, livestock production is the most suitable enterprise to sustain livelihoods. However, due to climate variability and change being experienced, livestock production was declining. Climate change conditions of excessive rains caused foot rot on cattle and goats, and on chickens it caused diseases such as Newcastle and infectious coryza. Reduction in pastures (due to droughts) for livestock grazing, combined with livestock diseases resulted in livestock deaths. Poultry deaths had the highest frequency (42%), followed by cattle and goats (Fig. 1).

Livestock production disasters induced by climate change and variability have called for the need to introduce and encourage farmers to adopt climate smart initiatives to enhance livestock production.

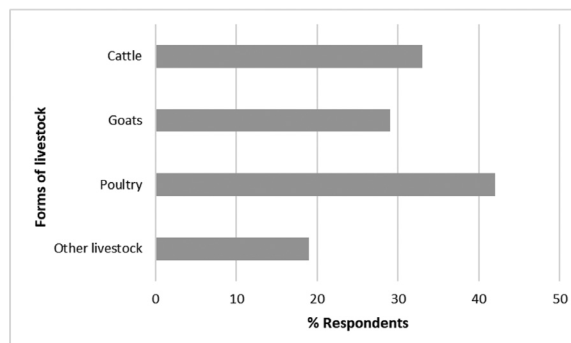

Fig 1. Proportion of farmers who reported livestock deaths.

3.4. Climate change induced social disasters

The study revealed that climate change had made households and communities more vulnerable to different kinds of risks and stresses. Extreme climatic conditions had also caused reduction in agricultural production resulting in many people becoming food insecure.

The climate induced hazards identified in this study all affected people by compromising their sources of livelihoods, that is, food production and income generation (Fig. 2)

3.5. Gender and age of populations vulnerable to climate change induced hazards

Vulnerability to the prevailing climatic variability and change conditions was compared among males, females, and children (below the age of 16). Fifty-one percent of the respondents thought that females were the most vulnerable, while 36.3% and 12.7% were of the view that males and children were most vulnerable to climate hazards, respectively. Greater exposure to vulnerability was found to be higher in women than men and children most probably due to women's roles as providers of food and general care to their families. Similarly, in a study to mainstream gender and climate change, Mainlay and Tan (2012) concluded that climate change exposed women more than men, to vulnerability because of their gender roles, for example, women have to fetch water from distant places during drought periods.

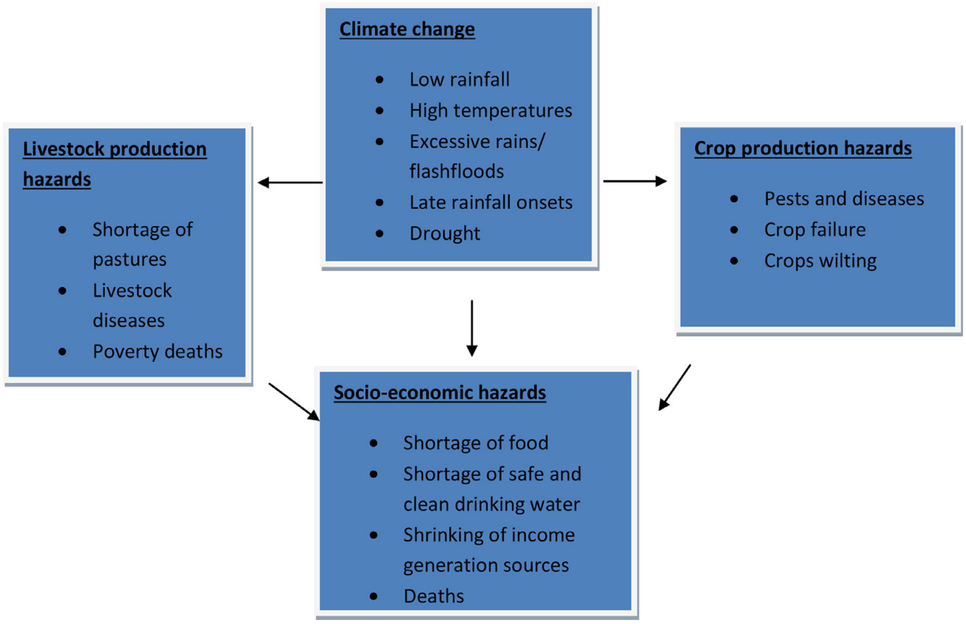

Fig 2. Climate change induced hazards in Chiredzi district.

The study findings revealed that during unfavourable cropping seasons, for example, during droughts, males migrated to neighbouring countries to search for employment. This issue was raised in a FGD comprised of females who indicated that their husbands had crossed borders to South Africa during the 2017/18 drought year. Some females were quoted saying "We are now having the burden to upkeep children, send them to school and buy them food and other necessities whilst our husbands are enjoying themselves in South Africa". In their study to explore gender dimensions on vulnerability to climate change, in semi-arid regions, Rao et al. (2019) ascertained that absence of men in rural communities was a common feature and that it enhanced women's vulnerability to climate change-related risks and stresses.

Women travelled very long distances of over 5 km to collect water and firewood. School dropouts had increased significantly and were still increasing due to the impacts of climate change. Climate change was also affecting all sources of household income and both females and males suffered from its consequences. During disaster times most men engaged in casual labour sales to sustain their families.

3.6. Implemented climate smart initiatives and their effectiveness

Manifestation of climate change impacts called for the need for development actors, communities, government departments and individuals to collaborate and design innovative strategies and techniques to curb climate induced disasters. The strategies initiated can be categorized as crop production, livestock production and community development interventions.

3.6.1. Crop production interventions

Small grain crops production: Rainfall variability and high temperatures were significantly affecting crop production. As a result, individuals, households and communities were developing mechanisms to mitigate the impacts of negative these climatic conditions. They were being assisted by NGOs such as CARE and Plan International as well as by Government Departments. To address the effects of low and erratic rains and high temperatures, farmers were increasing the area planted to small grain crops such as sorghum and pearl millet, which can withstand low soil moisture conditions better than maize. The observed adoption rates of small grain crops reflected that growing of these crops is an effective measure to guard against climate change impact on food insecurity. The study findings revealed that white sorghum (*Sorghum bicolor*) and pearl millet (*Pennisetum glaucum*) were being grown by more farmers than other crops (Fig. 3). This was because these crops were able to withstand the prevailing climatic conditions of low and erratic rainfall as well as high temperatures and they were most preferred as a substitute for maize (*Zea mays*). Red sorghum, grown by 33% of the respondents, on the other hand, was mostly grown for beer brewing and was mostly grown on contract basis. In a FGD respondents highlighted that pearl millet and white sorghum tasted better than other grain crops that were being grown to avert the impact of climate change. Other crops grown by the farmers in Ward 3 were rapoko (*Eleusine coracana*) grown by 18% of the respondents; maize (30%) and groundnuts (*Arachis hypogea*) (15%) (Fig. 3).

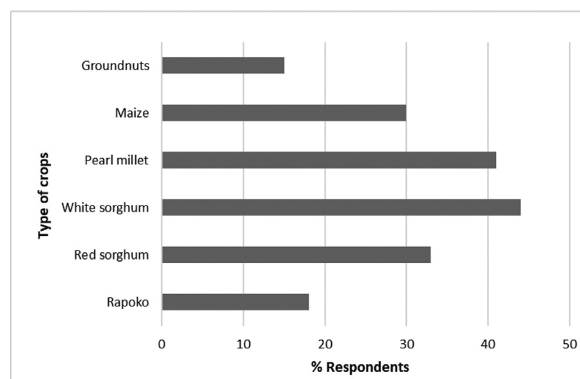

Fig 3. Types of field crops grown by the respondents.

The adoption of small grain crops has been supported by the Enhancing Community Resilience and Sustainability (ECRAS) project partners, Plan International and International Crop Research Institute for Semi-Arid Tropics (ICRISAT) through training of farmers on production practices and giving them inputs (at reduced price) to maximize production. Farmers who received seed highlighted that the seed had improved farm production and enhanced food security status. In a FGD, farmers expressed the highest level of satisfaction with these small grain crops which they indicated as their solution to recurring droughts. Analysis of AGRITEX reports, revealed that prior to involvement of NGOs in the promotion of small grain production, the adoption rates were relatively low being approximately 43%. However, after the involvement of the

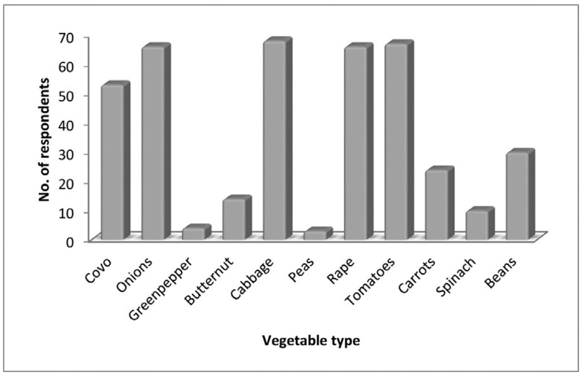

Fig 4. Vegetable types grown in established nutrition gardens.

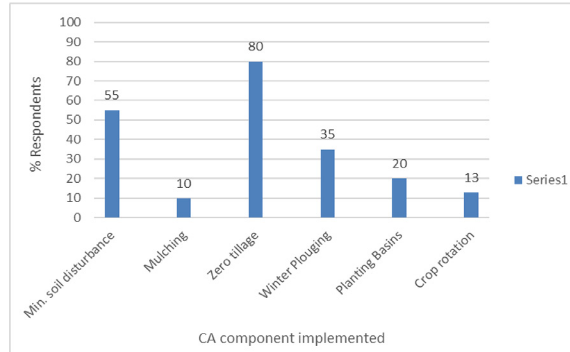

Fig 5. Components of CA implemented by farmers in Ward 3 of Chiredzi District.

ECRAS project the adoption rates rose to over 70%. The increase in the adoption rate may be attributed to availability of markets for the small grain crops (the project sourced markets for all commodities produced by project beneficiaries) and introduction of improved (high yielding; less prone to bird damage) varieties. It is worth noting that reasons for the generally low adoption rates for small grain crops across the country include low preference as food (compared to maize); low yield potential; high labour requirements for both cultivation and processing; limited markets and bird damage (Phiri et al., 2019). Despite these perceived challenges, growing small grain crops remains a key strategy in the face of climate change and climate variability and efforts to reduce these challenges should be reinforced.

Solar powered boreholes and nutrition gardens: The ECRAS project further assisted farmers in the study area to uptake water from the subsurface through introduction of solar powered boreholes. This was done to supplement moisture supply to crops during moisture stress periods resulting from erratic and low rains. The solar boreholes facilitated the establishment of nutrition gardens. The initiative had notable successes which included improving food security status of many households. Farmersworking these gardens indicated that they were doing double cropping due to constant availability of water. Results revealed that, from a nutrition view point, the initiative was of great importance as it facilitated growing of vegetables which included cabbage (*Brassica oleracea var. capitata),* covo (*Brassica oleracea var acephala*), rape (*Brassica napus*), carrots (*Daucas carota*), spinach (*Spinacia oleracea*), onions (*Allium cepa*) and tomatoes (*Lycopersican esculentum*) (Fig. 4). The major vegetables were thus, leafy vegetables, tomatoes and onions.

Solar powered boreholes, unlike those which use conventional sources of energy (e.g. diesel powered ones), have low operation and maintenance costs and have long life spans, factors which collectively promote sustainable water supply (IRENA 2016). Hence, their suitability in rural communities where households are generally resource poor and cannot afford high costs of operation and maintenance. It was learnt that local community members were being trained on maintenance of boreholes a factor which contributed to sustainable water supply.

Conservation Agriculture (CA): In this paper CA is taken to refer to any practice that conserves the soil, water and energy, resulting in sustainable production. Of the 130 sampled households, 63.6% were trained in CA, while 60.6 % were practising CA. It was established that farmers in Ward 3 practised different components of CA either singly or in combination. Zero tillage was being used by the highest proportion of respondents (80%), followed by minimum tillage (55%) and winter ploughing (35%), while mulching was used by the least number of respondents (Fig. 5).

There were three major reasons why 39.4% of the respondents were not practising CA namely: shortage of labour (cited by 31%), lack of knowledge (46%) and lack of interest (23%). Minimum & zero tillage practices reduce the need for conventional tillage which requires one to have adequate draft power and the associated tillage implements; hence the technologies are handy for the farmers without draft power and / or implements. This may explain why a high proportion of the respondents opted for these tillage systems. It is also likely that the farmers understood the other advantages associated with minimum disturbance of the soil, since some had been trained on the subject; for example, soil and water conservation, as opposed to conventional tillage where soil is immensely disturbed. In Zimbabwe the problem of draft power shortage has been highlighted in several studies and some researchers have established that 25–55% of the smallholder farmers faced challenges of draft power shortage (Makuvaro et al., 2017, Mutambara, 2015, Mutami, 2015), depending on region.

Few farmers (10%) used mulch from crop residues to reduce soil water loss through evaporation. Mulching also smothers weeds, whose prevalence is high under most CA practices. The major reason for low adoption of mulching was that farmers had an alternative use for crop residues as animal feed during the dry season. It was also noted that the ECRAS project had introduced fodder production and preservation to farmers to compliment natural grazing which was often in short supply. Thus, some of the farmers grew crops such as fodder sorghum and velvet bean solely for this purpose. They got initial seed from the project. For mulching purposes, farmers could consider alternative plant (non-crop) material, if available.

Winter ploughing conserves moisture and controls early weeds. At the time it is done the soil is still moist and draft animals are in relatively better condition compared to what they are during summer ploughing. Relatively few farmers practised it probably due to lack of draft animals and / or implements.

The proportion of respondents rotating their crops was rather worrisome (only 13%), given that the practice has been on the cards for a long time and given the potential benefits (e.g. efficient use of water and nutrient resources; breaking of pest and disease cycles) that can be accrued from such a practice. There is need for extension service providers to assist farmers adopt crop rotations.

Benefits of using planting basins are well documented (Marongwe et al., 2012, Mazvimavi et al., 2010). However, the labour intensive nature of this practice is prohibitive to their adoption (Grabowski and Kerr, 2014, Marongwe et al., 2012, Mazvimavi et al., 2010). As a result, those who use them do so on relatively small fields compared to when conventional methods of growing crops are used.

Adoption rates for CA were relatively high in Ward 3 compared to the average national rate of approximately 35% (Mango, et al., 2017). This was due to the on-going ECRAS project activities, meant to enhance communities' resilience and sustainability, which had started three years back from the time of the study, in Ward 3.

3.6.2. *Implemented livestock production initiatives and their effectiveness*

Climate change impacted negatively on livestock production, through many ways. Some of the identified effects included high disease incidence cited by 37% of the respondents, lack of pastures (29%),

A. B.

Plate 2. (A) Cross sectional cattle kraal
(B) Raised goat pen

lack of financial resources (3%) and lack of drinking water (11%). These have prompted designing of innovative tools to address climate change impacts.

Fodder production and preservation and water troughs: Droughts and low rainfall have led to shortage of pastures and numerous livestock poverty deaths were recorded. Farmers in the study area were trained to produce and preserve fodder for livestock, cattle in particular. Fodder was prepared using locally available stover and urea. Of the sampled households, over 50% had adopted fodder production and preservation. Farmers who managed to prepare fodder indicated that they had recorded less or no livestock deaths at all due to shortage of feed, an experience which was likely to encourage other community members to adopt the practice.

The ECRAS project with its initiative of installing solar pumps on boreholes helped to reduce the problem of shortage of safe drinking water as livestock drinking troughs were constructed at the boreholes. This helped to reduce trekking distances from 5 to 2 km, on average.

Livestock housing structures: The ECRAS project further intervened and trained farmers to construct improved livestock structures. This was an initiative targeted to prevent diseases such as foot rot in goats and cattle and air borne diseases in chickens caused by poor ventilation. It was noted that muddy conditions prevailed in livestock pens , especially during the rainfall season. These conditions favoured occurrence of foot rot, a contagious disease that causes inflammation of the foot and subsequent lameness in hoofed animals (Petrov and Dicks, 2013, Currin et al., 2009). Maroyi (2012) identified foot rot as the most common disease affecting goats and sheep in the Nhema communal area, in central Zimbabwe.

According to the farmers, in addition to promoting foot rot, muddy kraal pens were not conducive to animals as they could not lie down when housed overnight. This led to failure of animals to effectively graze when released during daytime. Introduction of the three- sectional kraals (Plate 2A) by the ECRAS project, helped in reducing the effects associated with muddy kraal pens as cattle would be housed on a rotational basis. For goats, raised pens were constructed to house the animals (Plate 2B).

The major poor ventilation-related diseases affecting poultry in the study area were Newcastle and *infectious coryza* diseases. Farmers adopted fowl runs with improved ventilation and raised from the ground by about 30 cm to reduce effects of high temperature. According to Aviagen (2009) ventilation also regulates humidity and prevents wet, caked litter and ammonia build - up which leads to health and reduced performance problems in poultry production.

Of the sampled population, 48% had constructed improved chicken structures, whilst fewer respondents had constructed raised goat structures and three-cross sectional kraals (Fig. 6).

Adoption of improved livestock structures significantly led to increase in livestock numbers and quality as revealed by chi-square tests results. Chi square test results revealed that there was a strong positive relationship (P value= 0.002) between adoption of livestock structures and increase in livestock numbers.

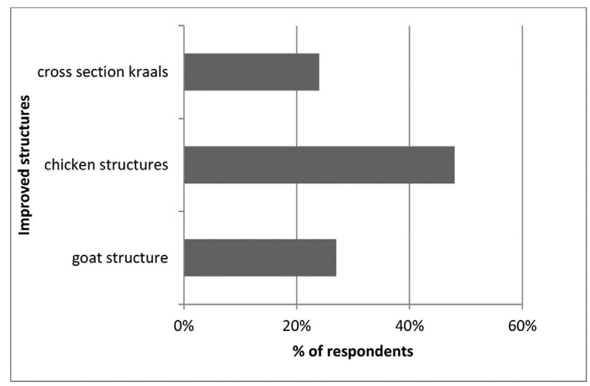

Fig 6. Proportion of farmers who constructed improved livestock structures.

3.6.3. Community development initiatives to reduce climate induced hazards

Farmers in Chiredzi District rely on crop and livestock production as their means of livelihoods, that is, for income and food. However, these had been greatly and negatively impacted by the effects of climate change to such an extent that they could no longer earn a living from crops and livestock production schemes, alone. Households engaged in Village Savings and Lending (VS&L) as a strategy of generating income and adapting to climate change. VS& L were modified and multiplied under the ECRAS project and farmers continued to sustain this initiative and formulated more groups. It is an off-farm activity whereby people form groups of 10 and above but not exceeding 25 members. Of the sampled households over 53% were involved in the VS&L scheme. With VS&L, participants made contributions on agreed time frames and the money would be loaned to willing persons, with a certain interest attached. VS&L proceeds were being used to buy food, agricultural inputs and livestock vaccines. Hence this had become an important strategy to mitigate the adverse impacts of climate change.

The positive contribution of VS&L to the wellbeing of households in rural communities has been acknowledged by previous researchers; For example, Mwansakilwa et al. (2017) established that such initiatives contributed significantly to total (38%) and per capita (17%) weekly household expenditure, respectively, for rural households in Eastern and Western Zambia. Similarly, women in South Sudan were empowered through participation in VS&L; their income and involvement in decision making both at household and community as well as their ownership of assets increased (Mark et al., 2019).

Hypothesis testing performed to determine the nature of relationship between farmer involvement in VS&L scheme and disaster risk reduction gave positive results. Results of the test performed between farmer involvement in the VS&L scheme and walling material used to construct houses showed that there was a strong relationship (*P* value=0.004) between involvement in VS&L project and use of modern walling material which is a measure to withstand high rainfall conditions. Farmers were using VS&L proceeds to construct houses with cement bricks which are stronger than pole and dagga structures and they also well plastered the walls.

5. Conclusion

The study identified major climate related hazards in the study as droughts, floods, erratic and low rainfall and high temperatures. These hazards were recurring and intensifying in frequency and intensity. Some livestock, crop and human pests and / or diseases affecting households and communities were climate induced. Households and communities viewed effects of climate-related hazards to be greatest on crop production, followed by livestock production and then human beings. The identified hazards compromised household food security and incomes. Several climate smart initiatives were being implemented by individuals, households and communities to sustain livelihood sources in the face of climate change. Crop production related initiatives included growing of drought and heat stress tolerant crops, implementation of various conservation agriculture technologies such as minimum tillage and mulching as well as operating nutrition gardens. Livestock poverty deaths due to shortage of pastures were reduced through own production and preservation of fodder, while diseases such as cattle and goat foot-rot were managed by use of appropriate housing structures. Some of the climate smart initiatives were directed at improving availability and access to water for livestock, vegetable production and domestic use viz use of solar powered boreholes. It was also noted that households derived income from off-farm activities; for example, in bad cropping seasons men migrated to neighbouring countries to search for jobs. The Village Savings & Lending initiative was pivotal in sustaining livelihoods in the study area.

Research findings established that the adoption rates of climate smart strategies such as growing of small grain crops and conservation agriculture were much higher in the study area compared to national figures, due to intervention of an NGO-led project (whose focus was on building resilience among households and communities in the area) in collaboration with the relevant Government departments. It was quite evident that the climate smart strategies adopted by households and communities contributed to disaster risk reduction, for example; through the Village Savings & Lending initiative, households managed to construct stronger (and modern) houses which were not easily damaged by heavy rainfall and strong winds while through use of appropriate (improved) animal housing structures, diseases associated with wet conditions were curbed. Growing of small grain crops also reduced the impact of drought through improvement in food security. The high level of collaboration among service providers (private and public sector partners), choice of appropriate climate smart initiatives as well as farmer engagement and involvement were instrumental to the successful implementation of the initiatives in the study area.

Disasters due to climate induced hazards can be reduced on a sustainable basis through use of appropriate strategies that engage and empower households and communities. The climate smart initiatives and approaches used in the study area embrace co-design and co-development concepts which are key for sustainable development. Household and community capacities to withstand current and future shocks call for both development actors and communities to strengthen existing climate-smart initiatives. The initiatives and approaches learnt from the study can be replicated in other rural communities in similar economic, social and bio-physical environmental conditions. However, in the long-run, a review of the current climate smart initiatives is necessary to determine their validity in the face of the ever increasing climate variability and intensification of extreme weather events.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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