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ADAPTION AND MITIGATION STRATEGIES IN SUSTAINABLE LAND RESOURCE MANAGEMENT TO COMBAT THE EFFECTS OF CLIMATE CHANGE IN CHIPINGE, ZIMBABWE

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ABSTRACT

The study assesses the adaption and mitigation strategies in sustainable land and water management to combat the effects of climate change in Chipinge. Climate change has undermined efforts in the sustainable management of agricultural land and water in Chipinge. The impact of climate change on agricultural land management includes an increase in pests and diseases, recurrent droughts- floods cycle, changes in the distribution of rainfall, and an increase in violent wind and rainfall intensity. The research used both qualitative and quantitative research methodologies. The results indicated that climate change intersects with sustainable land management (SLM) efforts directly (by affecting soil function, watershed hydrology, and vegetation patterns) and indirectly (by stimulating changes in land use practices). Although people's adaptive and mitigation strategies may not succeed completely, they form the basis of solutions to natural disaster preparedness. Addressing the threat of increased soil erosion posed by climate change will require better quantification of the problem, greater attention to prioritizing which production systems are vulnerable, and a redoubling of land and water management efforts. Climate change is occurring within a background of plethora of global challenges, such as population growth, urbanization, land and water use, rural- urban migration, and biodiversity depletion. Thus, efforts to adapt to the impact of climate change should do so in a manner that is consistent with these broader development issues. Sustainable land management is crucial to minimize land degradation, rehabilitating degraded areas, and ensuring the optimal use of land resources for the benefit of the present and future generations.

Keywords: Sustainable Land Management; Climate Change; Conservation Farming; Zimbabwe

BACKGROUND OF THE STUDY

In the marginal dry lands of Chipinge, the rural poor live between the traditional agricultural areas and the arid rangeland with less than 240 millimeters of yearly rainfall. Extending more than 560 square kilometers, the valley's main habitats are agriculture lands and rangelands that are home to 71 villages and a population of approximately 47,000 (Cloke & Park, 1985). The farming systems are dry land, rain-fed, mixed crop-livestock and pastoral, as defined by Vogel and O'Brien (2006). Agriculture is based on extensive rearing of cattle and cultivation of maize and millet for household consumption. However, livelihoods depend on both off and on farm income. Therefore, the main copying strategies of households living in Chipinge include diversifying livelihood strategies, intensifying agriculture, finding off-farm employment, and exiting agriculture

Chipinge receives very hostile climatic conditions, characterized by high temperatures, variable rainfall, and poor soils. Other challenges include lack of credit and financial capital, lack of information about new technologies and farming practices, unclear land rights, policy disincentive to invest in dry areas, and lack of markets and market information. As a result of high population growth rates, land holdings are shrinking in size and land productivity is decreasing, thereby resulting in increasing poverty and out- migration. These challenges raise questions on who to target and with what. If the goal is primarily poverty alleviation, then intervention should focus on the poorest. If the objective is to increase food production, then the focus should be on capacitating the farmers. If the focus is on protecting the land, the emphasis should be on addressing the government-controlled, communal land, tenure system.

The unpredictable climatic conditions have heightened the vulnerability of smallholder producers to shocks from extreme climate events. Climate change has significantly undermined the efforts to sustain and manage agricultural land in the southern parts of Zimbabwe. The disruptive impacts of climate change on agriculture have been experienced in terms of increased seasonal and inter-annual climate variability and higher frequency hostile events. The stress factors have increased the vulnerability of smallholder farmers from shocks from climatic events, thus leading to a heightened risk of poverty trap at the local level and diminished growth at the national level (Brown & Lall, 2006). The maladaptation to climate variability could increase over the next decades, with climate change potentially derailing the future development efforts in Chipinge.

STATEMENT OF THE PROBLEM

Climate change has undermined the efforts in the sustainable management of agricultural land in Chipinge. Climate change has altered the rainfall patterns, amplified the drought cycle, and increased the agricultural pests and diseases. The maladaption to climatic changes have increased, with the impact of climate change derailing community’s efforts to sustainably manage agricultural land. Land degradation in Chipinge is an environmental, social, and political time bomb. The dependence on rain fed agriculture, combined factors of variable rainfall, high temperatures, and poor soil fertility has heighten the vulnerability of farmers to hardships from extreme climatic conditions. Unless these hostile climate are soon reversed, the future viability of the food system in Chipinge will be imperiled

JUSTIFICATION

The research gathered information on the impact of climate change in Chipinge and it also explored the efficacy of indigenous knowledge systems in adapting and mitigating the effect of climate change. The research further proposed recommendations to practitioners in land resource management. This information is important to the stakeholders in land and water management. These stakeholders include the government and quasi-government institutions, such as district councils. The research will assist institutions to see the impact of climate change on sustainable land and water use. These institutions will also find this information handy as it will give recommendations to organizations and institutions in land and water management.

AIM AND OBJECTIVES

Aim

The major aim of the study is to assess the adaptation and mitigation strategies in sustainable land and water management used to combat the effects of climate change in Chipinge.

Specific Objectives

The following specific objectives guide discussion in this study: assessing the impact of climate change in order to preserve and enhance the productive capabilities of cropland and grazing land ; evaluating the role of the traditional knowledge systems which have the capacity to reduce and reverse the degradation of natural resources and the ecosystem essential in sustaining healthy communities and land productivity, and generating recommendations for practitioners in sustainable land management which will assist in better understanding of and support for local coping strategies, resolving production bottlenecks and promote broader use of water conservation in agriculture.

RESEACH METHODOLOGIES

The study used both qualitative and quantitative research methodologies. The questionnaire was the only quantitative data collecting tool utilized and, in the qualitative methodologies, a number of methods were used, which included focus group discussions and semi-structured interviews with key stakeholders, such as district council officials, local committee members, and traditional chiefs. Rapid Rural Appraisal (RRA) was also utilized to assess the general environmental conditions. Participants were selected on the basis of the vulnerability to climate change, community responsibility, and livelihood diversification. The research also utilized observations where the administration of questionnaires was concurrently carried with observing the condition of the environment. The study was divided into two phases, beginning with a pre-study survey and a final stage of intensive field study. During the final stage, the researcher stayed on the site for a fortnight, accessing information from 100 informants, covering different socio-economic backgrounds. Informants were selected on a random sampling basis and, wherever required, purposive sampling was carried out. Participants whose age ranged between 25 and 65 were selected, on the assumption that young people would have less experience of climate changes and fewer relevant observations.

Through the focus group discussions and questionnaires, individuals who showed appreciable knowledge of environmental changes around them were selected for in-depth interviews. They were mainly experienced local farmers, who could attest to noticeable changes in rainfall and temperature, and traditional elders and leaders, who were involved in the community decision making. The data was analyzed using Statistical Package for Social Sciences (SPSS) and presented in graphs.

RESEACH FINDINGS

Age- Sex

The research utilized respondents from all sexes, but females constituted the majority compared to their male counterparts (67% as compared to 33%). The ages of the respondents ranged from 25 years to 65 years. This showed that the ages of the respondents were still economically active and no participant was in the retirement age or a minor. Furthermore, these respondents were selected on the basis of their experiences and observations, which they possessed and passed over to other generations over a specified period of time. The 25-34 age group constituted 14%. Table 1 shows the age-sex profile of the respondents

Table 1: Age-Sex Profile of Respondents

Age group	**Males**	**Females**
Below 30 years	4	10
31-40	5	17
41-50	17	26
51-60	7	14
Total	33	67

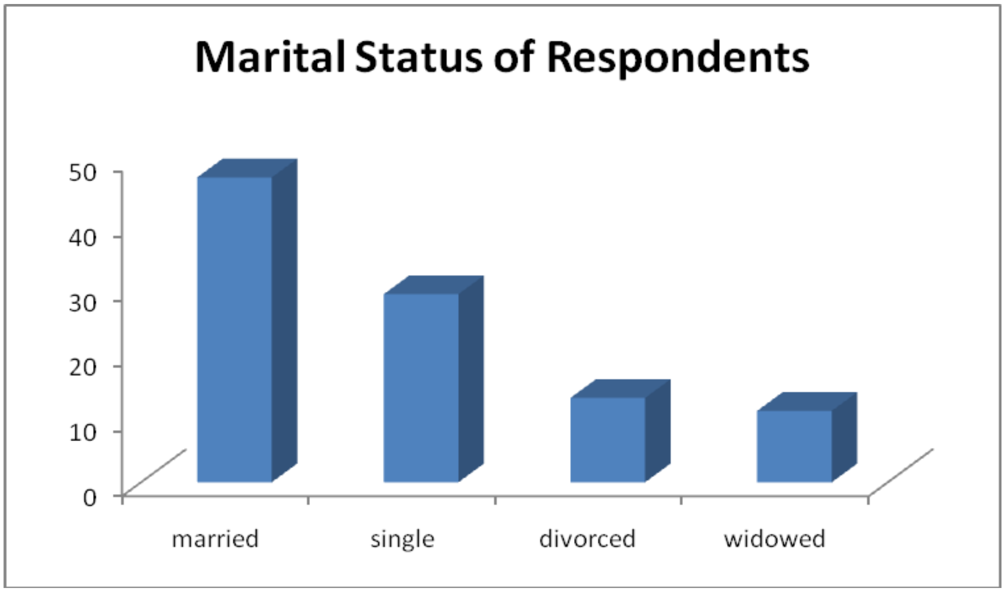
Source: Survey, 2010

Academic Qualification of Respondents

The respondents were of different educational backgrounds. The study also included those who had no formal education, those with elementary education, and those with tertiary education. A number of respondents had acquired meaningful education, as 70% of them had at least Zimbabwe junior certificate level of education; of this, 20% had at least attained an ordinary level. Only a few had no formal education (10%) which shows that the majority of the respondents were literate and, therefore, could read and write. These people could be trained to effectively use sustainable land management approaches if the program is planned well. Some of them who had ordinary level qualifications could be trained to take positions of responsibility so that they can lead land reclamation projects. If the local people are capacitated, they can develop their own structures, which may assist in the management of land. Outside assistance should be channeled to develop local people’s initiatives so as to build local skills, thereby empowering them to manage the land.

Marital Status of Respondents

The respondents were drawn from varied marital statuses, which ranged from married, widowed, divorced, and single. The majority of them were married (47%) and 29% of them were single, of which males were the majority. The widowed and the divorced constituted a combined 24% (13% and 11%, respectively). Figure 1 shows the marital status of respondents.



Source: Survey, 2010

AN OVERVIEW OF THE IMPACT OF CLIMATE CHANGE IN CHIPINGE

The local people in Chipinge may not understand the concept of climate change, but they observe and feel the effects of the decreasing rainfall, increasing air temperature, increasing sunshine intensity, and changes in rainfall patterns. Their observations are corroborated by a study that recorded a reduction in the means of annual rainfall (21.7 percent) and a gradual rise in the average maximum temperatures (1.4^0 C or 4.3 percent) from 1981 to 2009 (Murhpree, 2004).

The Save River has been characterized by a decrease in the amount of discharge, partly as a result of reduced rainfall, deforestation, and land degradation. Some feeder streams have completely dried up. Flows in the Save River have decreased from $9.7m^3$ per second in 1982 to $2.7m^3$ per second in 2009, a 43 percent reduction (Murhpree, 2004). During the dry season in 2009, the flow was so low that the river bed was exposed and some of the wells and boreholes dug by farmers to ensure availability of water year round also dried up, indicating a possible reduction in groundwater. Water availability is decreasing in Chipinge at a time when communities' water demand is increasing because of population growth.

Farmers noted that recent crop failures in the study area have been attributed to low rainfall, prolonged rainfall shortages, and changes in rainfall patterns. Agriculture, in the study area, is rain-fed. Farmers have developed ways of predicting the arrival of the rainy season. Croplands are prepared, in anticipation of the rains, to start the cropping season. However, the beginning of the rain season has become unpredictable. Thus, it has become difficult for farmers to plan their cropping seasons to coincide with the rains to ensure maximum crop yield. Prolonged rainfall shortages caused drought situations, with reduced water available in the soil for crop growth, resulting in crop failure.

Heat and water related diseases are becoming more common in Chipinge. The incidence of Malaria has increased as villagers are exposed to mosquitoes by sleeping in the open because of unusually high temperatures. During prolonged rainfall shortages, water sources become scarce, stagnant, and contaminated, raising the incidence of diarrhea and bilharzias. Shingles and other skin diseases have become common during periods of high temperatures.

Amplification of the hydrological cycle, in which climate change is manifested by an increased frequency and intensity of flooding and drought, has remarkably affected the land and water management in Chipinge. Considerable increases in future soil erosions are projected because of the role of severe events that contribute to total soil erosion (Homewood, 2005). Agricultural soils in Chipinge are particularly exposed to erosion because the low soil organic matter levels and weak structures reduced their resilience to erosive forces. In Chipinge, crop productivity is sensitive to increasing the soil loss. Socio-economic factors that mediate land use practices influence the future changes in soil erosion risks. These factors include a shift in cropping pattern and land use in response to market signals that would occur, for instance, with increased out-migration of young people to Chipinge town and other towns in Zimbabwe.

Addressing the threat of soil erosion posed by climate change in Chipinge requires better quantification of the problem, greater attention to prioritizing the production systems which are vulnerable, and increasing the soil erosion management efforts. Approaches in soil erosion modeling and assessment need to capture the role of extreme events in soil erosion (Boardman, 2006). Since Chipinge District Council has limited resources available for addressing the multitudinous impact of climate change, identification of priority areas where serious soil erosion is occurring is necessary. The study revealed that widening the adoption of practices and technologies that enhance soil coverage is increasingly critical to future agricultural land management under climate change. The broad categories of conservation farming involve many interventions, such as cover crops, agro-forestry, and improved fallows to reduce the period during which soil surfaces are exposed. Conservation tillage and use of organic manure have the potential of maintaining and increasing soil organic matter levels and conserving soil moisture (Sanchez, 2000).

The adoption of conservation farming is a challenge because the land tenure system is unstable. Furthermore, labor shortages and non-farm income sources tend to have a dissuasive influence on soil improvement measures. Developing more coherent links between land management and institutional change can create conducive environments for land management (Belzer, 1999). For example, the re-vegetation in Buhera is rooted in technical support for land improvement and in decentralization of resource management decisions to local people. This approach in resource management can result in sustainable management of land resources if it can be adopted in the dry areas of Chipinge.

Regions that are highly dependent on climate sensitive sectors are susceptible to changes in water availability with climate change (World Bank, 2006b). Chipinge’s dependence on rain fed agriculture exemplifies this situation because of the combined factors of variable rainfall, high temperatures, and poor soil fertility heightens the sensitivity of smallholder farmers to shocks from extreme climate events. The study also revealed that long term changes in precipitation patterns may reduce the total amount of land available for agriculture. However, in the near term, there is potential to sustain and enhance rain-fed production through improvements in water capture and storage, combined with better soil management. One of the challenges will be to diminish the feedback between water management risks and a decline in soil fertility, which, in turn, diminishes the potential of soil to capture and retain water, thus increasing the vulnerability of drought. One way to address this issue is to focus on the manageable part of climatic variability by complimenting rainfall conservation with incremental amounts of fertilizer to bridge ephemeral dry spells that occur during the sensitive plant growth stages. Rockstrom (2004) reported that these types of fairly small scale changes can double and triple cereal yields in high risk farming environments.

Farming and land management activities are exposed to seasonal climate risks arising from inter-annual climate variability and anthropogenic perturbations of the climate system, which results in more frequent extreme weather events. A key element of the agricultural and rural risk management includes the efficient use of inherently variable natural resources (for example, runoff) and measures to increase the resilience of land and crop management systems against seasonal climatic threats (for example, droughts and floods). Unmitigated risks are likely to result in increased crop and yields loses and, in extreme cases, in a loss of natural resource base (for example, soil erosion).

Land management practices and agricultural expansion can alter the exposure to natural perils and the potential impacts associated with them. Extreme climatic events can result in irreversible damage to water and land management and farming systems and, by extension, to human livelihoods (Alternatives to Slash and Burn, 2002). Coping strategies of rural peasant farmers in Chipinge, in response to such events, has led to unsustainable land management practices. The research revealed that after cyclone Elina destroyed maize and bean fields, many farmers turned to shifting cultivation that infringed on protected areas and eventually resulted in soil erosion. Thus, sustainable farming, of which risk management is an important component, is essential to sustainable land management and the preservation of the natural resource base.

Longer- term changes in climate patterns, such as the ones projected by climate change scenarios for many parts of the developing economies, have the potential to change current land management practices fundamentally and to alter the risk profile of agriculturally based economies (World Bank, 2003; Blackie, 2006; Taylor, 2006). These changes represent an additional layer of risks and uncertainty, and increasingly, they need to be considered as part of a sound climatic risk management framework.

Agricultural productivity and economic growth strongly tracks seasonal and inter- annual rainfall variability in areas that rely on rain-fed agriculture (Brown & Lall, 2006; Eicher & Staatz, 1990). This relationship has important implications for sustainable land management in highly variable climate regimes because investments in land improvement and yield-enhancing technologies are often stymied by uncertainty and risk around the timing, distribution, and quantity of rainfall. To the extent that climate change is manifested as increasing intra- and inter-annual climate variability, the influence of rainfall uncertainty in dampening sustainable land management investments could become even greater.

THE ROLE OF TRADITIONAL KNOWLEDGE IN COPYING WITH CLIMATE CHANGE

Traditional knowledge – the wisdom, knowledge, and practices of the indigenous people gained over time through the experience and orally passed on from one generation to the other – has, over the years, played a significant part in solving problems, including problems related to climate change and variability. In Chipinge, villagers often rely on the activities around them to adapt and mitigate the effects of climate change. The research noted that the appearance of certain birds, mating of certain animals and flowering of certain plants are all important signals of changes in time and seasons that are well understood in traditional knowledge systems. People in the study area have used biodiversity as a buffer against variation, change, and catastrophe; in the face of plague, if one crop fails, another will survive.

In coping with risks due to excessive or low rainfall, drought, and crop failure, farmers in Chipinge grow many different crops and varieties with different susceptibility to droughts and floods and supplement these by hunting, fishing, and gathering wild food plants. The diversity of crops and food resources is often matched by a similar diversity in the location of fields, as a safety measure to ensure that in the face of extreme weather, some fields will survive to produce harvestable crops. Adaption to climate change includes all adjustments in behavior or economic structure that reduce the vulnerability of society to changes in the climate system (Rockstrom, 2004). Whether people can adapt, and for how long, depends on the resources available. Chipinge, like the rest of Southern Low Veld, is one area most vulnerable to the negative impacts of climate change and, at the same time, has low adaptive capacity. However, people at the local level are making efforts to adjust to the changes they observe.

The research revealed that a variety of coping strategies are applied with mixed success, which suggests that the local traditional knowledge could provide the basis for development of more effective strategies. Villagers in the surveyed communities realized that water shortages are a major threat of their survival and have developed several strategies to adapt to this phenomenon. Most households have resorted to the reuse of water, for example from washing clothes or utensils, to irrigate backyard gardens and nurseries. Households are also rationing water, trying to reduce the water use per person, per day. However the practice is abandoned as soon as the rains begin. This strategy needs to be part of a behavioral change and not applied only during periods of water scarcity.

Villagers have also resorted to reviving rain water harvesting, a traditional way of collecting and storing rainwater in barrels placed under the roofs of houses. This method had largely been abandoned when the villagers, with the assistance of Canadian Agency for Relief and Emergency (CARE) International, installed wells and boreholes. However, water harvesting has attracted interest again as a result of their drying up.

The study revealed that the traditional and local authorities in Chipinge identified the clearing of vegetation as a major factor increasing soil erosion and siltation of rivers, which eventually reduces stream flow, and they are adopting measures to correct the situation. The measure include creating awareness of the effects of deforestation around water bodies and sacred areas, sensitizing communities about prevention of bush fires, promoting community-based management of forests through Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) projects, and imposing fines on those who indiscriminately set fire to the forests, clear vegetation, or violate other measures to protect the environment. However these efforts, by the traditional and local authorities, are not yielding anticipated results because communities in Chipinge have become more cosmopolitan or heterogeneous and no longer adhere as absolutely to traditional authority as they did in the past. The communal nature of the society is breaking down; people now tend to be more concerned with individual interests than with collective well-being.

Traditional norms and ethos, such as sacred days when villagers are not allowed tilling the land or going to the river so that the land-sun spirit could have a day of rest, provided a means of protecting land and water bodies. However the observation of such taboos has declined with modernization and the increasing heterogeneity of communities. With the widespread adoption of Christianity, traditional spiritual practices are now seen as superstition. Religion is a delicate issue in the communities, and some of the traditional laws, although potentially useful, are not completely adhered to.

The research noted that indigenous knowledge in land and water management, acquired over time, previously helped farmers in Chipinge to cope well with water shortage, droughts, and crop damage or losses, but traditional approaches have become difficult to apply in recent years because of changing rainfall patterns. Farmers are adapting to this constraint by planting different crops. Crops that thrive well under the current prevailing conditions are increasingly being planted in areas that previously did not support their cultivation. An example is the shift from maize to millet. Vegetable growers are also gradually moving into the river plains where their crops can get more water. These are forms of adaptation, but are not obviously sustainable. The clearing of vegetation to establish vegetable gardens and the use of agricultural chemicals close to the rivers and streams create hazards for the environment and ultimately for the people who live downstream.

The research noted that the partial success of the use of traditional knowledge in coping with climate change leads to the conclusion that a healthy relationship between scientific knowledge and traditional or indigenous knowledge, which both have limitations, is desirable. Whereas most precipitation models and records mainly focus on changing the amounts of precipitation, indigenous people also emphasize changes in the regularity, length, intensity, and timing of precipitation. Whether or not scientific models are incorporated into local experiments depends on the status and accessibility of science within a culture and on the influence of the communications media (Salick & Byg, 2007).

There is much to learn from indigenous, traditional, and community based approaches to natural disaster preparedness. Indigenous people have been confronted with changing environments for the millennia and have developed a wide array of copying strategies. Their traditional knowledge and practices provide an important basis for facing the even greater challenges of climate change. Although their strategies may not succeed completely, they are effective, to some extent, which is why the people continue to use them. While villagers will undoubtedly need much support to adapt to climate change, they also have expertise to offer on coping through traditional time-tested mechanisms.

RECOMMENDATION FOR PRACTITIONERS IN LAND RESOURCE MANAGEMENT

Climate change is occurring within a background of lager global change, with respect to population growth, urbanization, land and water use, and biodiversity (World Bank, 2004). Thus, efforts to adapt to the impacts of climate change should do so in consistent with these broader developmental issues. In this context, efforts should be channeled towards enhancing adaption to climate change in agriculture through addressing maladaption to current climate variability, invest in soil protection, and couple soil fertility with soil management.

There is a significant scope for enhancing climate risk management in Chipinge. Climate risk management can be accomplished through a broader use of water conservation in agriculture, better understanding of and support for local coping strategies, resolving productive bottlenecks, such as access to seeds, promoting changes in policies to give local communities greater stake in resource management decisions, and providing access to seasonal climate information by national decision makers..

Conservation agriculture practices and measures that increase soil organic matter and reduce the time that soils are bare will become more important for enhancing the resilience of soil to greater erosive forces with climate change. Stabilizing the resource base and replenishing soil fertility through low costs and locally relevant means is an important precursor to more technologically intensive adaptation measures, such as expansion of irrigation and use of drought-tolerant varieties (Sanchez, 2005; Millenium Ecosystem Assessment, 2005; Lele, 1989).

In Chipinge, farmers tend to invest in soil fertility only after other production risks, especially those associated with access to water, are lessened. Reducing water risk is more cost effective than attempting to address absolute water scarcity. Sustainable land management could assist in this process through several entry points, such as targeting small investments in rainwater capture and storage for supplementary irrigation, promoting practices that reduce run off to bridge the gap between rains, and linking fertility inputs to seasonal rainfall projections.

The study further revealed that knowledge sharing and increased public awareness of land degradation are required to facilitate closer cooperation among stakeholders involved in sustainable land management. It was noted that in the past, promising interventions were not adopted because they were developed in isolation from the requirements of the local communities and were based on an inadequate understanding of the asset base and flows as well as local informal institutions. Clearly, a need exists to study livelihood strategies in greater detail for better targeting of agricultural and non-agricultural interventions. Multi-stakeholder processes are required to bring together local populations and decision makers to develop common understandings of different perceptions of these marginal zones and to facilitate a better organizational ability of community- based groups.

Production systems in Chipinge have two major constraints, namely water shortages and general low soil fertility. To make these systems sustainable at reasonable productive levels, farmers need to integrate soil and water conservation practices with balanced nutrition of crops by adopting Integrated Nutrient Management (INM). The knowledge available about different sources of nutrients, such as organic manures and mineral fertilizers, can be used to develop a sustainable strategy for INM to sustain crop productivity. The INM strategy is realistic, attractive, and friendly to the environment. INM will enhance the efficiency of biological, organic, and mineral inputs for sustaining productivity of these sub-arid tropical soils. Judicious and balanced use of nutrients from biological sources, mineral fertilizers, and organic matter is a prerequisite for making rain-fed agriculture more efficient through an increased efficiency of rainfall use.

Enhancing awareness among farmers, development agency, and policymakers to discuss climate change, soil quality, and to adopt sustainable INM practices is necessary. If land degradation is to be minimized, continued investments in capacity building and training of personnel involved are needed. Investments to enhance the use of biological and organic resources through incentives for increased adoption are needed for sustainable land management. There is a need to establish appropriate institutions that can ensure timely availability to farmers of high-quality products and knowledge about these products and sustainable INM practices. There is an urgent need to adopt an integrated strategy, rather than a piecemeal approach for sustainable development (for example, for most land management issues, addressing water management, fertility management, pest management, and improved cultivars is also necessary because all these components are synergistically interlinked with sustainable land management).

It is also vital to note that an appropriate risk management mechanism needs to be developed to mitigate, transfer, or share the residual risk. The appropriate management solution should be a function of the magnitude of the risk, the likelihood that a negative outcome may be realized, the institutional (informal and formal) capacity to cope with the risk, and the nature of the underlying hazard (for example, droughts represent a covariate risk that tends to affect large areas simultaneously and generally results in long term and indirect loses, whereas floods tend to be more localized and cause direct damage to crops and infrastructure, such as irrigation systems).

Authorities in climate change management should use effectively existing and new technologies to support risk modeling and management. These include indigenous knowledge systems and geo-information technologies, such as space remote sensing and cyclone and floods modeling and innovative approaches to transfer risks through market-based approaches. These innovations can enhance and complement more conventional approaches to risk management in the productive sectors, such as water storage, crop diversification, or floods mitigation schemes.

Advances in improving the ability to provide useful seasonal climate forecasts and in developing pathways for disseminating and applying that information, is required to address the critical information gap. Forecasts that are timely and locally relevant can aid in decision making. In good rainfall years, farmers and supporting institutions can invest in greater inputs to recover from or prepare for production downturns in poor rainfall years, when risk avoidance strategies are prudent (Homewood, 2005; Sanchez, 2005). Progress in climate-based crop forecasting will depend on continued advances in probabilistic forecasting and downscaling, embedding of crop models within climate models and enhancing the use of remote sensing and research into "weather within climate." For seasonal climate forecasts to be effective, however, advances in forecasting skills will need to be matched with better means of disseminating forecasts to farming communities through multiple forums, such as those where information on water, health, housing, and disaster management is shared.

CONCLUSION

The study revealed that addressing the risk posed by climate change in Chipinge requires better quantification of the problem, greater attention to prioritizing the production systems, which are susceptible, and redoubling of land and water management efforts. There is much to learn from indigenous, traditional, and community-based approaches to disaster preparedness. The rural poor have been confronted with changing environments for a long period of time and have developed a wide array of coping strategies. Their traditional knowledge and practices present an important basis for facing greater challenges posed by climate change. Although farmers' strategies may not thrive completely, they are useful to some extent and that is why farmers continue to use them. While farmers in Chipinge undoubtedly need much support to adapt to climate change, they have expertise to offer on coping through traditional time-tested mechanisms.

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