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Agroforestry as a Small Landholder's Tool for Climate Change Resilience and Mitigation in Zimbabwe

Tariro Kamuti

Abstract

Zimbabwe's agro-based economy is dominated by the country's majority population who live in rural areas and practice smallholder agriculture. While ameliorating the condition of the participant households, current practices of smallholder agriculture have caused challenges to the governance of land, water and forest resources. Massive deforestation has proceeded at an alarmingly high level, in a way that has threatened the long-term viability of smallholder agriculture and the sustainability of natural forest resources. So, smallholder agriculture has driven forest landscape changes that pose inherent environmental challenges including climate change. This chapter blends institutional and landscape approaches to explain how the integration of agroforestry, as a livelihood strategy, can be a tool for climate change resilience and mitigation in Zimbabwe. Drawing on documentary evidence, the chapter concludes that alternative institutional and livelihood initiatives anchored on agroforestry can transform smallholder agriculture and lead to climate change resilience and mitigation.

Keywords: Deforestation, smallholder farming, climate change, resilience, mitigation, agroforestry, reforestation, Zimbabwe

1. Introduction

Zimbabwe's agro-based economy is dominated by the country's majority population (about 70%) who live in rural areas and practice smallholder agriculture [1, 2]. While ameliorating the condition of the participant households as the mainstay of their livelihoods, there is the emergence of challenges in productivity with subsequent effects on production levels which stem from deteriorating environmental conditions. Practices of smallholder agriculture have in the long run caused challenges to the governance of land, water and forest resources. The decline in quality and quantity of these resources has led to the degradation of landscapes which in turn pose constraints on living conditions. These conditions leave people more vulnerable to external influences like climate change impacts as their capacities for climate change resilience and mitigation are compromised. The climate crisis is now more apparent given that climate change impacts are being experienced around the world more often than before, with Zimbabwe having its own experiences of

climate change impacts, especially in the growing season. The growing season is critical because agriculture in Zimbabwe largely relies on rain whose variability is felt by poor households because of their limited capacities to adapt [1, 3–5]. One of the most apparent impacts of climate change is the occurrence of extreme weather conditions which directly affect people's physical living conditions while hitting hard on agricultural production systems through which people eke a living [2–4]. For example, around the Middle Zambezi Biosphere Reserve in Zimbabwe climate change has been felt through water shortages, the transformation of forests, loss of livestock and wildlife, and famine [6]. Analysis of weather patterns over a long time in Zimbabwe has shown that there has been an observable trend of increase in average temperatures, declining mean rainfall per year, shifts in the rain season, increase in the occurrence of droughts and mid-summer dry periods, and the rise in the incidence of severe tropical cyclones [4, 7–9]. Thus, drastic changes in the weather regime especially during the rainy season, affect the production levels which in turn affect livelihoods [1, 10]. Effects of climate change are contingent on each locality such that people from different areas may not necessarily experience the same conditions of climate change impacts [10, 11]. For example, a study in two districts in Zimbabwe showed that the majority of respondents in Makoni associated climate change with the delayed start of the rainy season, and increased frequency of flash floods, while most respondents from Wedza linked climate change to successive dry summers, high temperature ranges across all seasons, and afflictions attacking crops and livestock [11].

This chapter attempts to explain how the integration of agroforestry, as a livelihood strategy, can be a tool for climate change resilience and mitigation in Zimbabwe. Climate change is causing devastating effects at various temporal and spatial scales. Broadly, from the time preceding the industrial era from around 1850–1900 up to now, the average temperature has gone up substantially [12]. In the intervening period from 1850 to 1900 to 2006–2015, this average temperature has gone up by 1.53°C thereby causing global warming [12]. Global warming has the effect of increasing the occurrence, extent and period of high temperature-linked weather patterns on terrestrial ecosystems [12]. For example, droughts have also increased in occurrence and severity [12]. The average rise in temperature over a long period has caused changes in climatic regions including the increase in land under dry conditions thereby negatively affecting the flora and fauna [12]. Climate change can accelerate the deterioration of the land “through increases in rainfall intensity, flooding, drought frequency and severity, heat stress, dry spells, wind, sea-level rise and wave action” [13]. Land degradation has an impact on livelihoods as it limits what human beings can obtain from the natural environment thus increasing their chances of falling into poverty [14]. The goods and services from nature range from food, water, clean air, fuelwood, the ability to increase groundwater, to the capacity to act as a sink for carbon, which all further have socio-economic implications [14]. Zimbabwe loses approximately US\$382 million per annum due to land degradation and this is equivalent to 6% of its Gross Domestic Product [14].

Climate change resilience here refers to the ability of communities to recover and rise above the effects or losses which they may have incurred due to climate change impacts. I will take climate change mitigation to mean the reduction in the impact of climate change on people's livelihoods and welfare. Interventions to deal with climate change are generally classified into three groups which are “hard solutions, such as engineered infrastructure like levees; soft solutions, including insurance and early warning systems; and nature-based solutions” [15]. Nature-based solutions are “interventions that use ecosystems as part of a broader, societal response to environmental change” [16]. One of the nature-based solutions which enhances

climate change resilience and mitigation especially for vulnerable communities is an ecosystem-based adaptation (EbA). Ecosystem-based adaptation “is a people-centric concept that recognizes ecosystem integrity as critical for human resilience to climate change” [15]. These approaches are based on the recognition of the central role of biodiversity in connecting ecosystems to human needs. So various kinds of ecosystems help enhance the capacity of human beings to withstand the adverse conditions brought in by climate change. For example, “wetlands, forests and mangroves, represent a proven strategy for building resilience to climate change ... (as) natural systems (that) can reduce the impact of floods and droughts, decrease hillside erosion and protect lives and property against storm surge and high waves” [15]. Agroforestry fits well under nature-based solutions.

Agroforestry here is taken in general to refer to, “the integration of trees and woody shrubs in crop and livestock production systems” [17]. Agroforestry assumes some multifaceted roles in that some trees and woody shrubs constitute part of the agricultural systems as food and cash crops, while their integration in agriculture at the same time will enable the harnessing of their ecosystem roles that are critical in enhancing climate change resilience and mitigation. Thus, the idea that agroforestry is a source of livelihood is not new. However, this chapter is just amplifying the voice that there is a need to ramp up efforts to use agroforestry not only as a source of livelihood but to be integrated into broad measures towards climate change resilience and mitigation. This is more applicable at the small landholder level where climate change impacts are most felt. Households can do agroforestry with limited resources to help themselves while contributing to the greater good of climate change resilience and mitigation through the cumulative positive effects of agroforestry within local communities. The hard and soft solutions are expensive for vulnerable communities to implement, so nature-based solutions to climate change resilience and mitigation become a viable option. Nonetheless, small landholders have to devise ways to cope with the new climatic conditions that are prevailing now. The adoption of agroforestry is thus a viable option.

The chapter proceeds by blending the institutional and landscape approach as a conceptual basis to analyze the developments in small landholder agriculture in Zimbabwe. This is motivated by the idea that farmers are at the interface of institutional processes that guide their ownership, access and use of natural resources that are found in different landscapes. This will be followed by a treatise of how small landholder agriculture is connected to environmental quality that determines the levels of climate change resilience and mitigation. Next, is the section on climate change resilience and mitigation in Zimbabwe. This will be followed by a detailed justification of agroforestry as a viable strategy to complement other climate change resilience and mitigation measures. Then the discussion will open to reflect on the suggestion of agroforestry as a tool to enhance climate change resilience and mitigation. Concluding remarks will summarize the content of the book chapter.

2. Blending institutional and landscape approaches

Vegetation is important in natural cycles such as water and carbon cycles which all have a bearing on weather in the short term and climate in the long run. Forest resources are a critical component of ecosystems which together with the land constitute landscapes. The issue of “landscape sustainability” has gained prominence from around 2013 when so much attention has been given to the long-term ‘health’ of various terrestrial ecosystems [18]. Agroforestry as a human-driven initiative fits in the forest resources on agricultural landscapes that help to resuscitate and strengthen ecosystems for a human benefit like climate change resilience

and mitigation. Human wellbeing depends on these forest resources as well as the ecosystems and landscapes where they are rooted. Thus, human beings virtually rely on landscapes to obtain various ecosystem goods and services [19–21]. Landscapes approaches tend to be holistic in attending to the various dimensions of sustainability through “addressing multiple disciplines, knowledges, and needs that span science-society-policy interfaces and policy sectors and scales” [22]. Three distinct ways through landscape approaches are integrative have been noted. First, a landscape is taken as an interface between society and ecology where these two elements are given a fair chance to analyze their role in determining how the landscapes are constituted [23]. Second, landscape approaches are inclusive of all stakeholders at different levels of organization as their concerns and perceptions are considered for their buy-in and involvement [23]. Third, landscape approaches depend on a dynamic system of management that balances the needs of all the levels of organization to create landscapes that serve several functions [23].

Issues relating to ownership, access and use of natural resources bring in the human-nature dimension and its role in shaping the spatial and temporal outlook of landscapes. Thus, institutions are used to mediate human-nature relations, particularly in determining ownership, access and use of natural resources. Institutions are here regarded as the rules or regulations that are implemented on the access and utilization of natural resources at various levels of organization. The type and extent to which institutions are implemented to interface human-nature relations determine the condition of landscapes. For example, institutions are accepted to have an impact on how human beings utilize land which results in the transformation of landscapes [19, 20]. These components of a socio-ecological system are not mutually exclusive as it has been observed that there is a pitfall of analyzing them as disparate elements [19]. The argument is well put that “the spatial patterns in ecosystems that result from institutions are widely recognized and well analysed (e.g., changes or differences in deforestation patterns under different regulations) but the feedbacks from these patterns back to institutions (and especially, the creation and modification of institutions) are seldom explicitly analysed in studies of landscape ecology and land cover change and hence are poorly understood” [24]. This multifaceted situation needs to be looked at holistically to craft wholesome approaches that take care of the various dynamics that arise from how institutions set in motion by human beings influence ecosystems and the subsequent feedbacks.

Institutional arrangements are important in this chapter to understand that governance determines how natural resources are utilized to meet human demands. Natural resources also have limits through the quantity of goods and level of services which can they avail to support livelihoods depending on how they are managed. Institutions stand in between human beings and natural resources on various landscapes and the two-way interactions between them needs to be understood. Those interactions have a bearing on climate, thus inherently they can either cause or mitigate against climate change. The proposal to consider agroforestry as a tool for climate change resilience and mitigation can be understood in the context of how the relationships between human beings and natural resources are mediated by institutions across various landscapes. There is an assertion that “institutional, policy and governance responses to address land degradation are often reactive and fragmented, and fail to address the ultimate causes of degradation” [25]. This means that measures are put in place when land degradation has already happened, and these efforts are not well coordinated and ultimately not effective in attending to the factors that lead to the deterioration of landscapes. Overall, institutions do matter when considering the fight against climate change across various landscapes. However, there is a need to acknowledge the dynamics of power relations in nature-based solutions to tackling climate change which underpins this idea of institutions [16].

3. Smallholder agriculture and its impact on Forest resources in Zimbabwe

There is a history of policies that promoted white farmers to produce commercial crops such as tobacco by colonial governments in southern Africa whose countries fall within the areas dominated by miombo woodlands [26]. Thus, there has been a trend of damage to indigenous forests and their subsequent replacement with exotic timber and fruit trees as part of forestry, reforestation or agriculture in general. Deforestation is a major environmental challenge in Zimbabwe. People cut down trees mainly for household energy needs, construction purposes, clearing land for crop production, and overgrazing. Most recently trees have been felled to provide energy for treating flue-cured tobacco mostly in Mashonaland East, Mashonaland Central, and Mashonaland West Provinces of the country. Production of tobacco contributes to around 5% of deforestation in Africa, but unfortunately, there is a gap in considering the negative effects to the environment which come back to affect people's livelihoods [26]. Biodiversity loss is a crisis that is facing humankind today in conjunction with the climate crisis [27]. About a million species face the risk of being lost forever due to damage to ecosystems which will further worsen the current crises facing humanity [3, 28].

Globally, it was forecast that environmental change would be mainly pushed by the rise in population and its subsequent increased food needs [29]. Thus, population growth has caused a rise in demand for land under crop and livestock production subsequently putting pressure on land, water and forest resources to sustain livelihoods mainly in the rural areas. It has also been concluded that land degradation is a great challenge worldwide which is inherently associated with a decline in biodiversity pushed by an increase in area under arable and livestock production, poor agricultural and forestry management systems, shifting climatic regime, urban sprawl, urban and mining development [3]. In Zimbabwe, incessant and prolonged power outages from the country's electricity utility since the late 1990s have increased demand for firewood as an affordable alternative source of energy. Since then, the general transport of firewood (due to strong rural-urban linkages) and its trade from the rural areas have added to the toll of deforestation. The challenge of deforestation has been exacerbated by the lack of corresponding efforts in reforestation. So, even though vegetation is a renewable natural resource, the rate at which regeneration of trees and other components of the ecosystem that survive after the damage is lower than the rate of the loss is incurred [30]. Massive biodiversity loss follows. Indigenous forests also consist of woody tree species that are slow-growing which makes it difficult to restore forests to their climax levels within a generation. Historically, society has been able to contain short-term changes within a human generation climatic conditions but now climate change is enduring and happening at a faster rate than what they can do to cope [1, 31].

Crop and livestock production systems with less or without corresponding conservation in the rural areas have thus had a net effect of transforming landscapes in a way that contributes to environmental damage and subsequent degradation. This has compromised what the environment can give back to the people in terms of environmental goods and services which keeps driving productivity down to precarious levels that threaten livelihoods [3]. The effect of deforestation on landscapes is critical since the majority of the Zimbabwean population is rural-based and dependent on smallholder agriculture. This burden to the environment is also coupled with the colonial legacy of the displacement from fertile land and the concentration of the population into marginal land in what was called native reserves. These areas with marginal land have already been areas of low agricultural potential

due to adverse agro-ecological conditions characterized by low annual rainfall and poor soils, thereby having a low carrying capacity [3].

Under these circumstances, the biogeographical conditions in such areas have been worsened leaving the majority of the people who largely depend on agriculture at a vulnerable position where their capacity to adapt to climate change impacts is curtailed [3, 9, 32]. For example, shifts in the micro-climate have been witnessed with low locally induced rainfall during the rainy season than what it used to be 20–30 years ago. The increase in the bare surface due to clearance of the ground cover has increased the levels of soil erosion due to runoff and wind leading to the development of gullies while rivers and water reservoirs have been silted resulting in less fresh water available for domestic consumption and agricultural production in turn. Wetlands that have provided key environmental goods and services have been destroyed to pave way for agriculture due to the rise in the demand for land. Overgrazing has been due to a lack of control of stocking levels to levels of the carrying capacity of the land. With thin topsoils, the water holding capacity of the soil has been reduced, which together with increased runoff when it rains, and low annual rainfall, have eventually reduced the groundwater recharge. The decline in the water table levels also means that there will be less underground water available for extraction during times of crises in the dry season. Reduced water supplies have a direct effect on agricultural production [3]. The decline in agricultural production subsequently reduces available household food, their earnings, and ultimately the quality of life [33]. Environmental goods and services are variable both spatially and temporally across landscapes depending on the state of human-nature relationships [21]. Causes of climate change are global (with developing countries contributing far less), its impact at the local level is critical in such conditions of general environmental degradation. Therefore, it is now imperative to prevent, decrease and scale back the deterioration of landscapes to secure food and water while enhancing climate change resilience and mitigation [3].

4. Climate change resilience and mitigation in Zimbabwe

Climate change is a global challenge which is not confined to a country's national boundaries. So, climate action can start to be analyzed from the global level going down until it reaches the local level. This is where global environmental governance comes into play as countries around the world come together to formulate solutions against climate change. In this respect, numerous attempts have been made to reach a global consensus to combat climate change. This has resulted in the formulation of multilateral agreements on various issues relating to nature which have a bearing on confronting challenges associated with climate change. These agreements constitute part of international institutions which governments can tap in to formulate their specific policies and programs. Zimbabwe is a signatory to or a member of several international agreements, conventions and protocols such as the Paris Agreement, Agenda 21, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Convention on Biological Diversity, United Nations Convention to Combat Desertification, United Nations Framework Convention on Climate Change (UNFCCC), Intergovernmental Panel on Climate Change (IPCC), Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), Agenda for Sustainable Development (AfSD), and the Southern African Development Community (SADC) Protocol on Environmental Management for Sustainable Development. All these are global and regional institutional mechanisms by which the country has committed itself in unison with other nations to formulate its policies and regulations which are relevant to the efforts against

climate change. All these efforts are underpinned by the need to take good care of the natural environment so that it can in turn provide humanity with natural goods and services that sustain lives. In the same vein, that is where one can contextualize the role and subsequent integration of institutions and landscapes through agroforestry as one of the tools that can be used to enhance smallholder farmers' resilience and mitigation against climate change.

At a national level, these internationally crafted institutions from the world and regional bodies provide an overall framework and specific targets that government policies, laws, plans and programs can formulate and aim to achieve. National governments are also organized in various ways in pursuit of their specific environmental sustainability goals. Zimbabwe has various ministries and agencies which deal with issues relating to land, agriculture, water, forestry, fisheries, energy and other sectors that are all integrated and coordinated in a way that recognizes the critical role of nature and thus help to fight against the effects of climate change. The various ministries relating to land, agriculture, environment and water, and the various agencies like the Environmental Management Agency, Forestry Commission, Agricultural Extension Services, for instance, all have specific mandates, but their coordination and integration help to take care of the country's international environmental obligations while striving to people's livelihoods and welfare. Agroforestry in this case fits into broad agricultural and environmental policies, while there are specific laws crafted to cater for these issues.

The Forestry Commission has been instrumental in spearheading reforestation programs in Zimbabwe. The parastatal has worked with other state agencies, non-governmental organizations, private companies and local communities through various kinds of cooperation and working relationships. Using their motto, "Trees are Life" they have run campaigns to promote the conservation of trees. The National Tree Planting Day, which is synonymous with this parastatal is part of this campaign. Within these efforts, there has been the promotion of the propagation and growing of fruit trees. However, within these efforts to conserve trees and reclaim degraded landscapes, agroforestry has not been comprehensively developed and adopted as a viable initiative in favor of climate change resilience and mitigation. The state needs to seriously consider supporting initiatives that integrate agroforestry in the broad environmental policy and nature conservation. Agroforestry then should not be narrowly defined through the growing of fruit trees but taken as a broad nature-based initiative that encompasses environmental and agricultural production systems that have spiral effects on other sectors of the economy. These production systems are simply anchored on the integration of trees and woody shrubs. This is the reason why all stakeholders need to work in unison under this clarion call to reduce the impact of climate change which affect the country as part of the less developed world with severe impacts on the poor, vulnerable and marginalized majority.

5. Agroforestry as a nature-based intervention against climate change

Embracing nature-based interventions against climate change is a compelling option available to small landholders in Zimbabwe. With a greater percentage of the population already practising some form of agriculture, agroforestry can be easily integrated into the existing household livelihood strategies. In some cases, families are already into agroforestry but not within the extent to which they can reap greater benefits both directly in getting, for example, food or firewood and indirectly through ecosystem services which help to ease the impact of climate change. These interventions can be "sustainable agriculture, integrated water resources

management and sustainable forest management” [34]. Agroforestry as an ecosystem-based solution against climate change fits well with these nature-based interventions as the strategy has elements of sustainability, agriculture, water and forest resources management rolled into one. Most of the livelihood strategies in the rural areas are anchored on direct dependence on nature and it will be in the interest of the people there to take care of their immediate environs for them to sustain their livelihoods. Urban development had drastically the landscapes wherever towns and cities are found. However, the proliferation of urban agriculture in Zimbabwe has become an acceptable practice within backyards or open spaces around the suburbs. Home gardens, as one method of agroforestry, are very appropriate in this scenario of urban agriculture that is already existing there. This could explain the prevalence of fruit trees around people's houses in the towns and cities of Zimbabwe.

The land produces and acts as a reservoir of greenhouse gases (GHGs) and functions in the interplay between energy, water and atmospheric gases between the ground and air above it [12]. Natural forests that have not been damaged can store up to 510 billion tons of carbon dioxide and the world will not achieve its targets set by the Paris Agreement if forests continue to be damaged [27]. Key sectors such as agriculture, forestry and other land uses account for 76% of the overall GHGs produced in Zimbabwe [14]. In this respect, it has been found out that “land-based mitigation options rank among the most cost-effective opportunities to sequester carbon emissions. Economic evaluations of various climate change mitigation alternatives show that capturing carbon through restoring degraded lands (including degraded-forest) is a cost-effective option that offers multiple co-benefits” [35]. To mark World Wildlife Day by CITES on 3 March 2021, the theme was “Forests and Livelihoods: Sustaining People and Planet,” to emphasize the critical part played by forests and their associated biodiversity in supporting human lives especially indigenous people and local communities (IPLCs) who manage 28% of global terrestrial ecosystems [28]. The role of IPLCs should be acknowledged and taken into consideration to frame everlasting solutions in the fight against climate change impacts through nature-based interventions [36–38]. A study of communities around the Middle Zambezi Biosphere Reserve has also shown that the people have rich local ecological knowledge which helps them in raising their resilience against the external conditions induced by climate change [6].

This shows that forests should not just be protected from further degradation, but they need to be reclaimed too since 73% of the Earth's land surface has been modified by human activities [27]. Thus, there is a need to engage in natural resources management systems that serve human needs in tandem with the sustainability of forests [28]. These efforts to restore biodiversity can succeed when the cultural systems are put at the center of methods that yield win-win solutions for natural ecosystems and climate change resilience and mitigation [37]. Just like any country that is committed to the AfSD, Zimbabwe has a chance to play its part through SDG 15 which deals with “life on land” and specifically to achieve target 15.3 that refers to Land Degradation Neutrality (LDN) [14]. Good management of the land helps in lowering the adverse effects of climate change while the conservation of forest resources is critical in fighting poverty [12, 14, 39].

To tackle climate change, one has to understand the intricate ways through which people engage in activities to sustain their lives interface with natural ecosystems as these are not mutually exclusive. In her research, Laura Vang Rasmussen, an Assistant Professor at the University of Copenhagen, Denmark puts it aptly that, “the problem at the moment is that forest conservation, agricultural development, and poverty reduction are viewed as distinct from each other. However, the three factors do influence each other. Strategies to increase agricultural productivity can harm forests. On the other hand, an increase in wooded

areas makes it more difficult to produce enough food. So we hope that our research can contribute to highlighting the complex dynamics between agricultural productivity, deforestation, poverty and food security,” [39]. I then add that for example, forests and their dynamic relationship with other ecosystem constituents play a critical role in dealing with climate change impacts. In the same vein, the practice of agroforestry is an attempt to restore natural ecosystems while increasing agricultural productivity that raises outputs for the benefit of human beings. This is borne out of the understanding that the livelihoods of vulnerable people are anchored on natural resources including forests [30].

The majority of the Zimbabwean population is rural where they largely practice a mixture of arable agriculture and livestock production on communal land that is based on common-pool resources. These agricultural production systems are mainly in the mode of family farming which is based on family labor working on small landholdings. The general set-up under communal land tenure in rural Zimbabwe is such that people occupy individual landholdings for settlement (housing and basic amenities) and arable agriculture with common areas under pastures (for example, forest landscapes) and sources of water like wetlands, springs, rivers or man-made features like dams, wells and boreholes. Earlier on, I have highlighted how some of the agricultural practices by smallholder farmers are leading to land degradation which has devastating effects on productivity and increasing the levels of vulnerability and high risk of climate change impacts. So, there is a need to look again at the structures and practices of smallholder agriculture in the country with the idea to leverage them with agroforestry as a complementary strategy. Agroforestry here will be a way to sustainable livelihoods through ecosystem goods and services while increasing capacity for climate change resilience and resilience. Adoption of agroforestry at the household level by the small landholders will cumulatively uplift the local communities' climate change resilience and mitigation. This should work well with family farming that integrates various traditional and cultural values and practices in supporting their livelihoods [36, 37]. As farmers increase the range of crops which they can grow as a technique to increase productivity, studies have shown that this technique is useful for smallholder farmers to cope with climate change impacts [1, 33]. It can be argued that this method can be extended to including agroforestry to increase the range of what smallholder farmers can grow on their land [33]. This can be accomplished through, for example, intercropping of crops and tree species that complement each other together with conservation agriculture which helps to regulate soil moisture content [38, 40].

6. Discussion of agroforestry as a small landholder tool

Issues that relate to the factors that influence people's involvement in forest management programs need to be studied to determine the appropriate interventions [30]. Rural-based households in Zimbabwe encounter many hurdles to come out with relevant and applicable ways to cope with climate change impacts [8]. These issues need to be addressed and the government should lead the initiatives of mobilizing resources and participation of other stakeholders to spearhead supportive programs that integrate agroforestry as a climate change resilience and mitigation strategy. This is because it has been noted that the government's capacity to implement effective programs to combat climate change is limited despite having the right institutional mechanisms in place [5]. For instance, a study in two districts of Makoni and Wedza within the eastern Manicaland Province showed that smallholder farmers were not well informed about climate change though they could be able to describe conditions that show the onset of the phenomenon [11].

This shows challenges in addressing climate change at the awareness phase starting from the household level, which means that there is a lot to do to reach the extent of implementation of relevant plans of action with the involvement of the smallholder farmers [3, 10]. Development programs can be effective in bringing positive change in people's lives if they enhance their climate change resilience and mitigation [10].

A study of the importance of agroforestry in efforts against climate change impacts involving smallholder farmers in Kenya has shown that the trees enhance resilience against either scarcity or deluge of water thereby raising the threshold to which they can be affected by these extremes [41]. Family farming practised by these small landholders is suitable in this case and that is why the practised is well recognized under the declaration of the UN Decade of Family Farming which spans the period 2019–2028 [37]. The study concludes that “in both drought and flood events agroforestry had an important role to play in reducing sensitivity, largely through improving environmental conditions (shade, soil erosion, windbreaker, microclimate regulation), and increasing adaptive capacity by providing critical tree products and financial benefits (fruit, food, firewood, construction materials, fodder, traditional medicines, money from sales of fruit products)” [42]. This shows the multifaceted and positive role of agroforestry in climate change resilience and mitigation and more importantly for the small landholders who are often vulnerable. For example, concerning challenges encountered when there is a shortage of water, there is need perhaps a need to plant trees that are drought tolerant together or invest in irrigation infrastructure so that there is a substantial shift from rain-fed agriculture [2].

This strengthens the idea of adopting ecosystem-based initiatives as part of the broad nature-based solutions recommendations in tackling climate change among low-income groups who at most occupy small landholdings. The basis of these approaches is underlined by the critical role played by biodiversity which needs to be integrated into the climate change solutions. In this way, “integrated biodiversity conservation and climate change adaptation approaches can be instrumental in making people, places and wildlife more resilient to climate change. Beneficial outcomes may include improved food and water security, protection against the impacts of extreme weather events, more-secure livelihoods, the safeguarding of critical ecosystems and habitats, and carbon sequestration” [43]. The benefits show a win-win situation by balancing the livelihood needs of people while the landscapes upon which they eke their living are also taken care of so that they are sustainable. Ecosystem-based adaptation has shown positive spinoffs in food and water security in the Philippines, Bangladesh, Mongolia, and Uganda [44].

7. Conclusion

This chapter has highlighted the need to use agroforestry as a small landholder's tool for climate change resilience and mitigation in Zimbabwe. The majority of the Zimbabwean population resides in rural areas and largely depend on arable and livestock farming. While climate change is a global phenomenon, it has variable effects at a local level. More climate change impact is being felt in low to middle-income countries where the majority of the people are poor and directly depend on natural resources for their livelihood. Increased pressure on forest landscapes due to various human activities without adequate natural resources management systems and practices, has resulted in the transformation of those landscapes to precarious levels of degradation. Land degradation reduces the capacity of natural ecosystems to sustain livelihoods while increasing the levels of vulnerability of small landholders to the vagaries of climate change.

It is also important to note that natural resource access and use depend on the various kinds of institutions that are put in place to regulate and control these processes. Governance of access and use of those natural resources stretches from the global, regional, national up to local levels where we find small landholders. This governance includes both formal and informal systems of regulations that deal with the use of natural resources for people to sustain their livelihoods. As such, climate change is a global phenomenon, which is not confined to national boundaries, thus it requires them to work together to find collective solutions. In this regard, global environmental governance has been strengthened to reach a consensus to tackle climate change. This has led to the signing of several international agreements, conventions and protocols which provide frameworks to guide country roles and development of their policies, plans and programs to increase climate change resilience and mitigation.

Zimbabwe has put in place various kinds of institutional arrangements for its people to take care of the natural environment including forests, water and land. While these institutions look good on paper, there are a lot of challenges that need to be addressed in terms of the implementation of programs that help conserve the natural environment. It has been seen that various kinds of unsustainable activities lead to the degradation of the natural environment particularly in the rural areas where the majority population lives and directly depend on natural resources. This includes the cutting down of trees for various purposes including the increase in land and arable agriculture and livestock production. So, land degradation is associated with loss of biodiversity which is a critical component of natural ecosystems. Land degradation results in the loss of ecosystem goods and services, which compromise food production and water supply. Most importantly, land degradation is linked to climate change.

The chapter has justified why nature-based solutions are viable options for the smallholder farmers in the rural areas in the face of climate change. These solutions include ecosystem-based adaptation which are anchored on restoration of biodiversity. Agroforestry is an ecosystem adaptation intervention that is feasible for small landholders to adopt in Zimbabwe because of the multifaceted roles of trees and shrubs that are integrated into livelihood strategies. The implementation of such a strategy has its shortcomings that need to be worked around too. Favorable conditions for the adoption of agroforestry as a tool to enhance climate change resilience and mitigation make it a suitable approach under the constraints that face vulnerable the rural population.

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