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The Impact of Climate Change on Crops Genetic Resources Diversity in Ethiopia Consequence for Conservation

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Abstract: Climate change aggravates the issue for agriculture in general and biodiversity in particular. Climate change affects ecology dynamics in a variety of ways, including crop distribution changes and the loss of farming regions. Rising temperatures and changing environmental conditions may help invasive alien species, pests, and parasites spread. As a result of all this, global warming has already had a significant and widespread impact on plant genetic resource variety, and ensuring food security in the face of climate change is one of humanity's most pressing issues. Adaptation intervention and meteorological disaster preparedness are required to mitigate these negative consequences. Little is known about the causes, effects, and scope of genetic erosion on local crop plant species, as well as the list of landraces lost across the country. Ethiopia's indigenous crop genetic resources are under threat right now due to biotic, abiotic, and socioeconomic factors. As a result, crop genetic diversity preservation is critical in Ethiopia, according to homegrown knowledge, as diversity rosette, there was a continuous decrease in the variance of damage levels. Finally, improvements to in situ and ex situ conservation programs for domesticated species, their wild relatives, and other wild genetic resources are critical for the future of food and agriculture, particularly as the primary solution to global climate fluctuations.

Keywords: Climate, Biodiversity, Environment, Conservation

1. Introduction

In recent decades, the effects of climate change have become a major global threat. Adaptation intervention and meteorological disaster preparedness are required to mitigate these negative consequences [37]. The success of adaptation is heavily dependent on genuine understanding of climate change and how vulnerable farmers perceived the changes [9]. Farmers in this region struggled to obtain reliable and accurate climate information, making them more vulnerable to the effects of climate change [13]. Indeed, there is a substantial body of climate change literature in East Africa, including Ethiopia; they were primarily discussing farm-level perceptions and adaptation [3, 35, 69]. Few research has been done to compare perceptions with different time periods of climate records [2, 16], across regions [2, 24], and within societal groups. Small farms are similarly barred from participating in policy formulation and implementation, and their strategies and local knowledge have not been mainstreamed into national policies [26].

Climate change, throughout particular, has a significant impact on the diversity of Ethiopia's crop genetic resources. Climate change and extreme weather events are wreaking havoc on crop genetic resource diversity. A number of important agricultural species have their origins and diversification in Ethiopia. Farmers use their indigenous knowledge to maintain and manage these various genetic cash to accommodate their livelihood needs. Indigenous agricultural genetic resources, as well as farmers' indigenous knowledge, are currently in jeopardy and at risk of rapid genetic degradation. Climate change is one of the most significant factors that has had a significant impact on the country's crop genetic diversity. If this trend continues, the crop genetic resource gene pool may be depleted in the not-too-distant future. Farmers, districts, and regions must exchange landraces (genetic enrichment), train on crop diversity, use, production, and postharvest utilization, collect different crop landraces from growing areas, characterize and use a combination of one or more strategies, and collect different crop landraces from growing areas to increase the diversity and conservation of crop genetic resources in the country [52].

Climate change has a significant impact on Ethiopia's crop genetic resources diversity. Climate variability and extreme occurrences (drought and excessive floods) are wreaking havoc on lives, property, natural resources, and the economy, putting the country's most essential economic institutions at risk. Large sections of the country, especially the dry and semi-arid regions, are prone to significant climate change and dry spells on a regular basis. According to recent studies, flood hazard is increasing in highland areas as a result of changes in land use/land cover, rainfall patterns, and drainage [41]. Ethiopia is one of the most vulnerable agricultural countries to the effects of climate change and variability [42]. According to the IPCC, future climate change will increase climate variability as well as the frequency and intensity of extreme events across Africa, including Ethiopia [55]. Changes in rainfall patterns, combined with warming trends, may increase the risk of rain-fed agriculture and exacerbate Ethiopia's food crisis. Such issues have an impact on the variety of crop genetic resources in Ethiopia [44].

Climate change's impact on plant genetic resources and agricultural productivity is a major source of concern all over the world. Climate change affects ecosystem dynamics in a variety of ways, including changes in crop distribution and the loss of farming regions. Rising temperatures and changing environmental conditions may aid in the spread of invasive alien species, pests, and parasites. When ecosystems change, the distribution of disease vectors is likely to change, which has implications for the epidemiology of numerous crop diseases [60]. Climate influences several environmental characteristics, including temperature, oxygenation, acidity, and salinity. Crop locations, as well as the degree of warming and the direction and magnitude of precipitation change, are likely to have varying effects on agricultural production [45]. Most previous studies sought to understand and predict how the distribution of a single species or a group of species will change in response to a specific environmental change, mostly climate and land-use changes,. Little attention has been paid to simulating processes at the leading and trailing edges of the distribution, where range change occurs migration, persistence, extinction [30].

Plant genetic resources for food and agriculture are the biological foundation of global food security. Both to maintain current levels of food production and to meet future challenges, agricultural variety and genetic resources supporting food crops must be efficiently exploited [23]. In order to increase or even maintain key food crop yields in the face of climate change, genetic features from a variety of sources, including wild species, will need to be combined [58]. Unfortunately, because of a lack of management measures that aid in their adaptation to changing conditions, wild animals are particularly vulnerable to climate change. Narrowly adapted species and endemics are especially vulnerable to the direct effects of climate change. Changes in biotic interactions, such as pest and disease pressure, can have significant indirect effects [54]. As a result, the goal of this review is to learn about the impact of climate change on crop genetic resource diversity and conservation in Ethiopia.

2. Literature Review

2.1. Ethiopian Climate Change Causes

Ethiopia has seen climate change as a result of both internal variability within the climate system and external factors. The external causes could be natural or fabricated. Human activities such as the use of fossil fuels and the destruction of forests are the primary causes of climate change [47]. ([14] state with 95 percent certainty that human influence is the primary cause of the observed warming in the atmosphere and oceans, as well as other indicators of climate change, and that continued emissions of greenhouse gases (GHGs) will cause further warming and changes in the climate system's components. Climate change projections indicate that the severe negative effects of climate change will progressively harm many poor countries around the world due to their limited adaptive capacity [1]. Ethiopia is the most vulnerable Sub-Saharan African country to climate change impacts because it lacks access to adaptive capacity-building components such as information, capital, and technology [19]. Climate change impacts on rural smallholder farmers are extremely sensitive due to recurring declines in crop yields, loss of livelihood assets, and opportunities [70]. Pastoral and agro-pastoral communities in Ethiopia raise livestock in drought-prone arid and semi-arid regions, accounting for 12% of the population. As a result, the decline in livestock population and productivity in these regions can be attributed to recurring climate change [11, 69]. Despite the challenges, farming has been practiced in these areas for many years, with farmers relying on indigenous knowledge to support their livelihoods [12]. Identifying perceived causes, indicators, and impacts of climate change, as well as planning potential adaptation options as part of a national program, is therefore critical for the country [65].

2.2. Ethiopia's Early Contribution to Climate Change

Ethiopia has a land area of approximately 1.2 million square kilometers and is located in the Horn of Africa. Ethiopia is a landlocked country in Africa's Horn. Its landscape is made up of high plateaus, mountains, and dry lowland plains [72]. Agriculture provides a living for 80% of Ethiopia's population of approximately 80 million people, including a large population of semi-nomadic pastoralists [72]. It is a mountainous country with diverse climates, biodiversity, ethnic groups, and cultures. It has a wide range of climates, from hot and arid to cold and humid. In comparison to the majority of African countries, the country has an abundance of water resources. These natural resource bases have yet to be developed in a sustainable manner for the socioeconomic development of the country. Despite significant economic improvements following the 1991 political change, Ethiopia remains one of the world's least developed countries (LDCs). As a result, the country is more vulnerable to climate change and variability. The environment has emerged as a critical issue in Ethiopia in recent years. Among the country's major environmental issues are land degradation, soil erosion, deforestation, biodiversity loss, desertification, recurrent drought, flood, and water and air pollution [18].

As a result, climate change is a major concern for Ethiopia right now, and it must be addressed as soon as possible. It has exacerbated the country's already existing environmental issues, such as deforestation [72]. Climate change affects agriculture, and agriculture affects climate change. Agriculture contributes to climate change through the emission of greenhouse gases (GHG) from various farming practices [8]. Agriculture and land-use change (deforestation) are two of the leading causes of climate change. According to the IPCC Fourth Assessment Report, agriculture (including cropland, pasture, and animal production) and forestry account for 13 and 17 percent of total human greenhouse gas emissions, respectively. Ethiopia's agricultural sector is currently the most significant source of emissions, accounting for 51% of total emissions [18, 72].

2.3. Climate Change Impacts on Ethiopia's Agriculture Genetic Resources Diversity

Ethiopian agriculture is primarily rain-fed and practiced by smallholder farmers with limited ability to adapt to climate variability and extremes, which contributes to its climate sensitivity. Climate variability, particularly rainfall variability and accompanying droughts, has exacerbated food insecurity and famine in Ethiopia [14]. Droughts have resulted in dramatic reductions in agricultural productivity and rural employment, with significant economic multiplier effects [10] and social consequences [10]. Drought-related deaths were highest in Ethiopia in 1973, 1974, and 1984, with the most people affected (14.2 million, or 20% of the total population) in 2002 [76]. The severe drought caused by the 2015 El Oxygen vacancies is currently affecting over 10 million people [57]. According to the reports of the Intergovernmental Panel on Climate Change [36], climate change has a wide range of consequences for society and the environment. This was supported by a number of other studies, including [62].

The relocation of suitable production areas for various crops is another indicator of the impact of climate change on Ethiopian crop genetic resource diversity. According to Evangelista et al. [20], Ethiopia's major cereal crops, maize, tef, sorghum, and barley, will lose over 14, 11, 7, and 31% of their current suitable area of production by 2020, respectively. By 2050, this is expected to rise to more than 18, 11, and 37% for maize, tef, and barely, respectively. This means that C4 species (maize, sorghum, millet, and tef) that evolved in warm tropical environments will be close to their upper limit of maximum temperature tolerance, and that a small increase in temperature above the current maxima will push them out of their current adaptation area. Aside from C4 crops, C3 species adapted to cool temperatures will be the most impacted by projected climate change due to a loss of suitable area caused by the conversion of current cooler environments to warmer conditions [48, 66].

Climatic changes and extreme events (droughts and heavy rains) are wreaking havoc on life, property, natural resources, and the economy, making the country extremely vulnerable to climatic variations (66). Climate, particularly rainfall variability, appears to be the primary cause of Ethiopia's recurring droughts and the resulting food insecurity and famine [17, 75]. Dry spell and flash floods have wreaked havoc on the country's lowland pastoralists and mixed cropping systems [66]. Flood hazard is increasing in highland areas, according to recent studies, as a result of changes in land use/land cover, rainfall pattern, and drainage [41]. For example, the 2006 flood killed 719 people, displaced approximately 242,000 people, severely damaged infrastructure and houses, and caused property losses totaling millions of dollars across the country [63]. Climate change has a wide-ranging impact on agricultural crop genetic diversity. One of the most noticeable effects is a reduction in crop production water availability. According to studies on the effects of climate change on agricultural water resources under various emission scenarios, by 2050 and the end of the century, there will be an increase in evapotranspiration [27] and a decrease in soil water, ground water, and stream flows [32, 56].

The effects of global warming on water supplies has a direct impact on agricultural productivity and output. Although prior research differs in methodology, models, scenarios, and time periods used to reach a general conclusion on the future impacts of climate change on crop productivity and production, the results provide a broad indication of Ethiopia's crop production and productivity. Some studies, for example, show a general decrease in wheat and tef yields [43] and sorghum yields [73] across the crops' current primary growing areas, while others show an increase in maize yields in the highlands [73, 66], but a decrease in the lowlands, such as the central rift valley and related agro-ecologies [41, 66]. The impact of climate change on Ethiopia's key agricultural productivity varies according to crop type, location, and future time span studied [66]. Changing climate, in addition to its effects on domesticated crops, will reduce the ability of many wild relatives of agricultural species to survive in their current locations. Species that cannot move quickly are particularly vulnerable to extinction. Between 16 and 22 percent of crop species' wild relatives are thought to be in danger of extinction in the next 50 years, including 61 percent of peanut species, 12 percent of potato species, and 8 percent of cowpea species [39].

2.4. Over View of Crop Genetic Resources Diversity in Ethiopia

There are around 270,000 plant species that have been identified. Approximately 7000 or more of these are being cultivated and/or used for food by humans at any given moment [61]. Thirty crops produce 95 percent of the calories in the human diet, with three crops (wheat, maize, and rice) accounting for more than half (56 percent) [79]. Sorghum, millet, potatoes, sweet potatoes, soybeans, and sugar (cane/beet) make up the remaining 75% of the overall energy consumption [22]. According to Prescott-Allen and Prescott-Allen [59], 103 plant species provide 90 percent of the world's plant food supply. Only one or two million unique accessions are estimated. Approximately 30% of known threatened species are currently kept in living collections, while 2% of threatened species are part of recovery and restoration programs, and 34,000 plant species are classed as globally threatened with extinction (Global strategy for Plant Conservation, IUCN). The Ethiopian region is characterized by a diversified agro-ecology, which accounts for the country's enormous range of biological resources [51]. The tremendous genetic diversity of the numerous crop plants grown in the country is one of these biological treasures. Ethiopia is regarded the genesis and diversification center for several crop species. As a result, this highlights the importance of strongly encouraging environmental rehabilitation and placing a focus on climate change mitigation, particularly among those enrolling in biodiverse regions.

2.5. Climate Change's Impact on Ethiopia's Economy and Food Security

The lack of attention paid to genetic resources in the context of climate change policy is partly due to a lack of awareness. Although there is a clear understanding of the need to maintain and sustain gene pool in the agricultural sector in order to respond to ever-changing production conditions, those involved in international climate change discussions need to be more aware of the roles and values of genetic resources for food and agriculture. To this purpose, the Commission on Genetic Resources for Food and Agriculture (the Commission) has submitted its genetic resources and climate change topic research [8].

Ethiopia's GDP is mainly reliant on agriculture, and rainfall variability is significantly associated with it [75]. As a result, rainfall variability and accompanying yield decreases are expected to cost the economy 38 percent of its potential growth rate and 25 percent of its population [75]. By 2025, climate change could cut GDP by 3-10% [20]. According to a marginal impact estimate, a 1°C increase in yearly temperature will result in a statistically significant reduction in net revenue from overall agriculture, including crop and livestock, of -694.15 Birr [25]. Climate change threatens the food security of millions of Ethiopians by having a major negative impact on the economy in general and by reducing agricultural yields, increasing land degradation, and lowering water availability in particular. The influence of climate change not only on output but also on global agricultural import and export commerce and pricing, according to a bio-economic analysis using maize as a case study, will increase the number of food insecure individuals in Ethiopia by up to 2.4 million people by 2050 [66].

Ethiopia's economy relies heavily on agriculture. It accounts for over 45 percent of GDP, employs 85 percent of the workforce, earns over 90 percent of foreign exchange earnings, and provides the majority of raw materials for the industrial sector [6]. Food and nutrition insecurity has become one of Ethiopia's largest challenges as the country's population grows, despite the country's vast agricultural diversity, which can be used to combat hunger and poverty [68].

Though changes in the traditional farming system, protection of crop genetic resources and documenting of farmers' indigenous knowledge have received little attention. Few studies have looked into the importance of traditional farming systems and the widespread usage of improved varieties in current agricultural systems in this regard [7]. The present sustainability discussions highlight this information gap and suggest that field studies of traditional systems be conducted to fill it [16]. The argument that better variations of a few crops feed the globe should be critically examined in light of the present displacement of landraces by improved crop varieties [80]. Crop genetic resources are the foundations of modern agricultural output in order to feed the world's rising population [53]. Crop genetic resources are also valuable sources of genes for crop development and tolerance to key biotic and abiotic stresses [78].

2.6. Genetic Degradation Due to Climatic Change Has Had an Impact on Ethiopian Crop Genetic Diversity

The loss of variability from crop populations in diversity centers, i.e. areas of domestication and secondary diversification, is referred to as genetic erosion [46]. It means that the regular addition and disappearance of genetic variability in a population has been disrupted, resulting in a net decrease in diversity [71]. Genetic erosion is defined by Guarino [28] as a long-term decrease in the richness or evenness of common localized genes or alleles, or the loss of a combination of alleles in a given area. According to the study on the State of the World's Plant Genetic Resources, genetic diversity is always changing [22, 68]. Natural calamities, population pressure, market preferences, agricultural modernizations, urbanization, high pest and disease pressures, and changing cropping patterns due to climate change and environmental degradation have all had a significant impact on the magnitude of crop genetic diversity in Ethiopia [34, 50]. If the current trend continues, the gene pool of crop genetic resources may be depleted in a short period of time. Due to human meddling, the rate of genetic degradation of crops and their wild relatives is growing at an alarming rate [61]. Droughts have ravaged the area in recent decades, destroying a significant amount of biodiversity. Furthermore, the causes, consequences, and extent of genetic erosion on local landraces or the list of varieties/species lost in different areas of the country are unknown. Furthermore, in Ethiopia, the causes and consequences of crop genetic resource genetic degradation are poorly known [50]. Generally Agricultural genetic erosion is a complex process involving a number of factors that have an impact on existing crop landraces, either directly or indirectly [49].

The genetic erosion and extinction of Ethiopian crop wild relatives is becoming more severe, owing primarily to habitat fragmentation and over-exploitation. Farmers and their production systems are currently facing new challenges due to genetic erosion, environmental degradation, and pressures to produce more from the land. Displacement of farmers' varieties by new, genetically uniform crop cultivars, changes and development in agriculture or land use, destruction of habitats and ecosystems, and drought are the most important factors for genetic erosion in the country [74]. Vitally valuable as genetic erosion of farmers' varieties is the loss of crop genetic resources in natural habitats as a result of the expansion of commercial agricultural production based on few improved varieties, changes in cropping systems, and market preferences, which have all had a significant impact on the country's crop genetic resource diversity [22]. Worede [74] stated that genetic erosion of crops and their wild relatives is accelerating at a faster rate in Ethiopia as a result of human intervention.

Drought has eroded a significant amount of crop genetic resources in the country over the last few decades [7]. Furthermore, little is known about the causes, effects, and degree of genetic erosion on local varieties of crop plant species, as well as the list of varieties/landraces lost in different parts of the country. Ethiopia's indigenous crop genetic resources are currently under threat due to a high rate of genetic erosion caused by biotic, abiotic, and socioeconomic factors. Furthermore, there has been little focus on assessing the diversity and conservation of indigenous crop genetic resources. As a result, some of Ethiopia's indigenous crop genetic resources are threatened, and they may be lost before they can be characterized and conserved [52].

2.7. Ethiopian Climate Trends, Variability, and the Effects on Crop Genetic Divergence

The rainfall in Ethiopia is categorized by seasonal and inter-annual variability [19]. The annual rainfall variability in most parts of the country remains above 30%. Areas of Ethiopia with higher variability also have a higher probability of crop failure. The Belg season experiences greater rainfall variability than the Kiremt season, and the majority of Belg season growing areas (eastern, north eastern, and southern parts of the country) experience unreliable season onset and frequent crop failures, which has an impact on crop genetic resource diversity. Long-term gridded rainfall data analysis reveals no substantial change in simulated mean annual rainfall across the country. However, rainfall per day is increasing in the western part of the country while staying unchanged in most parts of central Ethiopia [20]. In comparison, there is a significant trend in mean annual surface air temperature (an increase of 0.6 to 0.8 0C) from 1975 to 2005.

Per the Takele et al. [64], an analysis of previous rainfall extremes demonstrated that 18 stations in Ethiopia experienced a decreasing trend in the Simple Precipitation Intensity Index (SDII), with no station showing an increasing trend in the SDII. For the remaining precipitation indices, a small and equal percentage of stations showed an increasing and decreasing trend, whereas the trend is not significant for the majority of stations. In more than 60% of Ethiopian stations, both maximum and minimum temperature extremes showed an increasing trend. Cold days and nights, on the other hand, decreased at almost all stations from 1980 to 2010. As a result of the findings, Ethiopia has been warming over the last 30 years, with an increasing trend of severe warming indicators in most parts of the country. Environmental rehabilitations and indigenous agricultural crop resources are critical for Ethiopia's agricultural intensification, food security, and environmental preservation [67].

2.8. Climate Change's Consequences on Crop Growing Season Length (LGP)

Crop growth is affected by climate change by slowing or intensifying growth and development processes. Although there are no detailed studies in Ethiopia on how climate change affects LGP in different parts of the country, a recent study on maize in Ethiopia's central Rift Valley using two crop simulation models under various climate change scenarios predicted that maize growth duration would be reduced by 14-33 days in 2050 compared to today due to higher temperatures and variable rainfall conditions [43]. Another study in northern Ethiopia found that the LGP decreased by 14–26 days in certain regions, but increased in others in the 2030s and 2050s [29]. These examples show that climate change will undoubtedly affect the LGP, but the degree of change will differ by area, prompting more local research.

2.9. Climate Change's Effects on Agricultural Crops of Disease and Pests

There are no research in Ethiopia that show how climate change affects the dynamics of crop pests and pathogens. There is information, though, that climate change would impact the geographic range of specific pest and disease species for a given crop growing region, resulting in increased crop losses [38]. Climate change may have an impact on the migration of agronomic and invasive weed species that exhibit features associated with long-distance seed dispersal, and it has been proposed that these species may migrate more quickly as surface temperatures rise [38]. Small-scale farmers rely on local genetic diversity to maintain sustained output and meet their livelihood demands in many circumstances. Farmers' capacity to cope with changes in pest and disease infection, as shown by the loss of conventional crop types, are harmed, resulting in production volatility and loss [67, 72]. It has been discovered that using variety combinations, multiline, or diverse varieties in the same production setting reduces disease incidence and increases productivity without the use of pesticides. By decreasing the distribution of disease-carrying spores and making environmental circumstances less conducive to the growth of certain infections, mixing crop species and/or types might delay the emergence of diseases [5].

The majority of known pest and pathogen resistance in crops utilized in breeding programs comes from local varieties obtained from farmers who grow them in genetically diverse systems. Nonetheless, in modern agriculture, the development of new cultivars cultivated in monocultures remains crucial. There are breeding programs in place to generate new types and replace those that have "lost" their resistance, but the current system's upkeep costs are substantial [40]. Traditional crop varietal diversity is an important component of farmers' disease and pest resistance methods. As the intensity of pest and disease stress grew, increased diversity in farmers' fields, as evaluated by the number (richness) and geographical distribution of local and modern crop types, was connected with a decrease in damage levels. Furthermore Conservation of crop genetic diversity is critical in Ethiopia's, as diversity rose, there was a continuous decrease in the variance of damage levels.

2.10. Important of Conservation of Crop Genetic Resources Diversity in Ethiopia

Farmers are the major creators, users, and preservers of crop genetic resources on farms in Ethiopia [67]. Understanding the concepts and causes of genetic erosion in a given crop is required for monitoring genetic erosion of crop species/varieties at any scale [67]. Crop improvement programs suffer when genetic variety is lost. To minimize this, all stakeholders in the country are working to conserve and effectively use the genetic resources that already exist. Furthermore, crop genetic resources as well as farmers' indigenous knowledge must be collected, characterized, appraised, protected, and documented for future generations [52].

The principal center of in situ diversity for a given crop is defined as the center of origin, and continuing gene flow between crops and their wild relatives is possible [22]. A center of diversity is a geographic location with a high level of genetic variety for specific crops and associated animals [4]. Furthermore, because diverse genetic constitutions of materials have evolved through evolution outside of the centers of origin, it may be argued that these materials originate from farms, where they were further molded and maintained by farmers [51]. With the development of advanced tools for examining genetic diversity, such as isozyme and molecular analysis, it is now obvious that the majority of genetic variety in a crop is not necessarily located in its origin. Ethiopia is a significant hub of domestication and genetic diversification of agricultural species and their wild cousins in this regard [31]. Ethiopia is rich in local cultivars/farmers' variants of various key crops as well as wild relatives of some of the world's most important crops [33].

Farmers' societies use and conserve diverse genetic resources in a variety of ways. The indigenous plant species, their wild relatives, and weedy species that make up Ethiopia's crop genetic resources are regarded for their potential significance as sources of essential crop improvement variations [53]. Ethiopian wild crop cousins' genetic diversity has been utilized around the world to generate novel resistant crop types and overcome current yield limits. Sorghums from Ethiopia, for example, have offered downy mildew resistance in several inbred lines and have been widely adopted in the United States and Mexico, resulting in a productivity increase of millions of tons per year. Undoubtedly, the total monetary benefit exceeds the amount required to permanently protect all sorghum diversity [51].

Additionally, on-farm genetic resource conservation receives less attention, with agricultural extension in the country focusing on improved varieties to increase yields [78]. Government agricultural policy has failed to adequately acknowledge the function and contribution that indigenous crop genetic resources can provide for decades [71]. This is partially owing to a lack of recognition of the worth of indigenous agricultural genetic resources, and partly due to a desire to close national food security shortages [52].

3. Summary and Conclusion

According to this information, climate change is a major contributor to the loss of crop biological diversity. Climate change threats and vulnerabilities to various sectors of biological resources happened in several regions of Ethiopia. This has an impact on the prevalence of land regions ideal for growing a diverse range of crops with genetic diversity. Climate change will have an impact on Ethiopian agriculture genetic diversity if adaptation and mitigation are not adopted.

The survival of the strategic reserve of crop genetic resources required to adjust production systems to future problems is also threatened by climate change. Farmers may abandon kinds and breeds when conditions change, and they may be lost permanently if no actions are taken to assure their conservation. Crop genetic resource populations are struggling to adapt quickly enough to keep up with climate change. They will need to adapt in the wild, relying on their phenotypic plasticity and genetic diversity. Climate change and the interaction of food and agricultural genetic resources On the one hand, the effects of climate change on genetic resources have not been thoroughly investigated and assessed; on the other hand, the potential critical role of genetic resources in mitigation and adaptation has not been thoroughly researched and assessed. Climate change has already had a significant and widespread impact on plant genetic resource variety, and maintaining food security in the face of climate change is one of humanity's most difficult challenges.

It is critical that the genetic diversity of the world's resources be preserved and not lost, even if future climate change has an impact. Enhancements to in situ and ex situ conservation programs for domesticated species, their wild relatives, and other wild genetic resources are critical for the future of food and agriculture. Farmers will most likely replace landraces with new or improved varieties that are better adapted to fluctuations as conditions change. On the other hand, several landraces include features that could be of greater use in adapting agriculture to the effects of climate change.

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