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Climate Change and Coffee Production: A Review

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Abstract

Despite the commodity's dominant role in social, cultural and economic aspects of the world, the world coffee industry is potentially at risk due to the negative impact of climate change on coffee production. Climate change has emerged in recent years as one of the most critical topics. Therefore, the objective of this review is, to review the current impact of climate change and variability on Arabica coffee production and productivity and different climate mitigation and adaptation strategies for coffee production. The already perceived and the future predicted impacts of climate change on coffee production will not only be threat small scale farmers but also all actors involved in coffee industry including consumers. The recurrent climate change affects the diversity of coffee specious, distribution and suitability of production area. It results not only in emergence of new diseases and pests, but also increases the incidence and severity and altitudinal shift of existing diseases and insect pests. Yield, growth, quality and etc are also affected greatly by climate change. Coffee species are under a severe threat of genetic erosion and irreversible loss largely due to climate change. Population numbers could reduce by 50% or more and extent of occurrence is projected to decline by around 30% by 2088. Out of the 124 coffee specious at least 60% of coffee species are threatened with extinction. Climate change will shift the altitude range for coffee to higher elevations over time. Area suitability of coffee is greatly affected by climate change and even 100% reduction at worst scenarios by the year 2080 in some countries. To cope up with such unmanageable proportions reaching climate change possible adaptation and mitigation strategies should be adopted and applied by the growers.

Keywords: Area suitability; Disease; Pest; Diversity; Quality; Yield

Introduction

Coffee is the most internationally traded commodity in the world next to oil; consumers from all around purchase and enjoy coffee regularly. The economies of many countries depend upon coffee production. But the recurrent climate change is threatening such a popular commodity. Over recent years we observe increasing temperatures in various regions, and increasing occurrence and intensity in extreme weather events. Climate change is expected to increase the annual variation in crop and livestock production because of its effects on weather patterns and because of increases in some types of extreme weather events.

Coffee is a highly sensitive to climatic change. Arabica coffee is the most sensitive coffee specious when compared with the other specious [1]. Several statistical studies based on projections of rising temperatures and altered precipitation patterns under present and ongoing climate change scenarios have predicted remarkable effects on the coffee crop including extensive reductions in agro-climatic zoning and losses (and drift) of suitable are as in most coffee-producing countries. Climate change affect coffee in many different ways. It brings about decreases in crop yields negative impacts on wild populations greater pest incidence increased agricultural, social and economic vulnerabilities. In addition, it has an impact on producers‟ incomes and coffee production viability.

Climate change mostly affects rural communities, especially those who are living below the poverty line and their livelihoods depend on agriculture. Similarly, Rojas (2012) reported that climate change projections indicate that temperature will increase and there will be changes in rainfall patterns, affecting coffee growing and production [2]. Due to expected climatic extreme events in the future, deteriorate of the coffee in the near future is expected. The objective of this paper is therefore to review the current impact of climate change and variability on Arabica coffee production and productivity.

Coffee Production and Climate Change

Impact of climate change on coffee diversity

Globally, biodiversity is being lost and increasingly threatened through a range of anthropogenic actions. Global climate change is often considered as one of the major factors causing biodiversity loss. The most important notable drivers behind the current loss of biodiversity are habitat modification, overexploitation, climate change, invasive alien species, and chains of extinction, known collectively as the evil five biodiversity threats [4].

Despite the importance of wild Arabica populations in Ethiopia and South Sudan, there are serious threats to the survival and genetic integrity of this species. Amongst the most serious of these threats are deforestation climate change and genetic erosion.

Coffee species are under a severe threat of genetic erosion and irreversible loss largely due to increasing population, expansion of large farms, crop replacement, the coffee crisis and climate change, among others. The additional stresses imposed by climate change can also aggravate these problems as they can disrupt the ecosystem [5].

In Ethiopia (the center of origin and diversity of coffee), diversity loss is underway due to drought stress caused by the changing climate especially at Hararghe. The popular mocha type Arabica coffee of Hararghe, eastern part of Ethiopia, is greatly affected by drought stress. Farmers are losing their popular crop due to the recurrent climate change. Currently, the most severe stress conditions (wilting and curling of leaves, loss of coffee crop, and plant death through drought) were recorded in the Hararghe coffee growing environments.

Researchers are using different projection models to assess the extent of risk of extinction. For instance, Moat et al. (2019) used all available future projections for the species based on multiple general circulation models (GCMs), emission scenarios, and migration scenarios, to predict changes in Extent of Occurrence (EOO), Area of Occupancy (AOO), and population numbers for wild Arabica coffee. Their research result indicated that population numbers could reduce by 50% or more (with a few models showing over 80%) by 2088. EOO and AOO are projected to decline by around 30% in many cases [6].

Another recent study by Davis et al. (2019) on extinction risk assessment for wild coffee species indicated at least 60% of coffee species are threatened with extinction. They pointed out that the application of the IUCN Red List Categories and Criteria resulted in 75 coffee species (60%) being assessed as threatened with extinction, including 13 Critically Endangered (CR), 40 Endangered (EN), and 22 Vulnerable (VU) species; 35 species were assessed as not threatened [Near Threatened (NT) or Least Concern (LC)], and 14 species were Data Deficient (DD) [7-10].

Impacts of climate change on specious distribution and suitability of coffee growing area

The presence and distribution of wild species is closely related to their agro climatic requirements and how those requirements are satisfied in various environments. The presence of climate change may threaten the satisfaction of these requirements and thus for the presence and distribution of wild species. Species affected by climate change may respond in three ways: change, move or die. Several species are relocated from their native place without human assistance in response to climate change.

According to Killeen and Harper (2016) coffee production area is changed because suitable areas become too warm or prone to periodic drought. Most suitable area becomes unsuitable because of climate variation. The reduction of land suitable for coffee production will influence the world coffee market and increase the price of coffee. Due to suitable areas shrinkage currently, some producers will try to push further up the mountain, potentially bringing coffee into conflict with other land uses and driving migration out of coffee-producing countries. In Asia especially, any expansion of coffee is likely to come at the expense of tropical forests, pushing up emissions and accelerating the warming (Rivera et al., 2015). Increasing temperatures are expected to make certain coffee producing areas less suitable or even completely unsuitable for coffee growing, hence production will have to shift and alternative crops will have to be grown.

The study by Bunn and Laderach (2014) indicated that suitability scores for the entire country Brazil losses in total are 49% by 2030, 64% in the 2050ies and 79% until the 2080ies. Until the 2080ies all area above the 78% threshold would be lost. Regarding the entire country losses of area according to this analysis would be 92% for the 2030ies, 89% by the 2050ies and 100% until the 2080ies. Davis et al. (2012) stated that profoundly negative trend for the future distribution of indigenous Arabica coffee would be 65% reduction in the number of bio climatically suitable localities, and at worst (scenarios of almost 100% reduction, by the year 2080 under the influence of accelerated global climate change) in Ethiopia [12].

Laderach et al. (2010) in their case study pointed out that coffee-producing zone in Nicaragua is currently at an altitude of elevation between 800 and 1400 masl; by 2050, the optimum elevation will increase to 1200 and 1600 m.a.s.l. Another case study in Uganda revealed that if temperatures increase, areas suitable for coffee will be higher in the landscape and unfortunately, the areas that will become more suitable for coffee will compete with other crops or national nature reserves (Jassogne et al., 2013). Laderach et al. (2008) also predicted that climate change will shift the altitude range for coffee to higher elevations over time, with the optimal altitude shifting from 1200 m at present to 1400 m in 2020 and 1600 m in 2050 in Central America [13].

Impact of climate change on coffee yield

Coffee yield is very sensitive to climate change. Climatic variables such as temperatures (both high and low) can remarkably affect coffee yields. In fact, abiotic stresses such as extreme temperatures, drought, salinity or chemical toxicity represent serious limitations to agriculture, more than halving average yields for major crop species. Generally, temperature is the most significant climate variable responsible for the trends in coffee yield (kg ha-1) globally. With a one-degree rise in the mean temperature, there is generally an average loss of 116 kg ha-1 of green coffee in east Africa coffee producing countries including Ethiopia [14].

In the last 50 years, yields in Tanzania, where 2.4 million people's livelihoods rely on coffee, have fallen by about 137 kilograms per hectare for every 1°C rise in Arabica's minimum temperature, or around 50 per cent since the 1960s. If climatic events such as overly high temperatures occur during sensitive periods of the life of the crop, for example during flowering or fruit setting, then yields will be adversely affected, particularly if accompanied by reduced rainfall. According to the projections made in Brazil, in the south of Minas Gerais, potential yield of Arabica coffee is expected to decrease by about 25% at the end of the twenty-first century [15,16].

Conclusion

It is clear that, coffee production is under threat from global warming due to climate change. It is affecting the coffee farmers hard in a dramatic manner. Climate change has emerged in recent years as one of the most critical topics. It affects coffee sector starting from producer level to the end consumer. It affects coffee production in different ways. It affects the diversity of coffee specious, distribution and suitability of production area. The change in climatic variables also affects the incidence and severity of diseases and insect pests. Yield, growth, quality and etc are also affected greatly by the recurrent climate change.

It is predicted that rising temperatures and water shortages will negatively affect coffee production suitability at lower elevations and vice versa. The already perceived and the future predicted impacts of climate change on coffee production will not only be threat small scale farmers but also all actors involved in coffee industry including consumers. World population will rise to nine billion by 2050. In this scenario, coffee production is also likely to decrease globally, particularly in Africa.

It is being reaching such unmanageable proportions, thus many farmers are replacing coffee plantations with other crop. Unless this devastating climate change is mitigated/adapted not about the yield, not about quality but one may not find this popular plant on the earth by near future.

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