State of the Art Review on Climate Change and Coffee

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Introduction

The 2009 report “Agriculture at a Crossroads” by the International Assessment of Agricultural Knowledge, Science and Technology for Development clearly defines what the problem of climate change implies for the future of agriculture. In a context of increasing demand for food, feed, fibre and fuel, is the potential to irreversibly damage the natural resource base on which agriculture depends.

A reciprocal relationship between climate change and agriculture exists: agriculture significantly contributes to climate change in multiple ways and climate change in general has a negative impact on agriculture. Water scarcity and the timing of water availability will increasingly act as a constraint on production.

Climate change will necessitate a re-examination of water storage as a strategy to cope with the impacts of more and extreme precipitation, higher intra and inter-seasonal variations, and increased rates of evapotranspiration in all types of ecosystems. Extreme climate events such as floods and droughts are increasing and expected to augment in frequency and severity. Significant consequences are expected in all regions for food and forestry production and food insecurity.

Climate change is affecting the distribution of plants, invasive species, pests and disease vectors and the geographic range and incidence of many human, animal and plant diseases is likely to increase. In this article I examine the implications for coffee and explore the options for farmers to adapt to the climate threat to production and livelihoods.

Results and Discussion

Brodziak et al articulate climate change from two different perspectives: social conflict and vulnerability. They highlight that changes are likely to impact the ecological, political, economic and social systems, with the poor and the vulnerable likely to suffer the more severe consequences.

Mexico is regarded as highly sensitive to the impact of climate change at the social, economic, institutional levels. Depending on the region, partial or total loss of agricultural production is expected due to floods, droughts or hurricanes.

The social effects that could occur from an agricultural sector under increasing threat from changing climate conditions include increase in food prices with repercussions for food security and the potential for conflict between producers and consumers; social unrest as governments are put under pressure to address the decline in production and rural incomes; an exacerbation of the migratory flights towards urban centres or other countries, and an increased exploitation of natural resources such as forests in order to sustain rural livelihoods.

The International Trade Centre has explored the possible effects of climate change on quality, yield, pests and diseases, and irrigation; considers potential areas of intervention, and looks at short-term solutions and long-term strategies to make coffee producers better prepared; discusses the issue of carbon credits, and provides examples of individual initiatives to reduce the product’s carbon footprint.

The ITC consider that smallholders will be most affected and make a salient point in saying that measures agreed globally are aimed at limiting further warming, rather than reverse it. There are warnings that if the current trend in greenhouse gas concentration is not slowed or even reversed, then it would be difficult to imagine the impact and harder to plan for.

This highlights the urgent need for adaptation. More coffee may need to be grown under irrigation, which will increase pressure on water resources. Together with the increasing incidence of pests and diseases, production costs could spiral, rendering the future of parts of the industry unsustainable.

It needs to be emphasized that different forms of agriculture including coffee production also contribute to climate change. This refers not only to the agricultural element, but to other links in the chain including processing, trading, packaging and logistics. However, growers represent the

most vulnerable part of the chain to the impacts of climate variability, and are also the most numerous.

Further research has underlined the importance of agroforestry systems in which the majority of coffee is produced. These environments are home to biodiversity and provide a wide range of ecosystem services.

Climate data generated for the 2040-2069 period has projected an increase to temperatures and a greater incidence and intensity of landslides and floods. If actions are not taken, the consequences are higher rates of migration and the abandonment of plantations, possibly leading to the conversion to pastures. Consequently, biodiversity loss will accelerate.

In Mexico, the predominant coffee species is Arabica, which requires optimum temperatures of 15?C to 24?C. Temperature is the most relevant climatic factor for coffee production given its response to seasonal temperature patterns.

Higher temperature will reduce the yield and the quality. Rainfall requirements are between 1500mm and 2000mm per annum. The relationship between temperature and quality is such that as the former rises, the berries ripen more quickly. This leads to a fall in quality.

A higher quality has been demonstrated at higher altitudes and therefore lower temperatures. One estimation of the suitability for growing coffee is based on an assumption that temperatures will increase by 3?C by the end of the century. Should this happen, the lower altitude limit may rise by some 15ft (4.57 metres) per annum. This would result in areas currently deemed unsuitable due to cold potentially becoming suitable.

Modelling has been used to demonstrate a profoundly negative impact on indigenous Arabica using three time horizons (2020, 2050, 2080). The most favourable outcome was a reduction of 38% of land area possessing suitable bioclimatic conditions for the species.

Other studies specifically assess the effects of temperature and precipitation specifically on the flowering and fruit development phases of the plant’s phenology. The importance of average monthly rainfall at the start of the blooming period impacts are experienced both in terms of surplus water as well as increased drought.

The unpredictable rains will cause coffee to flower at various times throughout the year, causing the farmers to harvest small quantities continuously. This is opposed to more distinct wet and dry seasons that lead to the preferred option of large quantities during a short harvest season.

Extended droughts can cause flowers to abort. Increased temperatures and sunshine can induce the premature ripening of the beans, with a concomitant reduction of the quality of the coffee as well as the yield.

As well as shifts in suitability, another consequence of climate is the proliferation of pests. In Mexico, areas where coffee is grown at relatively high altitudes and previously therefore not regarded as at risk, are now being impacted by the coffee borer. The severe 2014-2015 outbreak of leaf rust, a fungal disease, has been attributed to increasing temperatures and unfavourable patterns of rainfall distribution.

In response a range of potential approaches has been proposed, ranging from changes in crop management, the introduction of new, more resistant varieties, the concentration of the coffee crop in production areas with more a favourable climate, and the diversification of revenue through sales of other agricultural products such as wood , fruit, honey, flowers.

The following caveat is provided: the viability of these options will depend on the direct participation of farmers in decision-making and implementation. While a diverse range of measures was proposed, it should be noted that much of the literature laments the lack of finance available to producers to be able to affect changes and that this obstacle appears to be particularly acute in Mexico.

By 2011, arguments on adaptation had evolved to demand that adaptation measures be taken across the entire supply chain and that should address improvements to farmers´ livelihoods. Site-specific adaptation has been proposed that identifies the critical impacts of climate change and the repercussions for all actors in the system. A case study has looked at the prospects for coffee in Veracruz, the second biggest producer in Mexico after Chiapas.

Typified by its high acidity content, the highly suitable areas for this characteristic were expected to move towards higher altitudes. While it was suggested that many farmers in response to climate variation vary their annual crops, there is limited capacity for coffee growers to do the same: coffee systems are characterized by longer lead times in which to realize the changes, approximately three years is required before the plants begin to produce fruit.

In a 2006 study, crop diversification as a response to climate variation and market volatility was identified by some households involved in coffee production in Mexico, Guatemala and Honduras. Diversification, while a preferred option proposed by the Mexican government, has not been well defined in terms of financial support nor in terms of the precise nature of technical assistance to farmers. It is also not clear if this would be the preferred route for producers themselves.

More recent studies have focussed on the potential of sustainable production techniques under which shade management and the development of new varieties fall; the pursuit of financing options to invest in adaptation and mitigation, payments for environmental services initiatives, a strengthening of organisation among small scale farmers and, finally strategies that seek to introduce adaptation strategies throughout the value chain. Determining the optimal combination of activities should be based on careful site-specific analysis and be developed in conjunction

with farmers themselves and other key stakeholders.

Conclusion

The relevance and urgency in continuing research in this area is clear: climate change poses a distinct threat to coffee production and quality as well as vulnerable people's livelihoods and biodiversity. With projected increases in temperature and decreases in rainfall, agricultural production will be impacted.

Monitoring the latest climate trends, strengthening institutions from academia to government and utilizing local farmers' knowledge could contribute to effective adaptation strategies to reduce vulnerability to and promote sustainability across the sector. Additionally, the success stories around existing adaptation activities should be shared widely across the region.

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