Mesoamerican Coffee:
Researching Climate Change Mitigation Strategies

Agriculture is very sensitive to climate variability and extreme weather events, like droughts, floods and severe storms. Due to human activities such as the burning of fossil fuels and deforestation the amount of greenhouse gases in the air have increased, which is causing a global warming of our planet. The Intergovernmental Panel on Climate Change (IPCC) concluded that rising temperatures will negatively affect food production and increase pest outbreaks. This is especially the case for agricultural sectors at subtropical land regions such as Mesoamerica. In this region crops like coffee form the backbone of thousands of families’ livelihoods and contribute significantly to national agricultural GDP’s.

The potential of coffee production

The Mesoamerican coffee sector is besides suffering severely from climate change also contributing to its effects. Uncontrolled use of fertilisers and other agrochemicals, coffee processing activities and farmland expansion at the expense of forests are further increasing the amount of greenhouse gases in the atmosphere. But the coffee production in this region also presents opportunities; coffee ecosystems have a large potential to store carbon in soils and the biomass of shade trees and coffee plants. To utilise this climate change mitigation potential various stakeholders in the sector need a comprehensive overview of how different agricultural practices are impacting the amount of carbon that can be stored in coffee farms and the emissions that arise from growing and processing coffee. By reviewing literature it was found that this knowledge lacked. As a thesis project part of his studies Henk van Rikxoort tried to contribute to the capacity of the coffee sector to mitigate climate change by researching these existing knowledge gaps. His thesis project has been conducted together with the International Center for Tropical Agriculture (CIAT) located in Colombia. This research institute that conducts research in social and environmental fields had a need to explore the opportunities for climate change mitigation in its existing coffee projects in Mesoamerica.

Approach and methods

The main objective of the research was to quantify the effects of several different coffee production systems on climate change.

Research by the International Center for Tropical Agriculture (CIAT) reveals the effects of different coffee production systems on climate change. The institute stresses on the importance of traditional coffee polycultures in conserving large carbon stocks. A framework called; Site-specific mitigation has been developed based on the results to assist coffee farmers in mitigating climate change most effectively and utilise the potential of Mesoamerican coffee production to combat climate change.

Figure 1: A traditional policulture found in Mexico.

In literature it was found that coffee production systems in Mesoamerica can be divided into; (1) traditional polycultures, (2) commercial
polycultures, (3) shaded monocultures and (4) unshaded monocultures. The traditional polycultures (see Figure 1) are shaded agroforests containing native trees and the coffee grown in these systems is cultivated principally by smallholder farmers. In the commercial polycultures the native trees are removed. Instead the shade cover is made up of trees that all have an explicit function; adding nitrogen to the soil and more importantly providing additional cash crops such as citrus fruits and bananas. Shaded monocultures on the other hand aim at high coffee yields and use a shade cover that is almost exclusively made up of Leguminous trees like Inga species. The unshaded monoculture—the last researched production system—has completely abolished the use of shade trees, and coffee plants are grown in full sun light in this system.

Figure 2: Two coffee farmers in Nicaragua who are interested in the research and very willing to help with the field measurements.

Henk hypothesized together with his colleagues at CIAT that besides which of the four systems is used, as well certification systems such as Rainforest Alliance and organic agriculture have an influence of the GHG emissions that arise from growing and processing coffee. Therefore a sample that contained the coffee production systems outlined earlier and as well organic, Rainforest Alliance and UTZ certified farms had been defined. To quantify the amount of carbon stored in the different systems and the GHG emissions arising (as well called a "carbon footprint") a specific GHG quantification model was used; the Cool Farm Tool. By entering data regarding shade tree density, the use of fertilisers and processing methods the Cool Farm Tool can calculate the sum of the carbon that is stored in tree biomass and the carbon footprint. After defining the research design data has been collected on a broad scale in El Salvador, Guatemala, Nicaragua and Mexico. Thanks to the support in the data collection from several cooperatives and especially smallholder coffee farmers (see Figure 2.) it was possible to take data from 66 coffee production systems.

Results and implications

After collecting the field data and back at CIAT’s headquarters in Colombia the carbon stocks and carbon footprint of each coffee farm researched were quantified using the Cool Farm Tool. By performing analyses and comparisons it was discovered that agroforestry (polycultural) coffee systems conserve on average a mean 81 t CO$_2$-e/ha$^1$. The monocultures show with an average of 27 t CO$_2$-e/ha$^1$ a much more limited potential to store GHG’s in the on-farm biomass. This means that traditional and commercial polycultural coffee farming systems in Mesoamerica play an invaluable role in conserving huge amounts of stored carbon. It was further found that especially commercial polycultures show a low carbon footprint which means that coffee produced in this farming system has a reduced impact on the climate compared to the other systems researched. Furthermore this system provides a whole range of other products besides coffee only such as; banana, avocado, mango, orange, mandarin, lemon and vanilla. This makes the production efficiency in terms of climate change very favourable and provides much

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$^1$ The Cool Farm Tool (Hillier et al., 2011) University of Aberdeen in cooperation with the Sustainable Food Laboratory.
more income stability for farmers in times when coffee prices are low or extreme weather events occur. To start utilising this potential for climate change mitigation in Mesoamerican coffee farming most effectively a framework for climate change mitigation has been introduced called; Site-specific mitigation. This concept is based on specific results of the research that show that storing carbon in on-farm biomass, controlled use of fertilisation and reducing the production of wastewater in coffee processing are the most effective practices in climate change mitigation. But by means of discussions with coffee growers it was also discovered that not all these three focus points for mitigation are within their reach. A Mexican coffee farmer explains for example that: “Due to the high humidity at this altitude we are unable to completely sun-dry our coffee and make partly use of mechanical dryers to speed up the process”. Some farmers produce for high quality nice-markets and make use of fermentation basins (washed Arabica coffee) which contributes to the final quality of their product, but also results in high GHG emissions.

Taking these site-specific situations into account it was argued that it cannot be expected from these coffee farmers to reform their complete processing and farming systems for the sake of climate change mitigation. Instead, in line with the developed Site-specific mitigation framework coffee farmers can choose for one or two mitigation focus points tailored to their own coffee production systems. Certification systems—such as Rainforest Alliance, UTZ Certified and 4C—are the promoters and validators of sustainable agriculture and already actively working on integrating climate change mitigation in the agricultural practices they encourage. Therefore the findings of his research have been communicated in the form of a consult with several certification systems and various other stakeholders in the coffee sector. In this way the results can go beyond theory only and contribute to the conservation of traditional coffee agroforests and the acceleration of climate change mitigation in Mesoamerica and other coffee growing regions in the world.

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**Van Hall Larenstein** — is the largest “green” University of Applied Sciences in the Netherlands. Van Hall Larenstein is part of Wageningen University and offers a variety of Bachelor, Master and Postgraduate programmes which focus on nature, environment, human and animal health, nutrition food production and responsible entrepreneurship.

**The International Center for Tropical Agriculture (CIAT)** — is a non-profit organisation that conducts advanced research in social and environmental fields to mitigate hunger and poverty and preserve natural resources in developing countries. CIAT is based in Cali, Colombia and one of the fifteen specialised research centers of the Consultative Group on International Agricultural Research (CGIAR).

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