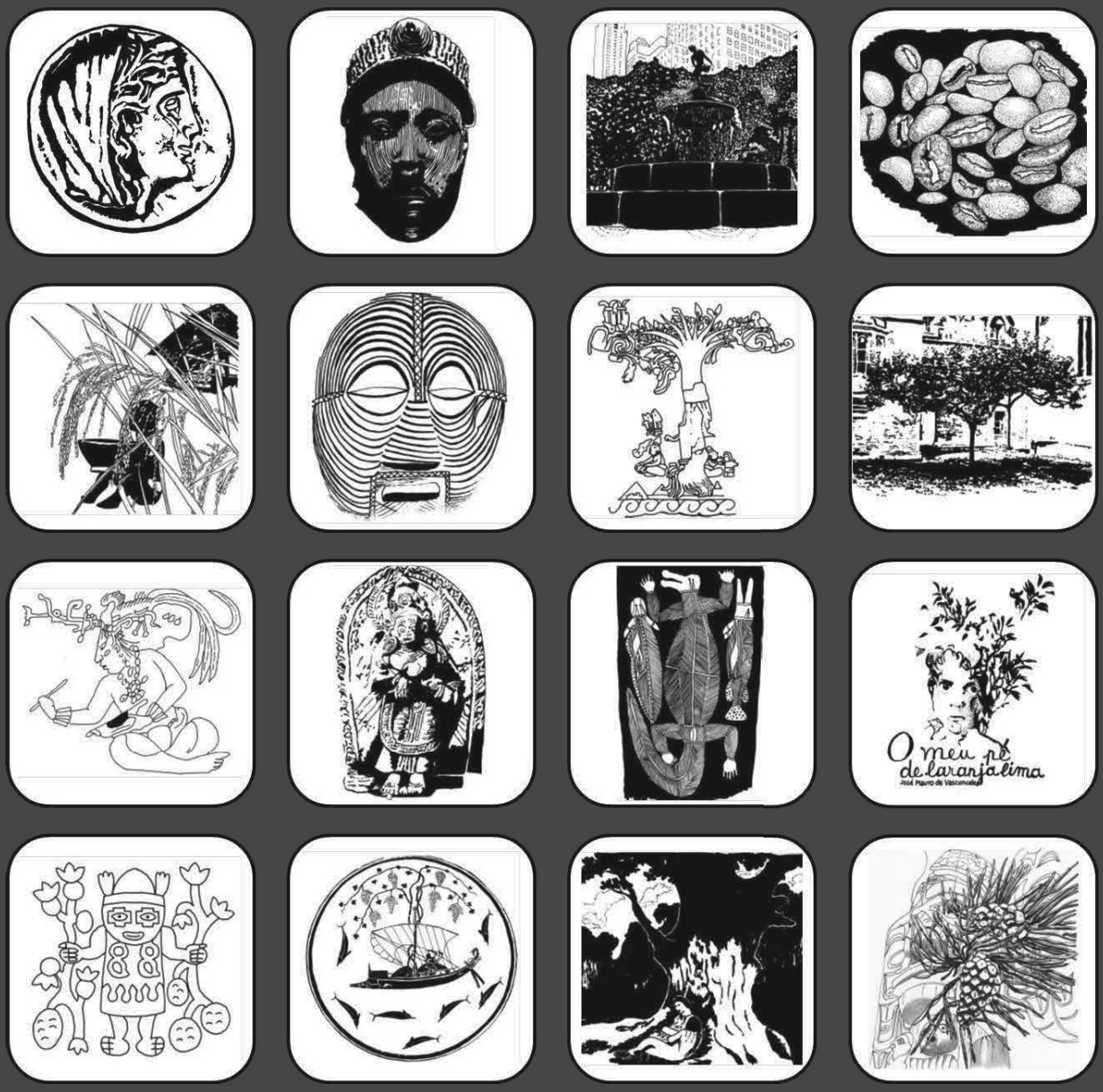

Global Plant Health Assessment

An international peer-reviewed evaluation of the state of plant health across ecoregions of the world, and of the effects of plant disease on ecosystem services

ISPP INTERNATIONAL SOCIETY FOR PLANT PATHOLOGY

OECD

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Edited by Laetitia Willocquet, Manjari Singh, Sonam Sah, Federica Bove, Serge Savary, and Jonathan Yuen

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Coffee in Central America

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Background information

Central America has a tropical climate which is modulated by elevation. Climate change is expected to strongly affect Mesoamerica in the near future, because low latitudes are exposed to climate change several decades earlier than higher latitudes (Hawkins and Sutton 2012). Central America may therefore be seen as an observatory for early climate change impacts. The region is also under the influence of two oceans (Pacific, Atlantic-Caribbean sea), and its climate is strongly influenced by El Niño – La Niña Southern Oscillation. This results in large weather variability with dry and very rainy years.

Coffee is one of the most traded agricultural products in the world. About 100 million people depend on it. In 2014, it was estimated that 26 million farmers in 52 countries produced over 8.5 million tonnes of coffee, worth US$39 billion. The retail value of coffee is much higher. In the US alone, sales reached US$87 billion in 2019. Coffee is generally produced by smallholders, who own areas of less than 5 ha (Rhiney et al 2021).

Coffee used to be the most important export in value and a very important contributor to national GDPs 30 to 40 years ago in Central America (Avelino et al 2015). Since then, the contribution of coffee to GDPs has dropped below 7 % in the region, with a maximum of 6 % in Guatemala, and less than 1 % in Costa Rica and El Salvador (Espíndola Rafael and Trewick 2021). Yet 1.9 million people directly depend on coffee in the region, most of them smallholders and agricultural labourers (Avelino et al 2015). The social and economic importance of coffee has been highlighted by the coffee rust crisis (starting in 2012), when 16–32% of the total labour force, depending on the country, a total of around 375,000 people, lost their jobs because of the decrease in coffee production, with consequences in terms of migration from rural to urban areas and from Central America to North America (Avelino et al 2015).

This report focuses on Arabica coffee (*Coffea arabica*).

Landscape with pruned and free growth erythrinas (flowering) (photo: J Avelino)

PlantSystem considered in this report

Coffee is grown in agroforestry systems (AFSs), i.e., associations of Arabica coffee with shade trees, which generate a range of ecosystem services: provisioning, supporting, regulating, and cultural services (Avelino et al 2018). Ecosystems services generated by these AFs can be summarised as follows (Avelino et al 2018):

- AFSs provide habitat for a large number of species (e.g., birds, ants, and fungi) with potential for the regulation of pests and diseases;

- dampen microclimatic variations;

- intercept light, thus suppressing weeds;

- contribute to carbon sequestration in the perennial plant species associated with coffee and in the soil;

- reduce surface runoff and soil loss through erosion;

- improve water quality; and

- enable a regular supply of water for human consumption or hydropower generation.

In terms of provisioning services coffee-based AFSs produce coffee as well as food, fuelwood, and construction materials, resulting into a diversification of farmer's incomes. Through radiation interception, shade trees suppress excessively high yields and extend the maturation duration of berries with buffered temperature.

Fertiliser application (photo: J Avelino)

Shading thus results into: (1) stabilised yields over years; (2) improved coffee quality; and (3) prevent the risk of coffee tree exhaustion through excessive production.

Furthermore (Avelino et al 2018), coffee-based AFSs improve their own environment by (a) reducing soil acidity, through the organic matter that is incorporated into the soil; (b) generating nitrogen in the case of associations involving leguminous trees (litter fall and pruning residues can produce up to 340 kg N/ha/year); and (c) increasing soil biodiversity (e.g. earthworms).

AFSs also enable ecotourism that contributes to the protection of complex, traditional, and culturally established systems.

Coffee health in Central America

State of coffee health in the past 30 years

Coffea arabica originates from the highlands of East Africa. Many coffee pests and diseases are still not reported in Central America, particularly: the Coffee Berry Disease (CBD, *Colletotrichum kahawae*) and the Coffee Wilt Disease (CWD, *Fusarium xylarioides-Gibberella xylarioides*). Recent introductions of pathogens and pests in the region include *Xylella fastidiosa* in 1995 (Rodriguez et al 2001) and the Coffee Berry Borer (*Hypothenemus hampei* in 2000 in Costa Rica; Staver et al 2001).

The past 30 years can be divided into two periods, first 1990-2010 with epidemics at national or specific coffee zone scales, caused by two main diseases, the American Leaf Spot Disease (ALSD, *Mycena citricolor*) and the Coffee Leaf Rust (CLR, *Hemileia vastatrix*). Prior to 2010, ALSD mainly affected Costa Rica and Guatemala in specific

years (i.e. during the very rainy La Niña years – J. Avelino, personal observation), where high elevation and cool temperatures favour development of the fungus. In 2010, a la Niña year, a regional ALSD epidemic occurred, also covering Honduras and Nicaragua, and even Colombia (Avelino et al 2018).

Three national CLR epidemics occurred in Costa Rica, Nicaragua, and El Salvador in 1989, 1995, and 2002, respectively. These epidemics mainly reflected farmers' economic difficulties, who could not afford purchasing fungicides to manage CLR. However, starting 2012, a regional CLR epidemic of a magnitude never seen before occurred, which affected the whole of Central America, along with Mexico and the Caribbean. That Coffee Leaf Rust regional epidemic actually had started in Colombia (2008-2011) and continued until 2013, when Equator and Peru were also impacted. Coffee leaf rust is the main threat on coffee in the entire region since 2012 (Avelino et al 2015; McCook and Vandermeer 2015).

These last epidemics have led the farmers to replant their farms with CLR-resistant varieties (Harvey et al 2021), which however are more susceptible to ALSD. Given the current climate change forecasts (elevation of temperatures), this large-scale variety replacement could lead to large ALSD epidemics in specific climatic years only. Moreover, this replacement of coffee varieties might not solve the CLR problem, because many new rust races have emerged that are able of overcoming resistance genes carried by the newly planted varieties. Some pathogen races seem entirely new. In Honduras alone, 11 new races of *Hemileia vastatrix* have for instance been identified since 2014 (Avelino and Anzueto 2020).

Leaf rust infected by Lecanicillium lecanii (photo: Isabelle Merle)

Evolution of coffee health over the recent 10 years

The Coffee Leaf Rust epidemics have been very serious, leading to variable production reductions with an average of 20% over several years at the region scale. Yield reductions in El Salvador have been in excess of 50% and the production of this country has not recovered yet. This is because much of the coffee area in El Salvador is planted to the highly susceptible tall Bourbon cultivar, with old plants and with limited disease management. Recovery of plantations in this country requires a gradual cultivar replacement, which will take several years (Avelino and Anzueto 2020).

The social impacts have been very large, with 375 000 workers losing their jobs, 130 000 households severely impacted and suffering various degrees of malnutrition (Avelino and Anzueto 2020; Avelino et al 2015).

It seems that the climatic variability in the region has increased, leading to the ALSD epidemics of 2010 and to the CLR epidemics since 2012. These two diseases have very different meteorological requirements. They used to only concern some specific coffee areas or countries at a time, but

Mycena citricolor on leaves – insert: propagules (photos: J Avelino)

never be a concern for the region as a whole (J. Avelino personal observation).

Ecosystem services, as affected by plant disease

Provisioning services **Regulating services**

Level of provisioning and regulating ecosystem services generated by coffee, as affected by plant disease, in the past 30 years

Coffee is the main agroforestry system in Central America: it constitutes the main human-made forest in the region. Coffee areas therefore serve to connect protected areas and significantly contribute to the conservation of biodiversity (DeClerck et al 2010). The overall ecosystem services generated by AFSs have been high over many years. The emphasis on environmental conservation in agricultural systems has generated innovations in the form of payment for ecosystem services (DeClerck et al 2010).

Despite these economic innovations for environmental conservation, however, the evolution of these systems has been negative over the past 30 years, especially in the recent past years, because of a reduction of shade cover in coffee plantations (Harvey et al 2021; Jha et al 2014).

Evolution of provisioning and regulating ecosystem services generated by coffee, as affected by plant disease, over the recent 10 years

There is ground to consider that a degradation in the provision of ecosystem services is taking place (DeClerck et al 2010; Jha et al 2014), because the reduction in production caused by coffee leaf rust epidemics, and because of a reduction of shade cover in coffee plantations to take advantage of the high yield potential of new CLR-resistant varieties.

Harvey et al (2021) report fast and extreme biophysical changes in coffee-based systems mainly resulting from low coffee prices, changing climatic conditions, and severe plant disease epidemics. These authors report seven trends of concern: (1) the widespread varietal replacement with coffee leaf rust-resistant cultivars, (2) the intensification of coffee cultivation with higher planting densities, greater use of agrochemicals and reduced shading, (3) the substitution of the coffee crop with other agricultural uses, (4) the introduction of Robusta coffee (*Coffea canephora*) into areas where coffee was not previously grown, (5) the expansion of coffee into areas with forests, (6) the urbanization of coffee areas, and (7) the increase of voluntary sustainability standards.

Complementary information

- as in many other tropical export crops where much of the production is in the hands of small-holders, a main concern is the price paid to producers for their productions.

- in countries where financial agricultural support is weak or non-existent, farmers producing export commodities are especially vulnerable to global markets.

- lower prices on the global coffee market leads to lower farmers' financial resources. The reduction of lower farmers' financial resource has been demonstrated to be one cause for the development of coffee rust (Villarreyna et al 2020).

- Another issue is the level of farmers' training and their age, which constrain the prospects to learn or adopt new approaches.

We are very confident in this assessment: many studies, publications, support your views. There are only few gaps in the literature.

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