Replacing Chemicals with Biology:

Phasing out highly hazardous pesticides with agroecology

by Meriel Watts
with Stephanie Williamson

PAN International

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Using slashed weeds and other waste foliage to cover soil in organic ginger field

8.3 Nicaragua: Beneficial forest microorganisms in coffee production

by Heather R. Putnam (Associate Director, Community Agroecology Network) and Stephen R. Gliessman (Professor Emeritus of Agroecology, University of California, Santa Cruz, and Board President, Community Agroecology Network)

Background: benefits of mycorrhizae on plant fertility and pest resistance

Endo- and ecto- mycorrhizal fungi (hereafter referred to as mycorrhizal fungi) are species of fungi that form a mutually beneficial (symbiotic) association with the roots of many plants, especially perennial shrubs and trees, either living in the soil or within the plant roots. They occur naturally in the leaf litter and root biomass on the floor of coffee groves (especially under shaded coffee systems, given the increased leaf litter). Mycorrhizal fungi help roots break down cellulose and increase their absorption of nutrients from the soil. In particular, they help improve roots' ability to assimilate phosphate, an element typically lacking in tropical soils. Mycorrhizal symbiosis in coffee plants is well established scientifically, as is its importance during the seedling formation stage.[291] It is also established that the symbiotic association of coffee plants with mycorrhizal fungi positively impacts coffee plants' resistance to pathogens.[292]

Case study context: smallholder coffee farmer cooperatives in San Ramon, Nicaragua

The Community Agroecology Network (CAN) has collaborated on a community food security project and an alternative coffee-purchasing model since 2010 with a second-level coffee cooperative organization, the Union of Agricultural Co-operatives Augusto Cesar Sandino (referred to as the UCA San Ramon) in San Ramon municipality in the northern Nicaraguan department of Matagalpa. The UCA San Ramon is made up of 21 first-level coffee co-operatives bringing together over 1,080 smallholder coffee farmers in the municipality, 36 percent of whom are women. CAN has engaged directly with one of the UCA San Ramon's members, the Denis Gutierrez Co-operative, to promote agroecological coffee production through its AgroEco® Coffee Program, which invests 10 cents per pound of coffee purchased in improving agroecological production practices.

CAN is an international non-governmental organization whose mission is to sustain rural livelihoods and environments in the global south through the integration of collaborative research, agroecological education, and locally informed development strategies. We operate as a network partnering with community-based organizations, farmers' cooperatives, nonprofits, and universities. Together, we promote food security and sovereignty in rural communities through agroecological farming practices; local control over food production, distribution and consumption; alternative trade models; and the empowerment of local and indigenous youth and women in the leadership of these initiatives. Our work is both regional and global, with projects and activities in Mexico, Central America, and the United States, and our international agroecology short course, which has trained hundreds of farmers, researchers, and community leaders from around the world since 1999.

291 Habte M, Bittenbender HC. 1999. Reactions of coffee to soil solution P concentration and arbuscular mycorrhizal colonization. *J South Pacific Agric* 6:29-34.

292 Andrade SA, Mazzafera P, Schiavinato MA, Silveira AP. 2009. Arbuscular mycorrhizal association in coffee. *J Agric Sci* 147:105-115.

CAN had been working with the 15 members of the Denis Gutierrez Co-operative since 2011 to reduce and eventually eliminate their usage of chemical fertilizers and insecticides, as well as increase their use of agroecological methods to improve soil fertility. In 2011, only 2 of the 15 farmers were implementing ecological practices to increase soil fertility, including composting or applying fermented coffee pulp left over from coffee wet milling processes to their coffee plants. All 15 farmers stated that they utilized chemical inputs despite being aware of their negative effects, citing ease of use and, especially, a lack of confidence in the effectiveness of 'organic' fertilizers and pesticides.

Experimenting with native forest microorganisms

In 2012, Nicaraguan coffee was devastated by the coffee leaf rust disease Hemileia vastatrix. The rust is present in all coffee growing regions of the world, and is the most economically significant coffee pathogen.[293] A major infestation in Central America began in 2011 and worked its way north. In San Ramon, farmers reported losing on average 40-100 percent of their coffee plants to the disease. In the Denis Gutierrez Co-operative where farmers work an average of 1.4 hectares of coffee each, farmers experienced an 80 percent reduction in yields in 2012 due to the rust and an accompanying anthracnose pathogen, which kills coffee plants already weakened by rust infection.

The crisis led, in 2013, to a small group of seven farmers within the C-ooperative taking a perceived "risk": experimenting with different combinations of native forest microorganism applications (mycorrhizal fungi), compost and mineral foliar fertilizers. They applied these materials to newly planted seedlings and recuperating established plants on about 5 hectares of land set aside for the experiments. The expectation was that increased availability of nutrients in the soil, plus increased root capacity to absorb these, would also result in more robust plants with increased resistance to fungal diseases like leaf rust and anthracnose. Increased yields, once the plants were fully recuperated or had reached maturity for fruiting, were also expected. The soil amendment preparations were applied for about 1.5 years while the coffee leaf rust attack subsided and surviving plants regained foliage.

Coffee plant with the disease leaf rust, La Roya. *Heather Putnam*

The specific practices implemented included a combination of solid native forest microorganism inoculum with compost applied to soil, plus application of natural mineral foliar fertilizers. The native forest microorganisms are prepared by collecting decomposed leaf litter, which is mixed well with semolina and molasses to accelerate fermentation. Water is then added to achieve a thick, wet mixture and is compacted into barrels and left to ferment. The resulting solid mixture is then applied to the soil around the coffee plant.

293 Arneson PA. 2000. Coffee rust. *The Plant Health Instructor.* http://www.apsnet.org/edcenter/Pages/phi.aspx

Cooperative peparation of the beneficial mycorrhizal fungi. *Heather Putnam*

Mycorrhorizal fungi fermenting. *Heather Putnam*

Results and benefits

In 2014, farmers observed that coffee plants in the experimental plots were bigger, visibly healthier, and more resilient to the leaf rust (it was present at normal levels but not affecting foliage) as well as other fungi, than other plants renovated at the same time or recuperating from the fungus attack in other fields. Trees in the experimental plot were also more resistant to attack by borer insects. It was noted at the onset of the 2014-15 harvest that the plants treated with the preparations had heavier fruit loads than those in plots that did not receive the treatments.

The other eight farmers in the co-operative, as well as other neighbouring co-operatives, have seen the results and are enthusiastic about learning and applying these agroecological technologies in their own fields, confident that they will also see increased yields as well as higher plant resilience to future infestations of insects or fungal pathogens.

The major benefits of the application of native forest microorganism inoculum, in combination with compost and natural mineral foliar fertilizers, is not only increased plant vigour and resistance to leaf rust, but also resistance to other fungal diseases and borer insects. This holds true both for plants recovering from the rust infection, and for seedlings recently planted. The plants that had been severely affected by rust two years prior had recovered foliage as well as fruit, and incidence of rust on foliage appeared normal. An additional benefit to this application is that it is cheap, costing a total of about US $0.08 per coffee plant to apply, as opposed to an estimated US $0.80 per coffee plant for conventional fungicidal applications. Furthermore, the application is easy for community members to prepare and accessible to farmers because it utilizes locally available natural materials.

CAN plans to accompany the expansion of this agroecological practice within the co-operatives of the UCA San Ramon with research processes that will identify the specific strand of mycorrhizal fungi and expand on the science and mechanisms of its beneficial impacts.

8.4 Brazil: Large-scale organics combined with agroforestry

A family-owned organic farm in Brazil's São Paulo state shows that agroecological production can occur on a large scale. Founded in 2009 by supermarket chain heir and former Formula 1 race-car driver, Pedro Paulo Diniz, Fazenda da Toca has become one of Brazil's leading producers of organic eggs, dairy and fruit. The farm fosters ecological awareness and provides eco-education to younger generations, to its engaged consumer