

Faculty: Colin Orians, Professor, School of Arts & Sciences

Project Locations: Medford, MA and Santa Maria de Dota, Costa Rica

Dates: early June – early August 2020

Project Title: Exploring the resilience of coffee production in Costa Rica

Project Details: Small-scale farmers around the world struggle to maintain stable production to support their livelihoods. Inherent drastic fluctuations in the quantity and quality of perennial crop yields, also known as alternate-bearing, thus pose an important socio-ecological problem. Such oscillations are widespread among fruit and nut crops, but the mechanisms differ across species and remain poorly understood in a globally important commodity crop: coffee. Coffee (*Coffea arabica*) is predominantly cultivated on small-scale family farms in rural regions of developing countries with limited adaptive capacity (Barrucand et al., 2017; Quiroga et al., 2015). In pilot interviews conducted with 33 coffee farmers, all participants confirmed alternate-bearing as an obstacle to livelihood stability but reports varied regarding its underlying causes and the potential for effective management (Garcia, in progress). The overarching aim of this project is to fill a critical knowledge gap by revealing the mechanisms of coffee's alternate-bearing and their relation to the broader context of farm management decision-making and farm landscape. In doing so, we hope to identify the social and natural factors that promote yield stability—a critical component of the system's socio-ecological resilience. We have two primary objectives: Objective 1: Identify the mechanism underlying fluctuations in fruit quantity and quality and isolate the effects of two key management practices (fertilizer and shade trees) on resource allocation tradeoffs. We are developing a theoretical model to characterize these tradeoffs. Objective 2: Determine the effects of landscape, management, and their interaction on growth-reproduction tradeoffs and alternate-bearing. We are developing a conceptual model of the relationships and feedbacks between social and environmental factors affecting stability. To date, we have established a three-year manipulative experiment, and initiated an observational study of 30 farms along a 500 m altitudinal gradient. For this observational component, we are pairing farmer interviews and ecological farm assessments to characterize the role of farmer perception, knowledge, and priorities in farm management, in stability. This coffee project forms the basis for Gabriela Garcia's PhD thesis. Through hands-on participation in all research activities described above, the global research assistants will gain unique exposure to environmental research methods from both natural and social sciences. In addition to the satisfaction of seeing their results, the students will gain important skills in hypothesis development, statistical analysis, and data visualization. The students will also help. We believe this experience in international environmental research will provide the global research assistants with numerous lessons that will continue to serve them throughout their academic journeys.

Tasks and Responsibilities of Research Assistant: This summer's research will build upon the three-year experiments established by biology PhD candidate Gabriela Garcia and GRAP assistants in the summer of 2018 and 2019. The specific tasks for the summer of 2020 GRAP assistants are described below. Objective 1: The students will assist in detailed data collection to characterize coffee plant reproductive tradeoffs and maintain the experimental manipulations of shade cover and fertilization on the three study farms. The students will also help collect and process plant tissue samples from the experimental farms which they will then analyze for resource concentration in the Orians laboratory upon return. Objective 2: On a wider set of farms that scale a 500m altitudinal gradient, the students will learn a broad set of ecological field methods to collect data on a suite of farm characteristics (including shade canopy cover, ground cover, planting density, and measures of plant health) and their relation to growth-reproduction tradeoffs

in coffee plants. Finally, the students will help conduct qualitative, semi-structured interviews with farmer participants to capture how farmer perception, knowledge, and priorities might affect their management choice and ultimately the degree of plant tradeoffs observed on their farm. Community engagement is a cornerstone of our approach. As such, the students will also assist in communicating our previous findings to the farming community. This involves the design of a Spanish-language info-graphic to be distributed to all the farmer participants. Upon return to Tufts, each student will analyze a subset of the data that is of particular interest to them. They will gain hands-on experience with laboratory techniques, statistical analysis, and data visualization. We found that this model of 4 weeks in-country followed by several weeks at Tufts increases student engagement and ultimately student learning. The students will also have the opportunity for continued research in the fall semester as a Bio93 project in the Orians lab.

Qualifications:

All interested students are encouraged to apply. Students with a background in biology/ ecology, an interest in agriculture and knowledge of Spanish would be preferred. Preference will be given to students with prior research experience and evidence of independence and comfort working in the field.

Description of Field Site:

The field site is in a small, rural town nestled in the coffee-covered mountains of Costa Rica. The farms are at a high elevation (1500-2000 masl) very close to a tropical cloud forest. WiFi access will likely be limited to the local cafes and restaurants, though cell service is good if students choose to purchase an international plan or a local SIM-card (requires an unblocked phone).

Housing in Costa Rica:

We will stay in a hotel in San Jose before departing to Santa Maria, where we will rent a house. Students should feel comfortable preparing most of their own meals at the field house.