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Assessing the adaptation strategies of farmers facing multiple stressors: Lessons from the Coffee and Global Changes project in Mesoamerica

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ABSTRACT

This paper analyzes the challenges and opportunities entailed in the design, implementation and dissemination of an interdisciplinary project that evolved into a knowledge co-production effort. The project explored the livelihood strategies of coffee growers in Mexico, Guatemala, Honduras and Costa Rica facing multiple stressors of economic (market shocks and price volatility) and physical nature (climate variability and pest incidence). Our objective was to determine the factors that influence farmers' decisions and the implications of those decisions for the people and the landscapes of the region. To achieve this objective, we intended to engage farm communities and sector representatives in the research process, and to a large extent this intent was realized. Nevertheless, the project illustrates the difficulties in achieving knowledge ''co-production'' with stakeholders whose day-to-day existence focuses on issues largely outside the domain of the research program. We adopted decision-analysis tools to integrate our knowledge and hypotheses to find a common language and structure for our research design. In relation to regional and national policy makers and sector experts, we aimed to communicate the decision–environment of the smallholder producer to enhance awareness of the institutional opportunities and constraints in the adaptation process. For the farmers themselves, we aimed to serve as conduits and mirrors of their own knowledge, rather than serving as external authorities on issues that appeared to be of little interest to them. Through the course of the project, we experimented with diverse modes of stakeholder interaction and, through collaboration with local experts in communication strategies, identified a set of tools for successful dissemination of results. The credibility and direct ties of the participating research organizations and collaborating institutes with the local communities were often an asset, sometimes a complication, but always a critical factor in the process of stakeholder

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interaction. The messages constructed from the collective knowledge of local farmers in distinct regions in four countries with different social and institutional histories represent crucial information for policy makers who are looking to support the adaptation processes of rural people facing changes of a global nature. However, communicating these messages in a usable and useful way to decision makers at various levels proved to be challenging.

1. Introduction

As one of the primary challenges for society today, climate change is inherently an interdisciplinary topic and a concern that bridges continents and places, highlights fundamental dependencies and feedbacks in human–environment interactions, and illuminates the implications of social inequities in resource access, distribution and exploitation around the globe. Despite the urgency to respond to climate change, and its salience to all human activity, it is not necessarily the primary concern – or at least an explicit concern – of specific populations in particular places, regardless of external perceptions of that population's inherent vulnerability. The multiple-stressor context of local decision-making and adaptive response is now well recognized (Burton et al., 2002; Nelson et al., 2007). In many cases, climate stress is only one of many factors that influence local decision processes and outcomes (Eakin et al., 2006). Making vulnerability and adaptation science useful to decision-makers and communities considered ''vulnerable'' is an additional challenge. Core issues include coordination and integration of interdisciplinary teams, balancing needs of stakeholders with expectations of the science community, defining the appropriate audiences for project outputs and creating the space, time and resources necessary for effective communication, knowledge co-production and collaboration among stakeholders (Lemos and Morehouse, 2005). As succinctly stated by Lemos and Morehouse (2005), the challenge is to achieve the ''delicate balance between what we need to know to understand complex problems and what stakeholders perceive to be their immediate needs for making decisions''. This requires innovation in constructing knowledge through the interaction of scientists, local stakeholders, practitioners in support NGOs and policy makers.

Our ''Coffee and Global Changes'' project[1] aimed to understand the primary drivers of change in the Mesoamerican coffee system and the responses of farmers, cooperatives and policy makers to experienced and perceived vulnerability. We identified price instability, climate change, and pest incidence as major challenges for coffee producers, and aimed to understand how farmers were adapting to these and other stressors, and the ramifications for the people, the landscape, and local economies. As our cross-national, comparative project addressed complex interactions among issues studied in various scientific disciplines, we assembled an international and interdisciplinary team, composed of researchers representing agroecology, anthropology, biology, ecology, economics, entomology, geography, and remote sensing. To capture cross-national variability, we selected study sites distributed across four countries: Mexico, Guatemala, Honduras and Costa Rica (Fig. 1). Initially, knowledge co-production was not a defined goal of the project, nor was the project originally framed in terms of science-policy theory; our project was relatively traditional in structure and method. Yet early on, we shared a concern to develop knowledge that would be useful to stakeholders, including the farmers, the practitioners in farmer support organizations, and policy makers at national and international levels. Although we endeavored to practice genuinely interdisciplinary science and involved diverse stakeholder groups – and in many ways succeeded – we also encountered unanticipated challenges.

In this paper we describe how our team evolved toward effective interdisciplinary science and knowledge co-production with farmers, as we endeavored to find ways to make the research and findings relevant to diverse stakeholders including policy makers. We reflect on the lessons learned through that process, realizing that certain experiences have been documented before, especially in assessments of development projects (e.g., Chambers, 1997). Our discussion also builds on contributions of other scholars, including researchers on climate–society interactions, who recognize the potential for participatory approaches to provide meaningful knowledge on adaptation (e.g., Tschakert, 2007; Patt and Schröter, 2008). For decades, academics working on development and education (Chambers, 1983; Freire, 1970) have highlighted the need to start any research or development program based on the knowledge of the actors involved. In agricultural research, it is well known that farmers experiment constantly rather than wait for external technical advice to find solutions to new problems (Conley and Udry, 2001). For example, pest management programs imposed by outsiders are rarely adopted, while programs that take farmers' knowledge into account have better chances of success (Morales and Perfecto, 2000; Segura et al., 2004; Zavala et al., 2005). International aid organizations such as the World Bank and USAID have recognized the need to document local practices in agriculture and incorporate participatory and multidisciplinary research (Warren, 1991).

State-of-the-art approaches to climate change science are increasingly suggesting that more effort needs to be made to incorporate the experience, perception and values of those who face climate change in their day-to-day decisions (Tschakert, 2007; Pettengell, 2010). Traditional scientific approaches can gain validity and utility by incorporating local knowledge on successful adaptation to environmental variability and change. In this area, one of the roles of science should be to methodically capture and document valuable local knowledge. Scientists have the possibility to share knowledge with decision makers who have the power to influence the structures that alter local level vulnerability. Our contribution offers an example of how a scientific research

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Fig. 1 – Study sites for the project Coffee and Global Changes.

team studying adaptation itself had to learn and adapt as the initial project goals became linked to a commitment to increase the use of the information by farmers, decision makers and other stakeholders.

Following the model of science policy co-production proposed by Lemos and Morehouse (2005), we evaluate this project in terms of producing useable science, achieving interdisciplinary integration, and interacting effectively with different stakeholder groups. Lemos and Morehouse propose that the degree to which a project can achieve these three components of science-policy knowledge co-production depends on the level of ''fit'' between science knowledge and user needs, the flexibility of team members to work outside their domain of comfort and training, and resource availability. In the sections that follow, we illustrate (a) the challenges and successes of conducting interdisciplinary research, with an interdisciplinary research team in which disciplinary knowledge was geographically and institutionally concentrated; (b) our struggle to capture, synthesize, and interpret local farmers' knowledge and experiences for a science and practice community, aiming for the knowledge to be *useable* in coffee and climate policy, while also serving to empower and validate local experience; and (c) the opportunities and difficulties we encountered as we tried to develop strategies for communicating with three different stakeholder groups: the science community; practitioners and policy makers; and the farmers themselves. We conclude by reflecting on the primary lessons from this experience.

2. The coffee sector in Mesoamerica under multiple global stressors

Coffee provides a key agricultural commodity for Mesoamerican countries, and when considered jointly, the four countries included in this study ranked in 2009 as the world's third largest producer of export coffee after Brazil and Vietnam (ICO, 2009). In Mesoamerica, more than 4 million people work in the coffee sector (Tucker et al., 2010). This population appears to be increasingly vulnerable in the face of market volatility, the spread of coffee pests and diseases, severe weather events, and uncertain support of government initiatives. In addition, some analyses of climate change impacts in the region anticipate that certain coffee-growing regions will face rising temperatures or changed climate patterns that may render production unprofitable or infeasible (Gay Garcia et al., 2006; Schroth et al., 2009).

From the perspective of national governments and development agencies, climate change presents a threat to the livelihoods and welfare of coffee-dependent populations. Funding agencies, bilateral development agencies and many non-governmental organizations are also keenly interested in climate change impacts in the sector. However, as a number of studies indicate, farmers do not necessarily rank climate risk as their priority concern (Eakin et al., 2006; Eakin, 2005; Chiotti et al., 1997). A pilot project conducted in 2003 at the peak of the ''coffee crisis'' – a period in which global coffee prices were at all-time lows–served as the seed for the four-country integrated research project described in this article. That project found that producers perceived the greatest threat to their livelihoods to be unpredictable, volatile prices. While they recognized impacts from severe weather events, they usually perceived weather-related losses as one of the unavoidable risks of farming (Eakin et al., 2006; Tucker et al., 2010).

By 2006, when we launched the four-year-long project addressed here, much had changed. Global coffee prices and market conditions had improved substantially, but a series of extreme weather events had highlighted the region's vulnerability to climate change. At the national level, governments

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and NGOs had begun focusing their efforts to confront climate change primarily through mitigation programs. The majority of those efforts center on carbon sequestration initiatives, which often are designed with little consideration of the knowledge and practices of the local communities where programs are implemented. For example, in Mexico, although the Government Special Program for Climate Change PECC is considering an adaptation program for agriculture, the majority of its budget so far has been designated to implement carbon credits programs and produce clean energy (Semarnat, 2009). Similarly, while the impact of disasters associated with extreme rainfall events and cyclonic activity in Mesoamerica continue to plague coffee growing communities, there is little evidence that local knowledge and experience is being used in disaster risk planning and preparedness efforts (Saldaña-Zorrilla, 2008).

As coffee prices recovered, farmer interest in niche markets and quality production – spurred during the crisis – continued to grow. As early as the 1990s, some farmers had sought to survive market liberalization through diversification into niche ''specialty'' markets: markets for sustainable coffees (fair trade, organic, bird-friendly, gourmet). This ''turn to quality'' (Murdoch et al., 2000) has had implications for public policy as well as for technical assistance and social organization across the region. During and after the coffee crisis, international development agencies, including the World Bank, USAID, and the International Development Bank, emphasized the need for coffee-producing countries to focus on quality, opportunities in niche markets, and diversification out of coffee in areas where biophysical conditions did not support high quality coffee production (Baffes et al., 2005; Lewin et al., 2004). National governments in the study region recognized the recommendations to various degrees, but gaps existed between policy makers' approaches and the realities facing farmers. For smallholder farmers, the move to quality production, including quality-related certifications, requires access to information and technical assistance, which can be difficult and require substantial investments of time and labor. The mode of disseminating agricultural policies and programs, which govern access to technical support and services as well as credit and knowledge, poses part of the challenge. For many smallholder producers, joining a farmer association or a cooperative may be the only viable option to gain technical information, and assistance to improve quality. Yet due to myriad factors that vary across the region (including bureaucratic complications, perceived problems, and local preferences), farmer associations have a mixed reputation, and organization in cooperatives is not the norm. A significant portion of farmers continues to operate through intermediaries as independent, and typically small-scale, producers but top-down national programs with rural development objectives do not always fit the strategies and challenges of coffee smallholders.

It was in this context that we conducted our four-country interdisciplinary project on Coffee and Global Changes. We aimed to frame farm-level vulnerability and adaptive responses in terms of multiple stressors. Our research confirmed our earlier findings that climate was not the primary driver of farmers' livelihood and land use decisions. Nevertheless, it was clear that farmers have become increasingly concerned with climate impacts since our pilot study (Eakin et al., 2006). Many had observed changes in climatic and ecological conditions, and suffered devastation and losses from the tropical storms, torrential rains and drought that hit the region since the turn of the 21st century (Cruz-Bello et al., 2010).

3. Defining the methodological approaches in a multidisciplinary environment

In an ideal situation, the development of an interdisciplinary research project proceeds from its inception with the involvement of researchers representing all of the requisite areas of expertise. In our case, the impetus for the project originated with the social scientists, proposing the theoretical framework and research questions, which required knowledge from the natural sciences to be fully addressed. Natural scientists working on relevant coffee research were invited to join as the proposal took shape. We met as a full team to reach consensus on the methods to be followed and assure comparability in data collection, only after funding was awarded. We encountered substantive challenges to formulate an appropriate methodological approach and design research instruments that would adequately accommodate the interests of the research team while addressing the hypotheses defined for the research project. As found in other interdisciplinary projects, a combination of standardized instruments with more open-ended data collection provided a fruitful combination of quantitative and qualitative data for comparative analysis (Bernard, 2006). After considerable discussion, we agreed on four different components and phases of research (Fig. 2): (1) qualitative consultations and interviews with key informants (representatives of government agencies, leaders of supporting NGO, leaders and members of coffee cooperatives, academics, and some individual farmers), which focused on the drivers of change in the coffee sector, the strategies farmers had pursued in response to those drivers, and the implications of those strategies for the landscape and for the livelihood options of farmers; (2) a household-level survey, implemented in two regions in each of the four countries (achieving a total sample of 1277 coffee producers), to document risk perceptions, livelihood and production strategies and experience with changing climate conditions; (3) remote sensing analysis in Mexico, Guatemala and Honduras to estimate land cover changes in coffee-growing areas; and (4) community engagement and participatory workshops to consult with farmers on the findings and obtain their feedback.

The household survey was the primary data collection instrument across the four countries. It provided a foundation of quantitative, structured data for comparing the four countries. The questions had to be comparable across diverse national and local contexts, while also accommodating site-specific differences, as in variability of coffee varieties and ethnic composition. In the interest of keeping the survey to a reasonable length, we had to limit the number of site-specific questions and not all of the scientific interests of each team member were adequately covered.

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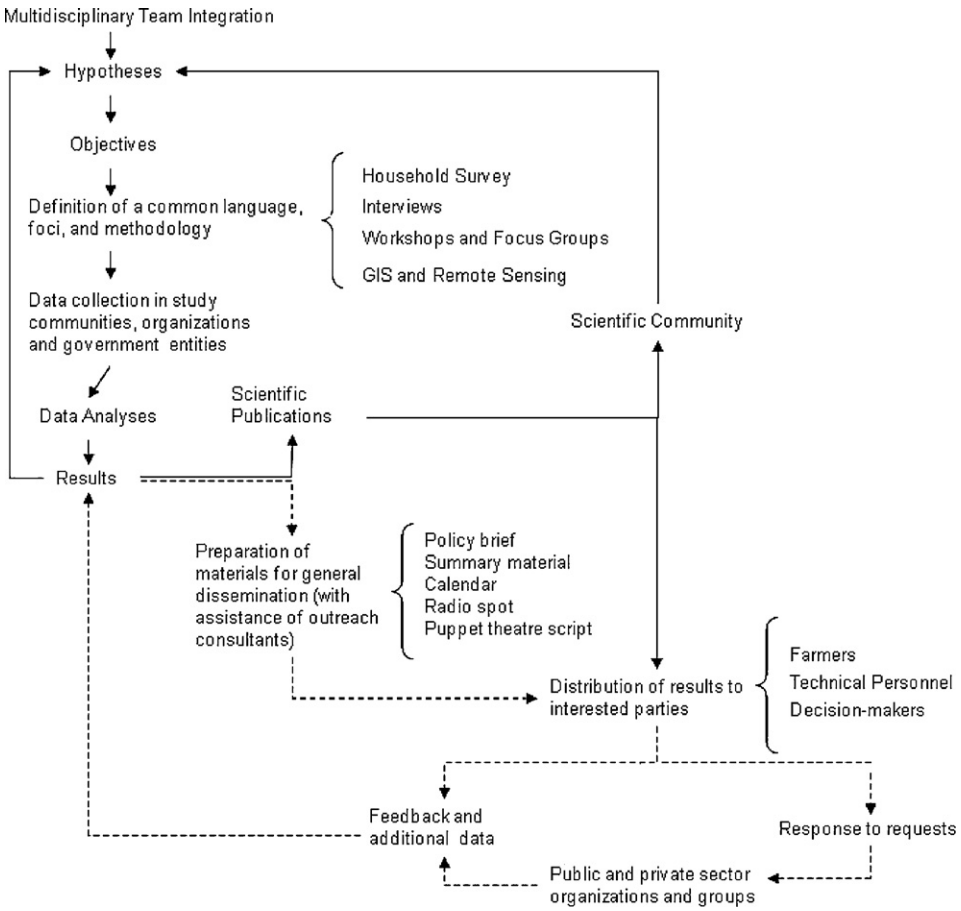

Fig. 2 – Stages of research, knowledge production and dissemination of results in the project Coffee and Global Changes. The solid arrows indicate the stages of scientific research. The dashed arrows indicate that stages involved in developing materials, returning results to, and obtaining feedback from the project participants, stakeholders and interested organizations.

Following initial team meetings, we held an annual meeting that rotated among the countries, and scheduled regular conference calls in addition to constant electronic communications to coordinate our efforts and discuss questions as they arose. Throughout the project, two key factors were flexibility and creativity to adapt techniques and methods as knowledge and goals evolved through interactions with farmers and other stakeholders. The process of knowledge production and dissemination from this project is summarized in Fig. 2.

3.1. *Challenges of carrying out interdisciplinary research and involving stakeholders*

Despite our commitment to interdisciplinary research, we learned that this is more easily said than done (Hicks et al., 2010). Complex analyses of problems of global nature typically demand the interaction of scientists from various disciplines with local stakeholders. These local stakeholders – farmers, merchants, local administrators and officials, and technical experts – provide valuable knowledge, which they have acquired over many years of careful observations and trial and error practices. The interaction among these groups with researchers is far from being a straightforward process. Within the academic community, few researchers receive the training that fosters cross-disciplinary collaborations, and even fewer have the preparation for implementing research that aims to produce knowledge in collaboration with the communities subject to the investigation.

In addition, most academics have little training in how to communicate research results to stakeholders, and usually they do not receive scientific recognition for such efforts. Besides, research centers rarely include personnel with such training on their staff (Lang, 2003). Despite these obstacles, many researchers, including our own research team, recognize the need to develop bottom-up strategies, especially when seeking adaptation strategies for complex problems such as climate change.

3.2. *Finding a common language and reaching balance among disciplines and among countries*

The common thread among participating researchers was previous experience working with some aspect of coffee production or commercialization. Although the social scientists knew the theoretical approach, natural scientists invited to participate in the team had to learn the terminology and theoretical framework on vulnerability and livelihoods. They

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found themselves initially handicapped in contributing fully to the project design discussion. As a consequence, natural scientists assumed the role of consultants for developing the project's entomological, agroecological and land use questions and assessment methods. While the core questions of the project were inherently social (farmers' choices and experience with environmental change), the contribution of the natural scientists in the interpretation of the data was ultimately very important. For example, while the project was designed to explore hypotheses based on theories of livelihood sustainability, we discovered synergies with agroecological principles that added considerable richness to the interpretation of findings in terms of social and ecological vulnerability. New questions also arose in the process of the project through the interdisciplinary interaction that were only partially addressed, specifically relating to the implications of household level action for ecosystem services and landscape-scale change. The contribution of remote sensing provided a first step in this direction, but there was general recognition that the household as the primary frame of analysis limits the extent to which conclusions at other scales can be determined. Since our initial project framing was epistemologically biased in favor of social science traditions, one of the main challenges to integrate the interdisciplinary team was to find a common language and reach a shared understanding of the system of our analysis despite differences in our disciplinary orientation.

We also faced an additional challenge in that our expertise was geographically concentrated: each country team brought different expertise to the project, yet was responsible for the implementation of all project components and activities within their own geographic domain. This led to some unevenness in the level of detail in our data across countries.

4. Bridging researcher interests and farmer expectations

Our experience shows that any approach with rural communities in Mesoamerica raises expectations of possible benefits to come. People in these communities interact regularly with government and non-governmental organizations that come to implement social assistance programs. Communities are willing to participate in a new project as long as they see a direct benefit. Overcoming community expectations for assistance can be an impediment to academic research, as universities usually do not have resources for complementing their research programs with social assistance. In several of our research sites, coffee growers expressed doubt as to the utility of the research; they wanted to know what benefits would come to them. We explained that we did not bring resources for development projects or road repairs, but indicated that the results would be returned to them in the form of reports that would also be presented to policy makers and local and national authorities. In some cases we were able to offer short information sessions (for example, on ecological pest management in coffee and corn) for the communities we visited; however, we emphasized that we were collecting their experiences and would return to share what we had learned from other communities and farmers in other countries.

Recognizing that farmers tended to place less value on information (what we could provide in this project) compared to tangible assets (which were not part of our project), we found it necessary to invest time to develop people's interest in participating in the project. Effective communication played a crucial role in ensuring that both sides involved understood what was being offered and what would be achieved. Trust is a key element that takes time to develop. We managed to build trust and enhance communication in various ways across our research sites. In La Campa, Honduras, the lead team researcher had conducted longitudinal research, and once the new team members had been introduced in a municipal meeting, they found it easy to gain rapport. By contrast, in the second site in Honduras (Santa Barbara) the support of a Honduran Coffee Institute (IHCAFE) district coordinator facilitated our introduction to coffee growers. The team also gained rapport by spending time with people as participant observers, not solely as survey collectors.

In Chiapas (Jitotol), starting a research program requires the permission of the local authorities that first evaluate the objectives, methodologies and research institutions involved. Only one of the communities that had been randomly selected for participation in the study rejected our proposal. In that community, leaders indicated that many of their peers were mistreated when they migrated to the US, and for that reason they did not want to receive any US citizens. In the other communities selected, the majority of the leaders and farmers felt that the project constituted a hope. They wanted to know how farmers in other places were confronting the coffee crises and wanted the government to learn about their problems and strategies. Their doors opened once we promised to document their strategies, communicate with policy makers and authorities, and share the project's cross-national research findings.

In Costa Rica, researchers encountered great differences in coffee producers' backgrounds, the level of local organization and the presence of government and nongovernment organizations. These differences compelled the researchers to develop different strategies for interacting with the producers in each site. In Los Santos, producers had a low organizational level and doubted the project's possible benefits. At first, participation was weak. As the project advanced, the ongoing interactions with growers increased their interest in participating. The Nicoya Peninsula presented a contrasting situation. Although its coffee production is relatively marginal, most of the producers are organized in cooperatives. The cooperatives and officials from the Ministry of Agriculture supported the research because the objectives were considered relevant, and the potential results were viewed as an important input to develop intervention strategies.

In Guatemala, the contact with local coffee growers at the two research sites was facilitated by the National Coffee Association ANACAFE, which participated as part of the core research team. The participation of researchers from this association facilitated the initial contact and trust from coffee growers, and helped the process of disseminating the results among relevant stakeholders at both the local and national level.

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4.1. *Moving toward enhanced collaboration between farmers and researchers*

Coffee growers participating in our research shared a hope that our work would reach government policy makers and decision-makers in national-level coffee associations. They wanted the government to listen to them. They also recognized the importance of sharing knowledge with other farmers, and hoped to learn from other farmers' experiences. In this context, we implemented our research instruments with overall success. Few coffee growers refused to participate in the household survey, and everyone approached for an interview accepted. Nevertheless, our initial approach was extractive: we focused on understanding farmers' perspectives and attitudes to communicate their situation to broader policy communities. As the project progressed, we sought additional expertise and approaches to bridge the divide between researchers and the farm community.

To ensure that our methods and approaches were appropriate for the specific regions, ethnic groups and rural communities we were working with, we hired an external consultant who specialized in participatory research and community building in the Mayan region (Mexico and Guatemala) to assist us in thinking through activities and methods that would be both engaging and constructive for the communities while helping us advance our research goals. Having the support of the specialist was crucial for the research team, as we did not have the training or the time to design and implement activities geared to various groups of stakeholders with different interests and levels of education. We were fortunate to have a funding agency that emphasizes the communication of scientific findings to policy makers and therefore encouraged us to incorporate new approaches and communication experts into the research process, but we recognize that not all funded projects have this opportunity.

An additional challenge to overcome was the barrier of language and culture, particularly in indigenous communities where many women did not speak Spanish, the working language of the research team, and where women typically remain silent in the presence of men or strangers. The need to use interpreters and locals to mediate the communication often limited the level of understanding and communication among community participants and the research team. In addition, the analysis of recorded information became cumbersome when translation was required.

While our aim was to accurately reflect farmers' concerns, priorities, motivations and actions across the four countries, it is hard to claim that we accurately represent farmers' experiences. Representations of ''others'' and their understandings and perceptions are unavoidably problematic (Clifford and Marcus, 1986). The effort becomes critical when the goal is production of useful knowledge and translation across different cultural and socioeconomic contexts. In order to address these concerns, validate our findings, and ensure that farmers found our representations to be accurate, we organized small group activities in the villages where we collected survey data. These included validation workshops and group discussions to explore additional issues with the communities.

These interactions, held primarily in the final year of the project, proved especially rewarding for both the community participants and the research team. The exercises allowed the farmers to educate each other and us on the knowledge they held on agronomic practices and risk management for coffee production. For example, we asked farmers to draw diagrams that illustrated their relationship to the coffee commodity chain, as they understood it. This exercise revealed a significant difference between individual farmers and members of cooperatives. While individual, smallholder farmers often knew little more than the intermediary to whom they sold coffee, cooperative members could often construct their commodity chain complete with names of the organizations that purchased and processed their coffee. The more limited sense of their commodity chain for individual farmers may reflect their specific constraints, which may include obstacles for obtaining market information. In other cases, farmers discussed traditional methods to mitigate coffee pests and diseases, manage shade, and respond to extreme weather events. One group of Honduran farmers, which was in the process of obtaining organic certification, shared ideas for managing pests and diseases without chemicals. They became enthused as the older members recalled tactics that had worked before the adoption of pesticides. Evidently, the reliance on chemical inputs had been erasing indigenous practices, and suppressing people's willingness to share the utility of traditional methods to manage pests. Group activities and interviews can provide an empowering context for farmers to share information that they may not otherwise have been inclined to share with each other.

In Costa Rica, the research team conducted workshops geared to help with policy design. Using a suite of participatory techniques, participants prioritized their primary problems related to stressors and with this input they developed a work plan for their farms, organizations and governments When technicians and decision makers from support organizations participated, the workshops focused on contrasting the services offered by the organizations with the needs presented by the coffee growers. The exercise helped illustrate unmet needs and misdirected support strategies. Unfortunately, these types of activities are not conducted often enough to assure that the support offered by organized groups is addressing farmers' real problems.

In general, farmers were open to the research process and hopeful that research findings would provide useful and compelling information for decision-makers. To many farmers, the research team undoubtedly epitomized privilege and power: mobility, access to knowledge and information, and – given our use of four wheel drive vehicles in the often remote areas – financial resources. Living up to farmers' expectations understandably proved difficult, despite our best intentions. Even well designed research with valuable results may appear to be of little help from the perspective of farmers. They often encounter obstacles to communicating their needs and receiving attention from decision-makers and authorities. At the same time, there are systemic constraints that limit the possibilities of decision-makers and organizations to respond efficiently and effectively to the needs of coffee farmers. The opposite is also true, as when organizations provide appropriate technical support to growers that lack the financial

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resources to implement recommendations. Therefore increasing small farmers' income is important to increase their adaptive capacities related to agronomic production (Barrera, 2006).

5. Communicating the results to stakeholders with contrasting interests

As typical of many researchers, we lacked experience communicating research results to the general public and policy makers. Research institutions often consider applied work as less valuable than theoretical work, and communication activities receive little consideration in tenure and promotion processes. Therefore research projects rarely incorporate communication strategies from their inception. Often, projects leave this for the end when results are available but few funds or time remains to assess communication options and design of a dissemination plan that fits the stakeholders' circumstances. Our research project had a limited budget for dissemination, and we found it a challenge to decide how to maximize these resources and deliver results to different audiences. We eventually identified two external groups able to help us in communicating information to policy makers, farmers, and cooperatives.

In Chiapas, we worked with an organization that promotes civic education. They had a creative team composed of an environmental activist, an editor, a graphic designer, a puppeteer and a journalist. They helped us create a report highlighting our results for the general public. The creation of the report and a puppet play for the general public created challenges as we tried to find a balance between overgeneralizations and presentation of scientific data. For example, the creative team wanted to present the coffee intermediary or ''coyote'' as a thief in the puppet play to make the story more interesting, while the research team wanted to acknowledge that intermediaries are sometimes necessary for coffee commercialization even if they may take advantage of local growers. The ingredients for successful final products were patience, respect and recognition of the other group's abilities.

Another group of communication specialists was hired to develop a calendar for the communities that provided key messages for each month. From prior experience, we knew that calendars are a good way to deliver short messages: families usually appreciate these publications and place them in prominent places. These specialists also created a brief radio message that was broadcast repeatedly by several local stations. Radio remains a popular media in rural areas and is used to communicate public service messages. With these communication products, one of the main challenges was again summarizing extensive results into a few succinct sentences that would catch farmers' attention and be useful knowledge to them.

In addition to the printed materials used in all the research sites, we organized workshops to present research findings in each of the study communities. Farmers, their families, municipal authorities, academics and specialists from government agencies were invited to attend and most responded very positively. Interestingly, farmers (particularly in Mexico and Guatemala) expressed the view that researchers provided them with a voice to reach other stakeholders, but they noted that we had not managed to document all of the challenges that they face. Even so, they appreciated our work, and recognized that our project results demonstrated the structural constraints on farmers' strategies and choices: the availability of appropriate technologies, lack of credit and technical assistance, lack of confidence in cooperatives as market intermediaries and the challenges of maintaining viability. While we synthesized the insights for farmers (for example, the value of maintaining land in subsistence crops along with coffee, something feasible for many), we aimed broader conclusions regarding the context of farmers' strategies for other decision-makers.

The interactions with practitioners from national coffee associations and representatives of government and nongovernment organizations were consistently friendly, and provided useful data and reports. When we returned with preliminary findings and subsequent reports, they usually received us warmly but our technical reports were not read in detail nor included in ongoing policy processes. The priorities and concerns of decision-makers evolved rapidly and often in directions distinct from that of the research. While climate change adaptation has emerged as a consistent concern in the region, the rise in coffee prices has alleviated much of the urgency associated with farmers' livelihood strategies and welfare. Public officials, in particular, are constrained by budgetary and programmatic priorities, and in our study countries many of these priorities are established nationally rather than regionally. Our research also emphasized the structural constraints of producers given their adaptive capacities, and the diverse stressors they faced. As such, the recommendations that emerged from our research addressed broad concerns of sustainable development rather than more narrowly defined agronomic or technical proposals associated with adaptation. As such, any policy response to our project would likely need to be cross-sectoral and multiscalar.

From the positive reaction of coffee growers to the project outputs, we can conclude with confidence that our research dissemination strategy was effective for those stakeholders, even though we were able to reach only a small portion of the entire coffee sector in the region; ultimately our success was in communication rather than knowledge co-production. The strategy proved less successful for gaining the attention of NGOs and government organizations. We often found it challenging to articulate the results of our project in terms and language that would be useful to policy makers. Given that our findings highlighted gaps between policies and effects on the ground, as well as farmers' concerns, the information could have been useful. We realized that useful adoption of scientific findings in policy might require the involvement of boundary organizations to lend credibility and legitimacy to scientific findings (Guston, 2001). While our research team incorporated experts from two organizations (INIFAP and ANACAFE) that had the mandates of boundary organizations, this did not mean that the individuals participating in the project were in the position to help transform the knowledge we collected in ways that would be salient to policy makers.

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6. Concluding remarks

As with other integrative and interdisciplinary projects, our own research faced specific challenges in bridging the science-policy divide, and in ensuring that our research goals were salient to the farmers we worked with. Our project was conceived in relatively conventional terms, yet as a team, we attempted to make our results more useful and salient to the communities we were working with as the project evolved. Our challenges were both internal, in establishing the mechanisms and understanding required for effective interdisciplinarity, but also external, in developing and learning approaches for making our work meaningful to the coffee community. We also faced the challenge of providing usable and useful information for the agencies and individuals who were most likely to have influence over the structural conditions that framed farmers' vulnerabilities. We were thus operating at multiple levels of decision-making. Where we gained credibility and salience with the farmers, we faced obstacles with the policy and practice communities. In part, our difficulties stemmed from our own learning process, and inadequacies in the initial structure of the project. We were not able to establish a deep collaborative relationship with an organization that could have served as a "boundary" organization to translate the science to the policy community (Cash et al., 2002).

While we were quite successful in reliably interpreting the complex nature of local-level vulnerability determinants and outcomes, this knowledge was less helpful in supporting farmers overcome the obstacles they identified to changing their strategies. The continued centralization of policy and rural development planning across the region means that it is not enough to understand local contexts well; we also need to have strong engagement at the levels at which management decisions are made in order to help facilitate effective change (Vogel et al., 2007; Cash and Moser, 2000). It was also clear that while we had been relatively successful in identifying the mode of communication that was valuable and appropriate for the farm communities, we relied on what now appear naive assumptions of the ways in which policy makers acquire and appropriate knowledge of use to their decisions. Not only does the knowledge created by the research process need to target the appropriate level at which management decisions are made, but it is also important to frame the presentation of knowledge to be most compatible with ongoing processes of decision-making and program implementation. Providing policy makers and administrators with research findings at moments in the policy cycle where there is little opportunity for altering course of policy or for reconsidering priorities will likely be unsuccessful (Vogel et al., 2007). In the particular case of coffee we failed to undertake an assessment of the policy dynamics and sector-wide decisions as an integral part of our research and communication process.

Ultimately, our project benefitted greatly from the interdisciplinary, participatory and cross-national strategies that we adopted. These strategies all came with a cost to the research team, and presented difficulties in terms of comparable data collection and interdisciplinary integration. Nevertheless, the knowledge gained from the project could not have been as broad and useful for farmers without the contributions of each discipline represented in the research team. Our commitment to participatory approaches and to returning the results to communities also compelled us to use novel approaches, to experiment with strategies for communication, and to invest in learning from each other and from the farmers whose experiences we aimed to analyze. The reward from this research goes beyond the satisfaction of contributing valuable scholarly information; it includes the relationships that we formed with the study communities and other actors, which facilitated the dissemination of research results. The results may carry further ramifications now that the research team received a third grant to continue this work.

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