Participation begets integration: lessons learned from incorporating ethnography into linear programming

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Abstract

Over the last decade, Ethnographic Linear Programming (ELP) emerged as an innovative method to explore farmer responses to varied livelihood system "disruptions," such as new technology, market interventions, and shocks. Modelers develop and use scenario-driven models that integrate social, ecological, and economic considerations of farm-based livelihood systems and strategies. ELP models have been developed for diverse livelihood systems across a broad geographic range. We analyzed three recent ELP modeling experiences to better understand and articulate the perceived strengths and limitations of the method. The three models reflected specific farming systems and addressed, respectively, the effect of HIV/AIDS on food security in western Kenya, commercial feasibility of a locally gathered palm in central Mexico, and potential adoption of ecologically based alternatives to chemical pesticides in highland Peru. ELP differs from linear programming in its use of ethnographic methods to capture, quantify, and integrate qualitative social considerations into biological and/or economic models. The greatest strength of the method was the use of participatory, ethnographic approaches. Community participation has intrinsic value but also greatly enhances representation of diverse social agents and facilitates integration of social, economic, ecological, and political systems in the model, all of which enhance model validity. In addition, the modeling process was flexible and amenable to the modeler's creativity. Conversely, participation increased time investments – in data collection and processing, model elaboration, and validation. Emphasis on intra-system rather than inter-system diversity limited broader application of the models. However, we recognize that the needs of academic researchers differ from those of field practitioners and expect that the latter could minimize observed limitations without substantial sacrifice to the numerous benefits outlined above.

1.0 Introduction

1.1 Linear programming

Linear programming (LP) is a mathematical procedure that optimizes (maximizes or minimizes) an objective function subject to a set of constraints and available resources. The emergence and continued growth of applied LP parallels the development of computing, as the method relies on high-speed computers (once mainframes, now laptops) to efficiently work through extensive iterations. LP modeling is a basic tool for analyzing smallholder farming systems. Models simulate the complex farming and livelihood systems of smallholder by including the many and diverse crops, cropping systems, and other activities. LP models allow researchers and practitioners to understand *why* households choose particular livelihood strategies, on the basis of their available resources and constraints (Gladwin, et al., 2001). Moreover, LP models help users predict the effects of possible changes (interventions) to the system by testing potential scenarios, or "What if?" questions. Despite increasing computational power of linear programming, smallholder systems presented a challenge to its practical application.

Practically speaking, smallholder systems are businesses, but they are also households. Relative to a business, smallholder objectives may be less clear, more diverse, or altogether different. Additionally, smallholder management directly relates to household composition, which may be quite dynamic and inflexible relative to the labor force of a large farm or other business. The addition of ethnography to the LP process, or the development of Ethnographic Linear Programming (ELP) represented a creative and pragmatic attempt to overcome the challenge.

1.2 Ethnographic linear programming

Ethnography is a qualitative research method used to deepen cultural understanding (Bernard, 1995) Ethnographic linear programming (ELP) brings a more profound human understanding to the LP modeling process through the use of ethnographic and participatory research methods that capture both qualitative and quantitative data. It follows Bernard's (1995) use of ethnography as an active process of interacting with the clientele to gather information, in this case, smallholders. ELP models typically focus on smallholder livelihood systems. ELP work is site and time-specific, with an ethnographic component to enhance understanding. Methods are usually participatory and include transects, rapid assessment protocols, such as *Sondeos* (Hildebrand 1981), and schematic modeling (Hildebrand, 2010a).

When modeling smallholder systems using ELP, the purpose of ethnography is to understand 1) *what* is done, 2) *who* does what, 3) *when* it is done, 4) *how* it is done, and 5) *why* it is done (Hildebrand, et al., 2003). Ethnographic data reduce need for assumptions in the LP model. Although commonly used, assumptions substitute for knowledge and inevitably lead to erroneous solutions and conclusions. Participatory approaches foster adaptive modeling, whereby researchers or practitioners work with individuals and households to address unrealistic or infeasible results. While all models are abstractions, this approach leads to a model that better reflects what the system *is* rather than preconceptions of what the system *should be*.

ELP models emerged within Farming Systems Research and Extension (FSRE) in the 1990s and, in particular, through the work of University of Florida faculty and graduate students. Early models addressed Amazonia livelihoods. A complete list of ELP models from UF is available online (Hildebrand, 2010b). For this paper, we analyzed three recent ELP models (Gill, 2010; Wilsey & Hildebrand 2010; Rios, 2010) to better understand and articulate the perceived strengths and limitations of the method. The three models reflected specific farming systems and addressed, respectively, the effect of HIV/AIDS on food security in western Kenya, commercial feasibility of a gathered palm in central Mexico, and adoption of ecologically based alternatives to chemical pesticides in highland Peru.

2.0 Three ELP models

2.1 Kenya

Livelihood systems of two, rural Kenyan communities were assessed using a comparative case study design to analyze the differences in diverse household livelihood responses to the impact of HIV/AIDS on household food security (Gill, 2010). The study sites were Amukura Division in Teso District, Western Province, and Mwatate Division in Taita-Taveta District, Coastal Province. These communities were selected to provide contrasting livelihood systems based on differing natural and socio-cultural environments. Amukura Division is located in the densely populated highlands of western Kenya, with a bimodal rainfall pattern producing abundant precipitation. Subsistence cassava and maize production predominates, with animal production less important due to regular outbreaks of trypanosomiasis and human population pressure on land. In contrast, Mwatate Division lies in a sparsely populated lowland region of southeastern Kenya, with an unreliable bimodal rainfall pattern and greater dependence on dry land cropping and hardy animal production. Mwatate farming focuses on maize-legume cropping, though drought frequently compromises maize yields.

Data were collected using mixed-methods including semi-structured interviews, focus groups, gender analysis, resource mapping, and seasonal calendars. Sixteen households were interviewed in each community, with households selected by referral sampling to ensure diversity of household composition for analysis of differential responses to the impact of HIV. Data were triangulated through mixed-methods, and models were constructed in the field, where they were also calibrated and validated by three households in each community.

ELPs were simulated for 11 years to model future livelihood decisions in the sixteen households. This was the baseline against which household HIV/AIDS impacts were compared. The models were then simulated, for each household, for two scenarios: 1) an adult male, or 2) an adult female contracting HIV in year 3 of the model and dying of AIDS in year 9. All households contained adult females, but four households in each community sample were without adult males and were classified as female-headed households (FHH). Models were not run for scenario 1 (adult male HIV+) for these FHH. Models maximized year-end cash in year 11. Major constraints included 1) inputs: i) land, ii) seasonal and gender disaggregated labor availability, and iii) seasonal cash availability; 2) outputs: i) gender-disaggregated seasonal cash requirements and ii) food and nutrition requirements of all household members, including both minimum caloric and protein requirements.

2.2 Mexico

An ELP model was developed for a farm and forest livelihood system in Oaxaca, Mexico to explore potential market-related interventions related to commercial harvest of local palm fronds (Wilsey & Hildebrand, 2010). La Soledad de Juarez (Soledad) is in the ethno-linguistic Chinantla region of Oaxaca. It is one of several communities along the Rio Cajonos, known for its abundance of the palm genus *Chamaedorea*. Historically, commercial palm frond harvest was an important livelihood activity in Soledad's predominantly agricultural livelihood system. Recently, the market has been in decline. Soledad livelihoods combine subsistence and commercial agriculture augmented by limited, commercial non-timber forest product extraction and local and non-local wage employment. Households are typically comprised of two generations, with members often cooperating with a physically distinct, but relationally connected, third-generation household. Context was established using locally available diagnostic studies of the community and broader region. A livelihood system framework emerged from a rapid community assessment, or Sondeo. Subsequent collection of agricultural and forest-based livelihood data was principally through two harvester workshops and in-depth interviews/conversations with three households. Livelihood data from the three sources were compared with and augmented by diagnostic study data.

It was anticipated that a more profound understanding of the local livelihood system and strategies of diverse households would improve estimated outcomes of palm frond certification efforts in the community, and would likely suggest possible steps for improving the feasibility of such interventions. The ELP model was used to test three hypotheses derived from the assumption that commercially oriented interventions should not negatively affect livelihoods. To be feasible, product certification must: 1) positively affect extractor household livelihoods; 2) benefit or not disadvantage the poorest extractor households, and; 3) be viable with respect to supply and demand. Optimal livelihood strategies were operationalized through allocation of critical household resources—land, labor, and cash—to livelihood activities. Price and supply operationalized four market/management scenarios. The palm market/management and household composition scenarios framed a solution table. The model was solved to first to maximize discretionary year-end cash, then again to minimize labor-driven migration. Thus, the process generated a range of outcomes framed by two solution sets, each representing the optimal outcome (and livelihood strategy) given the specified household composition, market/management scenario, and household objective.

2.3 Peru

The Peru case study explored impacts of ecologically based pest management (EBA) practices in Andean potato production systems (Rios, 2010). It was conducted in Aymara, a community located in the Central Andean department of Huancavelica, at 3.600 m.a.s.l. The community produces native and improved potatoes for consumption and sale. Crop rotation patterns can include second year potatoes, other Andean tuber and roots, or grasses for fodder. The larva of the Andean potato weevil (*P. suturicallus*) is the most problematic pest, rendering tubers unfit for market. The problem is more critical in larger, improved varieties destined for market, while smaller sizes are used for consumption and seed. Farmers apply highly toxic carbamate insecticides to control the adult weevil.

An ELP that followed a crop production calendar was constructed. The model accounted for potato sizes and types (native and improved), damage per potato type and damage type; i.e., damage that could still be used for household consumption or livestock feed under traditional insecticide application. Surveys captured yield, pest damage, and seasonal input data as well as farmer adoption of plastic barriers, bait traps and field tillage. Focus group data and secondary sources complemented the surveys by providing general information on crop and livestock production. The model tested the adoption of a hypothetical EBA technology vs. the traditional pesticide application practice using a sensitivity analysis. Different combinations of EBA attributes were assessed in the sensitivity analysis for a hypothetical family at three stages of the family cycle. Attributes evaluated included damage reduction, labor needs, and cash requirements. The model maximized discretionary cash.

3.0 Critique of the ethnographic approach

This section summarizes our collective critique of the ELP approach.

Participatory, ethnographic methods in the LP modeling process increased community participation in data collection, model development, and validation. Participatory, ethnographic methods increased but also influenced participation -- extending it from planned to unplanned data collection and into richer, protracted exchanges that influenced model development and validation processes. The methods engaged participants and fostered development of trust and relationships. Participants often sought continued or expanded involvement beyond initial experiences. In most cases, quantitative data collection generated unsolicited qualitative, or contextual, data. Occasionally, new quantitative data collection opportunities resulted. The use of diverse ethnographic methods therefore enhanced the likelihood that data collection, modeling, and interpretation would be culturally appropriate.

The Mexico case provides an example. A single interview, focused on household reproduction data, led to several transects covering multiple production systems. Of these, two transects were led by original interview participants while a third was led by her relatives, who farmed different terrain using different methods. Thus, a conversation with one household, intended to last a few hours, extended into several, open-ended conversations that involved multiple households. Moreover, conversations and experiences with these individuals substantially contributed to a more profound understanding of the broader community livelihood system. What was initially conceived as a focused enumeration exercise catalyzed a series of participatory experiences that led directly to an early version of the livelihood system schematic model.

The Kenya case lends a different example. Much care went into formulation of topic guides for suitable open-ended questions for semi-structured interviews and focus groups, with particular attention paid to the stigma of HIV/AIDS. No questions directly addressed a person's HIV status, but instead posed the hypothetical: "What would happen to a household when someone contracts HIV?" Through the open-ended question format, however, many respondents voluntarily disclosed their own HIV status and, in doing so, uncovered a trend of stigma barriers being overcome. We learned much of this was linked to the increasing availability of free anti-retroviral drugs in Kenya and the development of integrated food, nutrition and health programs for those living with HIV. Participatory, ethnographic methods led to unexpected participation, enhanced data reliability (as they were based on personal experiences), and extended participation that included HIV support groups at local clinics.

Participatory, ethnographic methods increased community representation in the LP modeling process. Participatory research typically aims to increase project participation and representation (or diversity). These methods provide modelers with numerous tools (and, thereby, flexibility) to broaden the modeling process to include diverse perspectives. Properly applied, these methods enhance visibility and representation in the model of community members' perceptions and practices, enhancing the likelihood of including under-represented actors such as women and the poor. Conversely, participatory methods highlight social and other contour lines in the community that allow modelers to focus livelihood system analysis. As a model reflects a system, not a community, efforts to broaden participation must be paired with efforts to deepen understanding of the system.

In Peru, ethnographic approaches revealed a subset of female-headed households that typically lacked labor resources relative to households with adult females and males. Potato damage often occurs in second or third year fields as a result of increasing amounts of weevil inoculums in the soil. Opening new fields demands fallow land and, generally, male labor for tilling. Lacking men, female-headed households often plant potatoes more than two consecutive years, leading to higher weevil-induced damage and lower yields due to reduced fertility. Recognition of female-headed households led to further emphasis on division of labor within the model.

In developing the Mexico ELP, community members were challenged by the realization that while a subset of the community did not participate in forest gathering activities, they might develop interest if commercialization efforts succeed. Through subsequent discussions, community members realized that a strong harvester organization would be necessary to maintain social, ecological, and economic sustainability of forest product harvest. Ultimately, they determined that non-harvesters should be excluded from the livelihood system model and that new social norms would have to be established to ensure long-term sustainability.

The ELP approach revealed underlying social, economic, and ecological processes, thereby fostering integration into the final livelihood system models. Participatory, ethnographic methods associated with ELP modeling revealed interconnected economic, ecological, and social systems in which livelihood systems were nested. Increased visibility translated into increased awareness and relatively more integrated models. These gains result from addressing *what we know* and *what we know to be unknown*. We cannot, however, account for unknown unknowns. We adopt the term "strategic integration" to describe intentional and strategic use of participatory methods to obtain and integrate what we knew and what we knew to be unknown about social, economic, or ecological systems. Likewise, "opportunistic integration" describes discovery of unknown unknowns resulting from exposure to underlying systems via intentional use of participatory methods. In our three examples, intentional participatory research generated "anticipated surprises:" new and unexpected information that increased integration of social, economic, and ecological system elements into livelihood system models.

In Mexico, production system research revealed critical information about household goals. There was initial awareness that traditional holiday schedules influenced labor availability, but exactly when and how much was unknown. Participatory methods were used to elaborate seasonal calendars for production activities (economic) and cultural events (social). Shortly after, during a farm walk intended to highlight some of the cropping practices discussed during the calendar activity, we learned about the household goal of minimizing labor migration. This previously unknown socio-economic objective differed from reported household objectives and dramatically influenced model development and use. In Peru, ethnographic methods generated insight into potato loss. Growers divided tubers into size classes. Larger tubers were sent to market while smaller ones were retained for seed and consumption. Pest driven revenue loss could not be calculated as a fraction of weight / ha, but as an estimate based on potato size. Moreover, families consumed lightly to medium damaged tubers and even heavily damaged potatoes were used for livestock feed. Integration of potato damage characteristics (biological), actual consumption practices (social), and labor availability (economic) information into the model greatly improved our understanding of EBA adoption. Furthermore, accounting for household composition dynamics suggested that EBA benefits varied by family life stage. EBA was less beneficial for young families who consumed most of the potatoes grown, including those damaged.

Participatory, ethnographic methods substantially increased demand for time and other resources. Participation and representation confer numerous benefits but also a shared challenge: they demand time and other resources. *Increased* participation implies *increased* time to collect data. More data, both quantitative and qualitative, requires more time to process, validate, and integrate into the model. These challenges grow with increased model complexity and diversity of scenarios and households. Herein lies the paradox: success takes time and resources but these factors are often in short supply. Here, it is important to revisit context. ELP emerged in the late 1990s from FSRE, a body of thought and work that, in many ways, co-developed with Rapid and Participatory Rural Appraisal (RRA and PRA; Khon Kaen, 1987; Chambers, 1994). RRA, PRA and, later, participatory rural development (PRD) employ rapid, low resource, participatory methods to quickly understand essential contours and key factors in livelihood systems. There is an inherent assumption and much evidence of a net benefit to researchers and practitioners of such approaches, especially when used to frame longer-term projects. The extent to which increased participation and representation should be pursued must be weighed against project context, including available resources, long-term project intent, and commitment to the region.

4.0 Discussion

We concluded that participatory, ethnographic methods increased community representation and participation, and extended community participation throughout the modeling process. Increased community participation translated into more data, and data that, arguably, were of higher quality. In essence, participatory modeling ensured that more livelihood model inputs came directly from within the livelihood system. Participation also provided important opportunities to acquire, strategically and opportunistically, new data and context, which positively influenced model design and use. In essence, ethnographic modeling initiated a kind of virtuous cycle, where increased participation led to more and higher quality participation, which enhanced model accuracy and validity. In this brief discussion, we present a few additional, related considerations and underscore some salient points.

Nuanced information. Ethnographic methods provided insight into why households and household members do what they do, and how likely the activities are to change in response to interventions. Often, our understanding of these issues came from nuanced information obtained through participatory methods, strategically and opportunistically. Nuanced information influenced model development (structure), model use (scenarios and objectives), and interpretation of results. The discovery and use of two disparate household goals in

Mexico to frame a solution provided one example. Often, models generate feasible results but modelers respond, "yes, but…" These insights typically come through experience working in the livelihood system, an experience for which participatory research is a surrogate.

Scholar versus practitioner. Graduate students developed all three of the ELP models highlighted in this paper as part of their doctoral research. In fact, this has been the case for most of the ELP models developed in the past decade. One important difference between students doing graduate-level research and national field teams working in their assigned areas is that students are expected to get more information than what is needed for a functional ELP, one designed to help organizations produce useful technology, infrastructure or policy for limited resource farmers. Discrepancy between data *wants* and data *needs* can be large, particularly when student modelers are focused on developing abilities in both participatory methods *and* modeling. Second, an ethnographer encounters a steep learning curve while initially seeking to understand the basic contours of a livelihood system, and then its particular nuances. Despite previous work in their respective regions, this characterized the experience of all three case study researchers. In contrast, those familiar with their study locales, such as local extension agents or development officers, might require substantially less time to develop an accurate, valid ELP.

Inter- versus intra- ELP methods emphasize intra-system rather than inter-system diversity. This emphasis confers important *in situ* advantages, but constrains broader application of models and conclusions. The ability of findings to be generalized from ELP-studied communities to other communities rests on the issue of representativeness: to what extent does the modeled system represent other systems regionally, nationally, and internationally. Integration of social, economic, and ecological systems increases the challenge. In other words, to what extent do the social, economic, and ecological contexts align? System integration potentially narrows recommendation domains. Although a legitimate concern, it does not mean that the external validity of ELP models is completely undermined. For example, the principles of the Kenya case study are applicable throughout many parts of sub-Saharan Africa, in particular the multiple smallholder subsistence communities that continue to be devastated by the impacts of HIV/AIDS.

5.0 Recommendations and outlook

In our final analysis, we assert that the ELP models presented, while still mere abstractions of the livelihoods systems they represent, more accurately reflected the actual livelihood systems as a result of participatory, ethnographic methods. Our collective experience suggests that the ELP approach produced more and better quality data, deeper understanding, increased model integration and validity, and more sophisticated model users. These benefits do not come without costs, most notably in the form of time and associated resource use. We maintain, however, that the benefits outweigh the challenges and that the latter are circumstantial and manageable, but also tolerable.

We encourage reflection on the purpose of modeling and on related expectations for models. Livelihood system models such as ELP frame and catalyze inquiry and discussion and, while they help to solve problems, they should not provide prescriptive answers. Smallholder livelihood systems differ from other production systems in that much remains misunderstood or unknown. There remains an urgent need for organizations and governments working in development to understand the complexity and diversity of livelihood systems and the decisions made within them in order to assess the potential effectiveness of proposed interventions. ELP models provide an effective means to this end.

Much of the resource intensive nature of the ELP models presented herein stems from the needs of graduate students working on doctoral research; in other words, students going beyond what is required for practical and productive inquiry and discussion. Practitioners are unlikely to encounter this academic challenge. For graduate students, the model may itself become the problem. In practice, the model must never be more than a path to a solution.

The reflections above also provide partial resolution to issues related to broader application of ELP models. If one accepts that functional ELP models (those which foster inquiry and discussion) can be developed using fewer resources, then the cost to benefit ratio for the process improves. In other words, the relative cost of developing a tool with (potentially) limited broader application decreases. Returning to the world of computing from which LP models emerged, model expenditures can be thought of as an investment in an application more so than in an operating system. In light of resource requirements, it is temping to recommend creation of standardized participatory research and modeling approaches. Despite the efficiency appeal, we believe the cost would be too great in terms of reduced flexibility in community work and modeling. An important strength of ELP modeling is its adaptability to local contexts and conditions: *standardization works against this strength*. On the other hand, *online ELP model repositories might increase access to modeling frameworks and techniques, streamlining and facilitating data collection and model development*. IFSA should consider hosting such a resource. Moreover, *development of an ELP short course for practitioners would facilitate more meaningful and productive field collaboration and partnerships centered on livelihood system modeling*. Likewise, training efforts directed toward increased familiarity with complementary participatory methods, such as the Sondeo (Hildebrand, 1981; 2010a), would be beneficial.

To conclude, our experiences suggest that pairing ethnography with linear programming represented a step forward for farming systems research. Participatory, ethnographic methods increased community participation and representation and fostered integration into the model of underlying social, economic, and ecological systems. Better information, better models, and better modelers add up to innovation, particularly when these benefits are distributed over manageable increases in time and other resources.

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