

The Role of Extension in the Assessment Process: Identifying Production Constraints Among Arabica Coffee Producers in Eastern Uganda

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Abstract

*Extension providers have an important role to play in the design and development of improved agricultural technologies by helping to assess local farmer knowledge of agricultural production, needs, and constraints. Constraint assessments are considered to be an important first step in the design and development of appropriate technological solutions for complex African farming systems that can be improved by grouping farmers who share similar production practices and problems into research domains. Working with local extension providers, the Integrated Pest Management Collaborative Research Program (IPM CRSP) conducted a baseline survey with 127 farmers producing arabica coffee (*Coffea Arabica* L.) on Mt. Elgon in Uganda in 2006. The main purpose of this study was to analyze farmer perceptions of primary production and pest constraints to determine an initial research and training agenda and to examine the contributions and benefits to participating extension agents. The results indicate that using coffee production zones, demarcated by elevation, as the concept for constructing domains effectively differentiated coffee production and most pest constraints. A future IPM research agenda would target coffee stem borer, berry borer, and leaf rust in the low zone; and antestia bug, lace bug, and coffee berry disease in the high zone. Future training programs would focus on insect and particularly disease identification and management. Extension agents contributed substantially to the process through their experience and knowledge of local farmers, farming systems, and markets. Through inclusion in the research process, they gained additional knowledge of production constraints, their communities, and increased technological proficiency.*

Key words: production constraints, research priorities, integrated pest management, Arabica coffee, extension providers

Introduction

Agricultural technologies are often promoted as key to the economic and social development of rural Africa. In turn, agricultural research is identified as one key to the development of improved agricultural technologies. However, the combined agroecological and socioeconomic complexity of African farming systems provides development specialists with manifold challenges in identifying and extending improved agricultural technologies that meet the location specific needs of diverse farming systems. Past reliance on a one-size-fits-all approach to technology design and transfer has proven to be an inappropriate response to these complex systems (Birner et al., 2006; Zinnah, Steele, & Mattocks, 1998). Targeting particular farmer groups who share similar production practices and problems has proven to be a cost-effective, efficient way to account for systemic heterogeneity and to improve the location specificity of research efforts (Erbaugh, Mark, Donnermeyer, & Kyamanywa, 2002; Bewsell & Kaine, 2004).

Traditionally, the perceived role of extension providers as agents of technology transfer has isolated and limited their contributions to agricultural research and technology development (World Bank, 2007; Feder, Willett, & Zijp, 1998). Yet, extension professionals have great potential to link research on production with the location-specific needs of farmers. This is because they are in advantageous and unique positions within systems of agricultural development. As agents living and working “in the field,” they have the ability to understand the heterogeneity of local agroecologies and the site specific production constraints and opportunities of farmers (Ashby, 1990), and to transfer this knowledge to research scientists whose linkages and knowledge of local farmers and farming systems is often restricted. By bridging this knowledge divide, extension providers contribute their experience and knowledge of local farmers, farming systems, and markets to the research community and help ensure that technologies are appropriately adapted to complex agroclimatic conditions and diverse farming systems (Angstreich & Zinnah, 2007).

Understanding local farmer knowledge of agricultural production and associated constraints is recognized as an important first step in the design and development of appropriate location-specific technological solutions for African farmers (Cleaver, 1993). The goal of participatory agricultural research (PAR) is to work with farmers to develop appropriate agricultural technologies that address their production needs (Venkatesan and Kampen, 1998). The first step in the PAR process is for farmers to identify their production constraints or problems and then these are used to determine an initial research agenda. Analyzing constraints and deriving research priorities from these analyses is a methodology for ensuring that the agricultural research and development process addresses key problems, and that these key problems are taken into consideration in the design of new technologies (World Bank, 2006).

Constraints can be assessed either as an ex-post (impact) evaluation of factors that constrain the adoption of a technology following its attempted transfer or diffusion, or ex-ante prior to technological research and development. Extension providers can play important roles in both ex-post and ex-ante assessments. Ex-ante approaches seek to identify constraints prior to technological research and development. The novelty of this approach is its attempt to identify constraints a priori, and then, in the design stage of research to adapt technologies to these constraints. Technologies developed in this way stand a better chance of being adopted because they meet the requirements of the farmer end-user.

Ex-ante appraisals of constraints can be improved by targeting particular groups who share similar production practices and problems. A market segment, or target, is a subgroup of

people or enterprises sharing one or more characteristics that cause them to have similar needs. In the farming systems literature, targets are referred to as domains that consist of farmers who have roughly the same production practices, circumstances, and priorities and thus the same researchable problems and development opportunities. Since targeting and domains construction can account for systemic heterogeneity and differentiate the market for agricultural research they have proven to be a cost-effective, efficient way to derive research priorities and focus research efforts and eventual technology dissemination strategies (Rivera & Gustafson, 1991).

The Integrated Pest Management Collaborative Research Program (IPM CRSP) uses a baseline assessment as a first step in deriving farmer production constraints that are then prioritized and used to develop an initial research agenda. In 2006, this project began working with groups of farmers producing arabica coffee (*Coffea Arabica L.*) on the slopes of Mt. Elgon in Uganda. A baseline survey was conducted with a sample of growers in cooperation with local extension providers. The goal of this baseline was to initiate the process of developing a grower driven research and training agenda for Uganda's Coffee Research Center (COREC) in collaboration with the IPM CRSP project.

A farmer-based non-systematic needs assessment of robusta and arabica coffee pest constraints was conducted with 20 farmers in Western Uganda in 2005 (Kucel, de Reuck, & Uringi, 2005). However, for Eastern Uganda where Mt. Elgon is located, arabica coffee pest assessments were considered to be out of date (Ogwang, 2006). This neglect was attributed to COREC's limited resources and to its primary mandate to focus research efforts on robusta coffee which comprises nearly 80% of Uganda's coffee exports. Assessing arabica coffee pest constraints in Eastern Uganda was thus considered to be an important step in developing a pest management research agenda so as to efficiently target and allocate scarce research resources.

Purpose and Objectives

The main purpose of this study is to identify Mt. Elgon coffee farmers' perceptions of primary production and pests constraints to determine an initial research and training agenda. The objectives are to: 1) provide a socio-demographic profile of coffee growers; 2) assess farmer knowledge of pests and pest management and identify key pests (diseases, insects, and weeds) for IPM research; 3) explore key factors for domain (target) construction that might identify systemic relationships that influence pest perceptions and pest management at the farm level; and 4) examine contributions and benefits to extension agents of participation in baseline studies.

Methodology

A baseline survey of coffee producers in three districts on the Ugandan side of Mt. Elgon, was conducted May-June, 2006. The purpose of the baseline was to gather basic socioeconomic information and identify farmers' production practices, pest perceptions, pest management practices and decision making processes. The survey instrument was developed from previous baseline surveys used with farmers in Uganda and adapted to coffee production during a two-day enumerator training workshop.

A multi-staged random sampling procedure was used to select coffee growers for interviewing. The districts of Manafwa, Sironko, and Mbale were purposively selected because they were reported to be important coffee growing areas and logistically accessible. Two parishes in each district were randomly selected. One parish from Mbale was eventually deselected when it was determined that the extent of coffee production was limited. Field

enumerators were instructed to bring lists of coffee growers from these parishes from which a random sample of 26 growers was selected.

Five sub county extension providers were selected to serve as survey enumerators. They were identified by District Agriculture Officers and personnel from the Coffee Enhancement Project as competent, interested, and knowledgeable of the main local language. A two-day enumerator-training workshop was held in Mbale-town with four IPM CRSP team scientists from the USA, Makerere University, and the Coffee Research Center serving as trainers. The main objectives of the training workshop were to review the objectives of the survey and revise the survey instrument, review interviewing technique, design the sampling framework, and agree upon contractual and logistical arrangements.

The workshop was followed by a pre-test of the instrument in which teams of interviewers, including workshop instructors, conducted interviews with ten coffee growers in a neighboring sub-county. Resulting from the pre-test, the instrument was shortened and questions altered and adapted to integrate better coffee production terminology and reflect the local Lugisu language. Final revisions to the instrument were then made and requisite number of copies distributed to each of the interviewers. All questionnaires were completed by personal interviews with selected coffee farmers. A total of 127 usable questionnaires were eventually collected.

Constraint elicitation. A priori assessments of farmer constraints are now considered essential for developing farmer-relevant technologies. The term constraint is generally applied to any condition or set of conditions that limit agricultural production, and when identified by farmers, represents awareness of a need. Contemporary approaches advocate direct participation by farmers in these assessments. Farmer knowledge is recognized as legitimate because it is based on experience and co-evolution with local agricultural production systems (Kloppenburg, 1991). Using farmer identified needs and constraints to orient formal research agendas can help ensure that research is demand driven, problem oriented, and relevant to farmers (Ashby, 1990).

The primary focus of this study was to understand farmers' perceptions of important insect, disease, and weed pests of coffee. If farmers are unaware of pests, then they will not perceive them as problems. The methodology used to elicit this information was to ask farmers directly to identify and rank pest problems of arabica coffee. Each pest mentioned as a most important insect, disease, or weed pest was coded as '1', and if it was not mentioned, it was coded as '0'.

Domain identification. The strategy for defining or classifying target groupings (research domains) is to identify key factors that determine farming systems. In the literature on farming systems the most important determinants are agroecological and socioeconomic factors (Fresco and Westphal, 1988). Similar agroecological conditions produce similar production patterns, farming systems, and given the biological basis of most agricultural pests, influence the incidence and severity of pathogens, pests, and weeds (Lynam and Blackie, 1994). However, social scientists claim that strict reliance on ecological attributes determining farming systems is environmental determinism and that socioeconomic factors are equally important. Socioeconomic factors provide the opportunity structure for farmers to extend their control over the environment by accessing new knowledge and using new technologies. To improve domain construction, each of these parameters should be given equal consideration.

In the case of Arabica coffee production, participating extension agents introduced the concept of coffee zones as demarcated by elevation. Coffee zones reflect agro-climatic conditions that impact the growing of different types of coffee (robusta versus Arabica in Uganda) and varieties; production practices; and the occurrence of pests (insects and diseases). Historically, arabica coffee production on Mt. Elgon was divided into three zones: low (900-1200 meters); medium (1200-1500 meters) and high (1,500+meters). Sampling was not stratified by zone because this information emerged following survey implementation. In later discussions with extension agents, it was decided to use 1,500 meters as the dividing line between high and low and collapse Zones 1 and 2 into one zone. It was their professional opinion that these two zones had more agroecological and farming system similarities and that coffee production in Zone 1 was in decline because of population increases in and around Mbale and other satellite townships in this zone. For the remainder of the report of this study, results will be differentiated by a combined Zone 1 and 2, and Zone 3.

Personal background characteristics such as experience or its proxy age, level of education, and sex could affect constraint perceptions by influencing access to new information and knowledge, and the ability to interpret and understand new information. Age and years of formal education are continuous variables. Use of production technologies and strategies such as new coffee varieties that are disease resistant; use of pesticide sprays to control certain pests; and use of hired labor to implement agronomic pest control practices such as pruning and mulching could also conceivably alter the occurrence and thus perceptions of pest priorities. Finally, those producing more coffee have higher incomes and this may affect perceptions of pests by structuring the opportunity to use new production technologies and strategies that alter pest occurrence and perceptions of pest priorities. Thus this study will incorporate level of coffee production as another potential targeting concept.

Three different methods were used to explore the creation of different coffee production research domains. A t-test of mean differences was used to compare zonal socioeconomic and production differences. Chi-square analysis was used to examine the association between zones and the more important pests constraints mentioned by farmers. Finally, logistic regression was used to examine the possibility that other factors besides zone may be important in domain construction. Logistic regression is recommended instead of multiple regression in analyses using binary or dichotomous dependent variables (Hair, J. et al., 1998).

Results

Socioeconomic and Production Profile of Coffee Farmers

Sampled coffee producers on Mt. Elgon reveal fairly homogeneous socioeconomic backgrounds; there were no significant differences of these characteristics when grouped and compared by zone (Table 1). Most of the respondents were men (89%); all 14 of the female respondents came from Zone 1 & 2; and 7 reported being heads of households. Respondents' average age was 49, and the average level of education was 9 years with 64% having received some post-primary education. The explanation provided by our extension enumerators for this relatively high average level of education was that the common aphorism in the area was that "coffee educates the children." The average household size was nine.

Also, there was no significant difference by zone for on and off-farm income, land owned and land in coffee production. Average farm income for the total sample was around \$427 per year. Farm incomes were higher in Zone 3 than Zone 1&2 reflecting the importance of coffee and or larger coffee holdings in this zone. Average off-farm incomes were estimated to be \$205

per year. Households in Zone 1&2 reported more off-farm income than did those in Zone 3. Only 28% of the respondents in Zone 1&2 reported no off-farm income whereas 48% of the

Table 1

T-test of Mean Differences for Socioeconomic and Production Variables by Zone in 3 Districts, Mt. Elgon, Uganda, 2006.

Variables	Sample (n=127)		Zone 1& 2 (n=98)		Zone 3 (n=29)		df	t
	M	SD	M	SD	M	SD		
Sex	0.89	3.14	-	-	-	-		
Age in years (mean)	49.00	13.60	49.80	14.21	46.76	11.22	124	1.07
Years of education (mean)	9.26	4.08	9.23	4.21	9.34	3.69	125	-1.27
Household size	9.02	3.74	8.78	3.31	9.83	4.92	125	-1.33
Farm Income	9.71	4.60	9.55	4.32	10.24	5.48	125	-.71
Off farm income	5.71	5.77	5.92	5.60	5.28	6.55	124	.52
Total Land farmed (acres)	5.73	6.72	6.33	7.42	3.69	2.64	125	1.87
Coffee acres owned	2.28	1.81	2.24	1.91	2.63	1.68	125	-.98
¹ Prop. Farm in coffee	50.87	30.37	43.00	26.50	77.45	27.13	125	-6.11**
Parchment sold (kg.)	618	589.00	523.00	464.00	932.00	821.00	119	-2.52*
Number of spray applications	1.17	1.95	0.56	0.98	3.24	2.85	125	-7.91**
Total hired labor	1.65	1.83	1.17	1.47	3.27	2.03	125	-6.14**
¹ Use of new varieties	0.49	0.50	0.39	0.49	0.83	0.38	125	-4.44**

Note. ¹Equal variances not assumed. * t-test significant at $p < .05$; ** t-test significant at $p < .01$

Respondents in Zone 3 reported no off-farm income. This would appear to be explained by farmers living in Zone 1 & 2 having better access to off-farm income generating opportunities because of living nearer larger population centers (towns and trading centers); having access to better infrastructure; and better access to different forms of income generation.

The average farm size for the sample was 5.73 acres (growers use acres rather than hectares) with Zone 1 & 2 growers averaging 6.33 acres and Zone 3 farms averaging 3.69 acres. Zones 1 & 2 had an average of 2.24 acres in coffee and Zone 3 farmers had 2.62 acres in coffee.

There were significant differences for all production variables when compared by zone. Coffee farmers in Zone 3 were selling more parchment (partially processed coffee); applying more pesticide sprays; hiring more labor; and were more likely to be using new coffee varieties than were farmers in Zone 1 & 2. Additionally, Zone 3 farmers had a significantly larger proportion of their farm in coffee revealing the greater importance and dominance of coffee production in this zone.

Priority Pests and Diseases

Priority pest rankings based on raw score responses by coffee farmers appear in Table 2. The most important insect pests in order were coffee stemborer (*Bixadus seirricola*), antestia bug, (*Antestiopsis spp.*), coffee berry borers (*Hypothenemus hampei*) and lacebugs (*Habrochila spp.*). The most important diseases in order were leaf rust (*Hemileia vastatrix*) and coffee berry

disease (CBD) (*Colletotrichum kahawae*). It should be noted that 29 (23%) farmers were unable to provide any examples of coffee diseases. The overwhelmingly most important weed indicated was couch grass (*Digitaria scalarum*), with other important weed species being *Oxalis latifolia*, and Galisonga.

In an attempt to refine and target research priorities, the relationship between zone and pest constraints was examined (Table 2). Most pest species were significantly associated with a zone except for coffee berry borer, couch grass, and galisonga weed. Coffee stem borer and leaf rust were clearly associated with Zone 1&2 (lower zone) and antestia bug, lace bug, coffee berry disease and oxalis were clearly associated Zone 3 (higher zone).

Table 2

Relationship between Most Important Pests (insects, diseases, weeds) and Zone as Indicated by Coffee Growers, Mt. Elgon, Uganda, 2006

Variables	n	%	Rank	df	X ²	Phi
Insects						
Not reporting	3	2				
Coffee Stem borer (<i>Bixadus seirricola</i>)	68	54	1	1	29.23**	-.480**
Coffee berry borer (<i>Hypothenemus hampei</i>)	15	12	3	1	.960	-.088
Antestia bug (<i>Antestiopsis spp.</i>)	20	16	2	1	36.66**	.537**
Coffee lace bug (<i>Habrochila ssp.</i>)	11	9	4	1	6.87**	.233**
Other	10	7				
Diseases						
Not reporting	29	23	2	1	5.42*	-.207*
Leaf rust (<i>Hemileia vastatrix</i>)	54	43	1	1	7.33**	-.240**
Coffee berry disease (<i>Colletotrichum kahawae</i>)	24	19	3	1	38.69**	.552**
Other	20	16				
Weeds						
Not reporting	7	5				
Lumbugu/couch grass (<i>Digitaria scalarum</i>)	73	57	1	1	.324	.050
<i>Oxalis latifolia</i>	16	13	2	1	7.66**	.246**
Galisonga, Galant soldier or nandekye	15	12		1	.871	-.083
Others	16	13	3			

Note. *p < 0.05; ** p < 0.01; (-) Phi = Zone 1&2; (+) Phi = Zone 3.

Analysis of Additional Factors in Domain Construction

The preliminary analysis indicated an association between most pest perceptions and zones. To assess if domain construction could be improved, socioeconomic and production variables were added to the model to compare and evaluate the relative importance of these factors in explaining pest perceptions (Table 3). The relative importance of each of these factors was evaluated using logistic regression analysis. With the exception of coffee berry borer, the full model does a moderate-to-good job in explaining farmer perception of pest species. The model for coffee berry disease has the highest pseudo R² value of .60. The likelihood of perceiving a pest as most important is in most cases significantly associated with zone and less

consistently with other variables in the model. The only exceptions were for coffee berry borer and to a lesser extent, leaf rust with a likely explanation being that these two pests are adapted to a broader ecological niche than are the other pest species. In the case of leaf rust, the results indicate that being older (more experienced) and having more education are associated with it being identified as an important pest. However the opposite effect is found for age with coffee berry disease. In summary, socioeconomic and production factors appear to have limited and inconsistent effects on farmer perception of pests when compared to zone and thus provide limited additional precision for targeting future research.

Table 3

Binary Logistic Regression Analysis: Major Pest Problems on Independent Variables.

Variables	CB	Leaf	Antestia	Stem	² Berry	² Lace
	Disease	Rust	Bug	Borer	Borer	Bug
	¹ b	b	B	b	b	b
	(S.E.)	(S.E.)	(S.E.)	(S.E.)	(S.E.)	(S.E.)
Background						
Age	-.079*	.056**	.014	-.007	.021	.039
	(.033)	(.018)	(.027)	(.016)	(.017)	(.023)
Yrs of Educ.	-.136	.128*	-.070	-.040	.134*	-.016
	(.094)	(.057)	(.090)	(.054)	(.054)	(.068)
Inputs						
Pesticide App.	.291	-.208	.008	-.130	.091	.320*
	(.193)	(.165)	(.160)	(.170)	(.139)	(.154)
Hired labor	.246	.082	.019	-.135	-.062	-.138
	(.207)	(.146)	(.196)	(.150)	(.140)	(.166)
New varieties	.472	.627	-.066	.097	.074	.857
	(.910)	(.488)	(.755)	(.493)	(.472)	(.588)
Level Coffee Prod.	.000	.001	.001	.000	.000	-.001
	(.001)	(.000)	(.001)	(.000)	(.000)	(.000)
Zones	2.62**	-1.43*	3.15**	-2.43**	-.593	1.57*
	(.887)	(.689)	(.807)	(.744)	(.652)	(.691)
Model Summary						
³ Total R ²	.60	.285	.449	.318	.105	.292
Classification %	92	70	88	73	64	83
Likelihood X ²	52.78**	28.66**	36.40**	32.64**	9.38	25.16**
⁴ Hosmer&Lemeshow	4.01	7.20	6.18	3.03	12.92	4.85

Note. *p < 0.05; ** p < 0.01; ¹ Coefficients are Log Odds; ² Indicated as first, second, or third important pest; ³ Nagelkerke R² is interpreted as a pseudo R²; ⁴ A non significant Hosmer and Lemeshow test suggest the relationship between the predictors and the dependent variables is nonlinear, justifying the use of logistic regression.

Suggested Pest Research Priorities

Differences in pest prioritization by COREC, the total sample and then as differentiated by zone are examined in Table 4. Although a wide variety of pests were eventually identified by farmers those ranked in this analysis were rated as most important by farmers in the sample. Gaps in COREC ratings represent pests not highly ranked in this study. Additionally, COREC

rankings did not include weed species. There are substantial differences in the ranking of insect pests between COREC and this study. Coffee berry borer and lace bugs were not ranked by COREC and coffee stem borer, the pest most often ranked as the most important insect pest by farmers in Zone 1&2, is ranked fifth by COREC. COREC and farmers ranked diseases in relatively the same order.

Table 4

Priority Insect Pests, Diseases, and Weeds of Arabica Coffee (Coffea arabica L.) as Defined by Coffee Farmers on Mt. Elgon and COREC.

Pests & Source	¹ COREC Uganda	Total Sample	Zone 1&2	Zone 3
Insects				
Antestia bug (<i>Antestiopsis spp.</i>)	1	2		1
Coffee Stem borer (<i>Bixadus seirricola</i>)	5	1	1	3
Coffee berry borer (<i>Hypothenemus hampei</i>)		3	2	
Coffee lace bug (<i>Habrochila ssp.</i>)		4		2
Diseases				
Leaf rust (<i>Hemileia vastatrix</i>)	2	1	1	2
Coffee berry disease (<i>Colletotrichum kahawae</i>)	1	2		1
Red blister disease		3	2	
Weeds				
Lumbugu or couch grass (<i>Digitaria scalarum</i>)		1	1	1
<i>Oxalis latifolia</i>		2		2
Galisonga, Galant soldier or nandekye		3	2	

Note. * Rankings range from 1 – most important to 5 - lower in importance.

¹ COREC ratings are for all Arabica production areas in Uganda. Gaps in COREC ratings represent pests not ranked in this study.

However, differentiating the total sample by zone provides additional information for targeting research efforts with greater precision. The analysis indicates that pest management research should focus on coffee stem borer, coffee berry borer and leaf rust disease in Zones 1 & 2, and antestia bug, lace bug, coffee stem borer and coffee berry disease in Zone 3. Additional research will need to be conducted on pest species that overlap zones, such as coffee stem borer, leaf rust and couch grass, to further define the impacts of climatic factors associated with zone on their distribution.

Conclusions

This analysis provides support for establishing research domains. Using coffee production zones as the concept for constructing domains effectively differentiates coffee production, pest constraints, and helps identify and target future IPM research. The next step in the participatory process will be to establish on-farm biological monitoring trials in each production zone to allow research scientists and extension agents to verify farmer perceptions of pest constraints and collect additional cost of production, processing, and marketing information.

Differentiating farmer pest perceptions by zone indicates that there are important differences between farmers in each zone. An initial pest management research program would target coffee stem borer, berry borer, and leaf rust in zone 1&2; and antestia bug, lace bug, and coffee berry disease in zone 3. These differences have important implications for plant breeders as they develop and test new varieties and for designing pest management interventions. It will be important to test these interventions either on-farm or at research stations that correspond to zonal pest occurrence.

Coffee farmers were less familiar with diseases and this would indicate a need for a farmer training program on disease identification and management. Couch grass was the overwhelming most important weed constraint as it is in many other areas of Uganda. Coffee researchers will need to evaluate other couch grass control studies to see if there is any opportunity for research spillover effects that might apply to coffee farmers on Mt. Elgon.

Differentiating coffee production by zone indicates that farmers in zone 3 are more dependent upon coffee production, have less access to alternative cash cropping and off farm income generating opportunities and are producing and selling more coffee. They are also more active managers of their coffee using more production inputs including more pesticides, hired labor, and improved coffee varieties. Although this is likely attributable to farmers in zone 1&2 living nearer to urban population centers and thus access to other income generating opportunities, another reason that will need to be explored is that coffee quality is reportedly better at higher elevations. In general, these results indicate that farmers in zone 3 are more focused on coffee production than are farmers in zone 1&2, and thus might be more open to new technologies, recommendations, and coffee training programs.

However, socioeconomic and production factors had very little effect on perception of pest priorities. In most cases, perception of pests was associated with zone. When comparing pest priorities developed by COREC with the total sample there are important differences, and then again, there are important differences when the sample is differentiated by zone. This would appear to provide strong support for both incorporating farmer knowledge of constraints and the development of targets to refine and add precision to research planning. Targeting has prevented over simplification and accounted for systemic heterogeneity.

Role of Extension in the Assessment Process

Extension providers can make an important contribution to technology design and development by participating in a priori assessments of farmer constraints. Extension agent experience and knowledge of local farmers, farming systems, and markets can help ensure that research and development priorities are carefully crafted, reflect on-the-ground reality, and better serve end users. In this particular study extension agents reintroduced the concept of “coffee production zones”, helped develop the sampling frame, located and interviewed farmers, and provided interpretations of local knowledge for research scientists. These are all important contributions that have resulted in a more precise definition of pest constraints and research priorities for an arabica coffee research program.

However, traditional extension approaches have tended to limit the role of extension to technology transfer thus eliminating farmer-to-extension information flows. The perceived role of extension providers as only agents of technology transfer has diminished their importance in local communities and made them dependent on external sources of information that may be scientifically sound, but lacks applicability because they fail to account for variations in microclimatic conditions and local specific production constraints. Participation in the research

process through constraint assessments provides a vehicle for extension agents to gather information, knowledge, and expertise of local production systems – a vehicle that has not been present for many extension agents for many years – and for them to resuscitate the farmer-to-extension linkage.

Not only do farmers gain something from improved agricultural technologies, but extension providers' benefit as well. Engaging them in the technology development process increases their technological proficiency and improves their status within systems and structures that seek to promote improved agricultural technologies and the development of rural economies. Extension agents who participated in this study are now included in coffee varietal assessment programs and regularly contacted by NGOs to conduct coffee training programs. Their active participation in the assessment process makes them more aware of attendant production constraints in their communities, and provides them with valuable information that they can share with farmers. When handed a hard-copy of the final baseline survey report one extension agent commented: "I now have something to show and discuss with my farmers."

As Rogers (1995) has indicated, complexity of new technology can be a constraint to its adoption. Yet, the development of improved agricultural technologies that account for the heterogeneity of local agroecological conditions increases the very complexity of solutions to overcoming production constraints. Hence, the extension provider, as the central link between the research and farming community, can facilitate mutual understanding by not only helping with the transfer of new agricultural technologies to farmers, but by improving the knowledge of production constraints within site-specific ecologies through the assessment process. This also benefits extension providers by increasing their knowledge of the research process, new technologies, and enhanced technical competence, which potentially improves their ability to transfer information on overcoming production constraints back to the farmers. The bottom line is that participatory agricultural research is enhanced when extension providers transfer information in both directions: from farmers to researchers, and back again from researchers to farmers.

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