Does It Matter Who We Ask in Household Surveys?

A Case Study on Gendered Effects and Decision Making Processes in Ecuador

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Abstract: The understanding of how households make decisions may improve the success of an economic development program and enhance targeted training efforts. If a relevant decision maker can be clearly identified and specifically trained to meet his or her needs, the development program may be enhanced. The questions are often asked of a single person, and proxy responses are commonly used. Though potential bias from proxy responses is well documented, there is less information regarding the relationship between the proxy and his or her characteristics and the veracity of responses to subjective questions. To design an effective training program, clear answers are needed. To address these questions, this paper employs a method of mining contrast-set (Bay and Pazzani, 1999 and 2001) to answer the general issue of does it matter who we ask in a given survey. Some of the findings show that, for instance, when only one respondent is interviewed, he or she tends to claim major responsibilities.

Key words: gender, effects, decision making

I. Introduction and Motivation:

A successful decision maker makes good decisions. Farm households make farming and sales decisions to maximize their expected utilities while designers of economic development programs wish to understand behavior to improve program success. In developing countries, well-being is closely tied to agricultural productivity. Agricultural productivity growth, however, is often accompanied with pesticide. Pesticide management is important and mismanagement can lead to health and environmental problems. Improper management is thus associated with inefficient production. A program to provide training in management practices with a focus on pest management practices can be helpful. Better understanding of how farm households make decisions may enhance the design of such training efforts. Information about who makes which decisions will allow better-targeted trainings.

Households do not make decisions by following static rules. Life experiences, traditions, customs and social environment may influence their decision-making. Decisions on farm management may be crucial to households in developing countries who make technology adoption decisions as part of an overall strategy to meet their food security needs (Thangata, et al. 2002). Investments, technology adoption, credit uptake and other household decisions may change as a result of an intervention and such decisions can make or break a program's success. On account of the importance of decision making, if a relevant decision maker can be clearly identified and specifically trained to meet his or her needs, the development program may be enhanced.

Approaches exist for identifying stakeholders and understanding how farm decisions are made. Participatory methods are commonly used in research and baseline surveys, and help engage stakeholders to share ideas (Gurung and Leduc 2009). Baseline surveys may identify livelihood clusters, and participatory appraisals are used to gain information regarding the identification of productive activities, assets, stakeholders, conditions faced, and knowledge (Barrera, et al. 2012). Participatory methods can suffer from questionable external validity, and the validity of information from baseline surveys can depend on questionnaire design and to whom the questions are addressed (Bardasi, et al. 2010).

In understanding household decisions, researchers often rely on responses to household survey questions. These questions are often asked of a single person, and proxy responses are commonly used. By interviewing a single person who responds to questions about himself and others in the household, researchers can lower survey costs and improve survey efficiency. For example, when other respondents are missing, reliance on a single responder can avoid "incomplete" surveys, and reduce costs of tracking down missing members or revisiting the household. Proxy reporting literally means that the questioner is collecting information about all members of household from a single respondent (Bureau of Labor Statistics).

A key issue is whether proxy responses provide accurate answers and allow reliable conclusions. In some cases they may, while in others it may be important to ask specific household members. Clearly, knowledge about the specific types of survey questions that are amenable to proxy responses will enhance survey design.

Though potential bias is well documented, there is less information regarding the relationship between the proxy and his or her characteristics and the veracity of responses to different questions. For example, subjective questions like who makes decisions within the household or who is in charge of major responsibilities may be especially vulnerable to proxy bias. To design an effective training program, answers to such questions are needed. The main issue is does it matter who we ask? Do we need a balance between men and women to get representativeness?

Gendered differences in responses to questions may be important. For example, a husband's estimate of his wife's income does not always produce reliable results. In a study on proxy responses in Malawi estimates of the wife's income provided by the husband and wife are in agreement in only 6% of households, and in 66% of households, the husband underestimated his wife's income by 47% on average (Fisher, et al. 2010). Buck and Alwang (2011) found that trust in information sources and, hence, willingness to accept information varies by gender. Different messages to different audiences can affect a program's success. A study on tomato production and gender in Uganda shows that no males responded that their wives control tomato production while about 18% of the females actually did (Montgonery 2011). These factors related to gender bias may affect the optimal design of a farmer training program.

This paper uses the results from a randomized experiment in Ecuador to examine perceptions about roles in farming and, particularly on pesticide decisions and management. Responding households are randomly assigned to one of three contrasting groups: a male respondent, a female respondent, and households with both male and female respondents, but interviewed separately. This paper employs an approach of mining contrast-sets (Bay and Pazzani 1999, 2001) to examine whether and in what way this treatment effect depends on household characteristics or type of question, specifically whether the question is objective or subjective. It also addresses specific questions such as what factors impact gender-specific responsibilities in farm and pesticide management decisions. Findings of this paper show that perceptions on household decision making processes differ significantly between males and females, and across treatment groups; men are found to be more likely to overvalue their roles and responsibilities in making household decisions, agricultural management and sales, and undervalue women's roles. The remainder of this paper is as follows: background, methodology, data analysis and results, comparisons and conclusions.

II. Background:

Kalton and Schuman (1982) found that specific wording and structuring of survey questions affect responses. A growing body of literature shows differences between male and female responses to survey questions in developing countries. One example is the husband's estimates of wives' income in Malawi, where accurate estimates are obtained in only 6% of the surveys. Husbands tended to underestimate female income (Fisher et al. 2010).

Literature on pesticides and safety shows that, on account of an increasing use of pesticide for agricultural purposes, pesticides pose a threat to people's health, especially to women and children (Mott, et al. 1997). In highland Ecuador, pesticide use is widespread and farmers face serious exposure to pesticide and health problems (Cole, et al. 2002). Bolivar is one of the two poorest provinces in Ecuador (Fair World Project). Since the agricultural sector is its main economic activity in Bolivar Province (Crop Biodiversity), clearly, it is a necessity as well as of great importance to realize agricultural development in the province in order to reduce poverty.

Survey Experiment:

Data[1] analyzed come from a survey conducted in the Chimbo River watershed, Bolivar Province, Ecuador. The watershed consists of two sub-watersheds: Illangama and Alumbre. The survey

[1] Some data points is believed to be measure errors and thus excluded from the analysis: in Alumbre: years of education 62; hectares of land for production 66.965, 1041, 1761; Male worker 180; Total worker 38, 200. In Illangama: distance 6000; hectares of land for production 200; for decision-making related questions, only the options of interviewee, your spouse, and you and your spouse were considered and included for data analysis.

was implemented from September-November 2011 by randomly selecting households from 72 communities. The number of households surveyed per contrasting groups was: 91 for only a male respondent, 131 for only a female respondent, and 98 households where adult male and female farmers were surveyed separately, a total of 418 responding farmers from 320 households. The survey covers areas such as household socio-economic conditions and demographics, marketing, pest management practices, knowledge of IPM, and household decision making processes.

The study focuses on two broad issues of whether membership in a randomly assigned contrasting group has an effect on survey responses, and whether this effect depends on other household characteristics. We also investigate whether the effect in each contrasting group differs meaningfully by objective and subjective types of questions. We also address specific questions such as what factors impact gender responsibilities in farm decisions, what types of survey questions can be combined or shortened, and does it matter who to interview.

III. Methods:

To address the objectives, this study employs a method of mining contrast-sets (Bay and Pazzani, 1999 and 2001). The mining process first counts the frequencies of responses to each question across contrasting groups. It then identifies all pairs of responses whose corresponding frequency differs across groups. Once all such conjunctions of survey questions and responses that are significantly different in their distribution across groups are identified, hypothesis tests are conducted. In these tests, the null is that the frequency or the probability of a response to a survey question is equal across the three groups. This hypothesis is that the probability is independent of group membership. Lastly, the probability of Type I error is controlled by using the Bonferroni inequality to adjust for the problem of false rejection caused by operating multiple hypothesis testing.

<u>Definitions and Mathematical Expressions:</u>

<u>Definition 1:</u> Let $A_1, A_2, \ldots, A_k$ *be a set of* k *variables. Each* A_i *can take on a finite number of discrete values from the set* $\{V_{i1}, V_{i2}, \ldots, V_{im}\}$ *. Then a* ***contrast-set*** *is a conjunction of attribute-value pairs defined on groups* $G_1, G_2, \ldots, G_n$ *, where* n *is the number of mutually exclusive groups.*

In our case, the attributes will be the survey questions, the values will be the corresponding responses to the questions, and the groups will be the three contrasting groups randomly assigned when conducting the survey. For example, assume that we have a contrast-set: $(Gender\ of\ respondent = male) \cap (Who\ is\ in\ charge\ of\ purchasing\ pesticide = self)$. This set literally says that, based on the survey data, a respondent responded the gender question as being a male and he also subjectively claims that he is in charge of purchasing pesticide in the household all by himself.

<u>Definition 2</u>: The ***support*** *of a contrast-set for a group G is the percentage or probability of examples in G where the contrast-set is true.*

In the current case, the support can be considered as a frequency or the probability of the occurrence of a contrast-set within a given group G_i , $\forall\ i = 1, 2, 3$.

Given these two definitions, the challenge is to find all such contrast-sets (cset) whose frequency differs significantly across groups in order to detect relationships among variables. Through this approach, the question “Does it matter who we ask for certain survey questions?”

can be addressed. Mathematically, the process identifies contrast-sets such that the following two conditions are jointly satisfied:

$$\exists ij\ P(cset = True|G_i) \neq P(cset = True|G_j), \text{ where } P(\cdot) \equiv \text{probability} \quad (1)$$

$$\max_{ij} |\ support(cset, G_i) - support(cset, G_j)\ | \geq \delta \quad (2)$$

The contrast-set is called ***significant*** if inequality (1) is satisfied, and ***large*** if Inequality (2) is met. Notice that in (2), δ is a user-defined threshold which can take $\delta \in [\ 0\ ,1\ ]$. If both inequalities are satisfied, we call it a ***deviation***. By identifying such deviations within the survey, significantly different survey responses across groups can be determined. For instance, assume a threshold with $\delta = 0$. .By counting relative frequencies, we get: $\forall i = male, j = female, P(Responsibility\ 1\ |\ G_i) = 0.95,\ P\big(Responsibility\ 1\ \big|\ G_j\big) = 0.25$, then we know that responses to the survey question "Responsibility 1" across the groups of male and female are, by Inequality (1), *significant*, and the absolute value of the difference between their supports is 0.7. Since this is larger than the threshold 0.5, it is deemed to be, by Inequality (2), *large*, and therefore represents a *deviation*. Based on the sample probability distribution, this result indicates that men and women answer this survey question differently. If the statistical significance test is also met, this finding will imply that male and female respondents answered the question significantly differently, and it is necessary to interview both households on "responsibility 1".

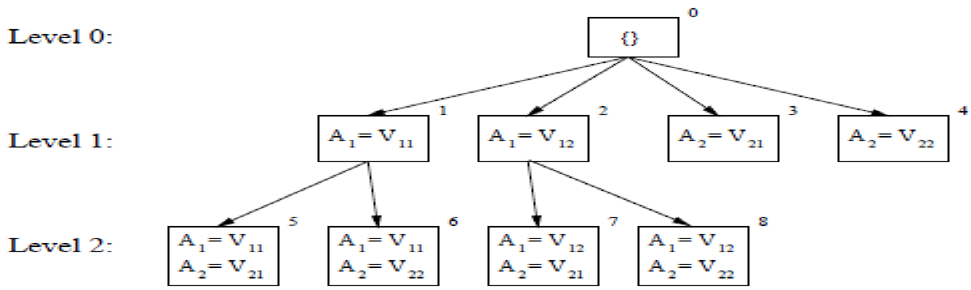
The method described above needs to be extended to account for the factor of the presence of continuous, discrete or mixed variables in the dataset. Agricultural surveys include mixes of categorical, ordinal and continuous data. Though ordinal data can be analyzed in the same way as categorical data, continuous data may not be most accurately analyzed in this way.

Thus, this paper introduces an additional method, use of optimal bandwidth of Kernel density estimates of continuous variables, to transform our continuous data into categorical form. This method not only provides an approximation of the original probability distribution, but also offers smoothness and continuity, which may better reduce information loss from this data transformation. The kernel density estimators have the properties of smoothness, no end points and the dependence on bandwidth rather than on width of bins, compared to the histogram method (Duong 2001). The use of an optimal bandwidth in a kernel approach provides an improved decision with respect to the optimal width of bins (the degree of approximation in a histogram approach). The optimal bandwidth for the case of Gaussian distribution with a Gaussian kernel (Zucchini 2003) is given by:

$$h_{opt} = \left(\frac{4}{3n}\right)^{1/5}\sigma.$$

An Algorithm for Mining Contrast-sets:

In order to systematically detect contrast-sets, this paper employs an algorithm, STUCCO (Search and Testing for Understandable Consistent Contrasts) (Bay and Pazzani 1999 and 2001), it, in practice, works efficiently to mine numbers of potential candidates even at a low support difference defined by Inequality (2) (Bay and Pazzani 1999). It also includes sub-algorithms for: (i) statistical hypothesis testing for contrast-set validity, and (ii) control of Type I error to limit false rejections. The following figure shows how STUCCO works with two attributes each taking two possible values:



(Figure from Detecting Change in Categorical Data: Mining Contrast Sets", by Stephen D. Bay and Michael J. Pazzani, the Department of Information and Computer Science, University of California, Irvine, Page 2)

This figure assumes two survey questions (A_1 and A_2) and two responses for each question: { V_{11}, V_{12} } for A_1 and { V_{21}, V_{22} } for A_2 . Begin by searching contrast-sets with an empty set at Level 0. Then for each subsequent level, add an additional term into this system and continue.

Finding Significant Contrast Sets:

When the contrast-sets are identified, it is necessary to ensure that each set is significant by conducting hypothesis testing. Chi-square test is used. Let the null hypothesis be that the contrast-set support is equal across all groups for both tests. Under these conditions, the support can be conceived of as a form of frequency data which can be analyzed in contingency tables. These tables include the truth of the contrast-set and the group membership.

Controlling Type I Error:

When testing a single hypothesis, the significance level sets the maximum probability of falsely rejecting the null hypothesis. However, when conducting multiple hypothesis tests the probability of false rejection can be high, and there still exists no optimal solution to address this problem. One way to control Type I error in the case of multiple tests is to use a more stringent α

cutoff for the individual tests. Relate the α_i levels used for each individual test to a global α using the following:

<u>Bonferroni Inequality</u>: Given any set of events $e_1, e_2, \cdots, e_n$, *the probability of their union* $e_1 \cup e_2 \cup \cdots \cup e_n$ *is less than or equal to the sum of the individual probabilities.*

Simply, this inequality holds as long as: $\sum_i \alpha_i \leq \alpha$. Therefore, a different level of significance can be used for each level in the searching process:

$$\alpha_l = \min(\frac{\alpha}{2^l} / |C_l|, \alpha_{l-1})$$

where α_l is a test cut-off for each level l, and $|C_l|$ is the total number of candidates at level l.

Comparison to Regression Analysis:

Very limited literature compares the method of mining contrast-sets and regression analysis. In order to make this comparison, econometric models were estimated using a Multinomial Logistic Model (MNL) to address the same issues examined by the contrast set methods. The measure by Cameron and Trivedi 2005 is given with person j selecting one of given options i as:

$$P[y_j = i] = P_{ji} = \frac{\exp(x_i'\beta_i)}{\sum \exp(x_j'\beta_k)}, where\ 0 < P_{ji} < 1$$

$$P[y_j = i] = P_{ji}(\beta_0 + \beta_1 x_1 + \cdots + \beta_k x_k) = P_{ji}(\beta_0 + x\beta), x\beta = \beta_0 + \beta_1 x_1 + \cdots + \beta_k x_k$$

where: $y_j \equiv$ the probability that the person j chooses option i ($1\equiv$ the interviewee, $2\equiv$ your spouse, $3\equiv$ you and your spouse jointly responded), $P[y_j = i]$; $x_j \equiv$ vector of variables in contrasting groups of gender, for instance, Gender1=single male when comparing male and female responses in this pair; $\beta_i \equiv$ vector of coefficients associated with the i^{th}option which measures the effect across the pair of groups. To access the importance of characteristics and other factors on household choices, again, six regression models are employed with MNL to explain the impacts of the independent variables on the probability of choosing either a male, a female, or both, for being in charge of those household activities. y_j is still the probability for a person *j* to choose option *i*, where option *i* is re-coded as 0 being only female, 1 only males and 2 both. Marginal effects are used for the interpretation of the models.

Data Analysis, Comparisons and Results:

The analysis on the survey responses by contrasting groups shows that the gender of the respondent does have effects on certain survey responses. For subjective questions on who makes decisions within the household and who is in charge of crop and pest management, combining all four pairs of contrasting groups together (Tables 1-3), a total of 22 contrast sets for Alumbre and 6 for Illangama were found, all of which passed the hypothesis tests of independence with the threshold of δ=0.15 for Alumbre and 0.2 for Illangama. Comparing the multinomial logistic models with the contrast-set mining method, results for both watersheds show that 20 of them are agreed by the MNL results (Table 1, Table 3 and Table 6), and the rest of inconsistencies mainly come from the responses to only two questions of "Who Prepares Pesticides" and "Who Applies Pesticides".

If focusing on the case of Alumbre watershed, Table 1 indicates that individually interviewed males and females responded significantly differently to the questions of who prepares pesticides and who applies pesticides. For both questions, males tended to claim that they were in major charge of these activities and they also responded that none of their wives were involved, similarly, this is agreed by their wives, too – only about 16% of the individually interviewed females claimed that these two household activities are majorly done by themselves while roughly 50% of them still agreed that preparing and applying pesticides are their husbands' roles. However, with the MNL models, Table 6 suggests that for these two survey questions, though in the pure gender MNL models, the likelihood ratio test indicates that gender is statistically significant at both 5% and 1% levels, it failed to deviate the responses to the questions. Interestingly, if we compare Table 2 and Table 6, MNL model results agree perfectly with the contrast-set results, and again, regarding the two questions of who prepares and who applies pesticides, both of the two different methods clearly agreed that when males and females were interviewed jointly but separately, both jointly surveyed males and females have the agreement that these two are more men-related activities with both relatively large observed frequencies or predicted probabilities. From this point, we can also conclude that, at least for these two survey questions, when females are individually interviewed, they tended to claim that the major responsibility are in their control while if the females were interviewed knowing that their husbands were also to be interviewed, they tended to claim less self-responsibilities but were more likely to claim that these were done majorly by males. And this can also be seen from Table 6 in the contrasting groups between females and jointly interviewed females, that for both of the questions, individually interviewed females were roughly 25% less likely to claim that these were done by their husbands than jointly surveyed females. For the survey questions who prepares pesticides and who applies pesticides, both contrast-set and MNL methods suggest that when only one female is asked, she is more likely to claim her sole responsibility than jointly interviewed females, and when both males and females were jointly interviewed, they made such agreement that preparing and applying pesticides are more male-related tasks. In addition, the contrast-set method itself also suggests that even males are females are individually interviewed, they tended to both agree that these two activities are majorly done by males.

In the watershed of Illangama, these is another story for the two questions of who preparing and applying pesticides: comparing the two methods (Table 3 and Table 6), results by the contrast-set method show that when males and females are jointly interviewed, males are much more likely to claim solely responsibility than females to the questions of who prepares and applies pesticides, while with MNL models, such result was not found, thus MNL suggests that regarding these two questions, jointly interviewed males and females did not responded significantly differently, even though the likelihood ratio test shows that gender is a significant variable in the models.

As we know, in fact, the Bonferroni inequality is generally conservative, and may become especially conservative given a small sample size, such as 13 total observations for male respondents in Illangama watershed in this study, and this may be one reason why contrast-set mining method generally found less results than the MNL models – some potential contrast-set candidates may be missed solely due to Bonferroni inequality, and because of the small sample, the pre-defined thresholds may not work very well in defining how different two *supports* can be, as, for example, a one data point change among the 13 male responses is relatively large. Thus, what would the contrast-set result be if loosening the conservativeness of Bonferroni inequality? By requiring that each contrast-set may have a significance level no greater than a tenth of alpha, which is a 0.005, then we would get a total of 28 contrast-set results among which 24 were agreed by the MNL models in Alumbre watershed and a total of 6 out of 11 contrast-set results are agreed by the MNL models in Illangama. The 8 out of the 9 inconsistencies still remain to be the responses to the two survey questions of who prepares pesticides and who applies pesticides.

Though it cannot be guaranteed that the contrast-set mining method has more consistency with the MNL model when the strictness of Bonferroni inequality is loosened and that contrast-set mining method works much better with larger sample size, based on the study sample, it may seem to be true. Tables 1 and 6 show that, besides the four contrast-sets for the two activities of preparing and applying pesticides, results from both MNL models and contrast-set mining lead to the agreements that, in Alumbre, individually interviewed males are much more likely to claim their solely responsibilities than females in household activities that relate to crop managements, pesticide purchases, and how much to spend on pesticides, while individually surveyed females also intended to claim major responsibilities on those activities, but not as much as males do – the observed percentage differences for an individually interviewed male and female responding those questions between "the interviewee" and "your spouse" are roughly 70% and 3% respectively. While in the watershed of Illangama, still no result were found by the contrast-set mining method between individually interviewed males and females regarding the decision-making related questions, results of MNL models (Table 7) however, show that the predicted probability for individually surveyed males to claim major responsibilities are roughly 40% higher than females' regarding who sells crops and who buys pesticides (contrast-set mining method also found individual results such as who sells crops at 5% and who buys pesticides at 10%, but because of Bonferroni inequality, these results were not returned). No matter what method is used, in general, if comparing the results between individually interviewed males and females between the two watersheds, it can be seen that males and females are generally more likely to share information and agricultural activities in Illangama than people in Alumbre.

Regarding the 8 inconsistencies remained between applying two different methods, in Alumbre, focusing on Table 1 and Table 6 for the contrasting groups of individually interviewed males and females, results show that, in Table 1, contrast-set mining method returned the four corresponding results because by its definition, the responses to the four options of the two questions indeed differ “meaningfully” across the contrasting groups of individually surveyed males and females based on the pre-defined threshold. However, if focusing on the column of females’ observed frequencies, it can be clearly seen that, females subjectively think that they take more responsibilities than their husbands though all the decision-making related questions but who prepares pesticides and who applies pesticides – females themselves subjectively affirmed that, regarding these two activities, their husbands are more likely to be in major charge, thus, both individually interviewed males and females tend to agree that these two activities are more male-related ones. Thus, even though the results and numbers shown in Table 1 and 6 indicate an inconsistency between the two methods, the analysis from both methods on these two activities imply that both males and females tend to agree that these are majorly done by males.

When comparing individually interviewed males and the males interviewed knowing that their wives were also about to be surveyed, in Alumbre, both methods returned no results, suggesting that within this pair of contrasting groups, individually interviewed and jointly interviewed males did not respond to any of the survey questions significantly differently. While in Illangama watershed, contrast-set mining method did not return any results, thus MNL model cannot be used to check if there exists any inconsistency, but if only looking at Table 7, it can be observed that individually interviewed males and jointly interviewed males responded differently to only one question of who sells crops: there’s a 39% more chance for an individually interviewed male to claim solely responsibility than jointly interviewed to this question and they are less likely to select joint responsibility with their wives compared to jointly surveyed males. It seems that, for both methods, on all the other five questions, it has been agreed that individually interviewed males and jointly surveyed males do not have surprisingly different answers.

To assess whether individually interviewed and jointly interviewed females responded to the decision-making related questions differently in Illangama, Table 4 and 6 are used. With the Bonferroni inequality imposed, no results were found by the contrast-set method, indicating that females from this pair of contrasting groups did not respond to any of the survey questions differently. However, Table 4 shows the contrast-set results when this restriction were loosened to one tenth of alpha. For all of the results except for the question of who manages crops listed in Table 4 found by the contrast-set mining method, MNL models have the corresponding perfect matches with the contrast-set mining methods, with one additional finding: there is a 16% less chance for individually interviewed females to respond joint responsibility with their husbands to the question of who buys pesticides compared to the jointly interviewed women. In addition to this point, Table 4 also shows that jointly interviewed females are more likely to claim joint charge together with their husbands than individually surveyed females, and for the same question, individually surveyed females tend to claim more responsibility. It can be seen that, females are found to be likely to over-value their roles and participations in selling crops, preparing and applying pesticides, and jointly surveyed females tend to claim joint responsibilities. Moreover, it has been agreed by females that preparing and applying pesticides are men-related tasks.

The last pair of contrasting groups consist of jointly interviewed males and jointly interviewed females. To examine the gendered effects in these two groups, Table 2 and 6 are referred for the watershed of Alumbre, and results show that for the total of 12 contrast-sets discovered by contrast-set method, a 100% consistency is gained by the findings of MNL models. Jointly interviewed males claimed sole responsibilities to all of the six decision-making related survey questions and in general, jointly interviewed females intended to claim these duties to be taken by their husbands, too, especially for who prepares pesticides and who applies pesticides. In Illangama however, both methods agree that jointly interviewed males tend to respond that they are in major charge of purchasing pesticides. Contrast-set mining method also suggests that jointly interviewed males and females both tend to claim that the activities of preparing and applying pesticides are mainly in charge by males, whereas by MNL models, there is a bigger chance for jointly interviewed males to claim major responsibility in selling crops and 23% less chance to respond joint responsibility with their wives.

To respond to the issue of whether the gendered effects differ by household characteristics and different type of questions, contrast-set methods mined no results, suggesting that gender is the only factor to influence the farmers responding household decision-making related questions differently, while both MNL model found that, for the questions of how much to spend on pesticides, the importance of recommendation from the extension is a significant factor to influence people's decisions – both methods suggest that males who responded very important to the question of how important is the recommendation by the extension are more likely to claim that they are in major role of deciding how much money to be spent on purchasing pesticides. In addition, MNL models also found that the ages of the respondents and the distance from their houses to the roads are also the factors which may potentially affect farmers, especially males to make household decisions such as in selling household crops, purchasing pesticides, preparing pesticides and applying pesticides. Moreover, the hectares of land own may potentially influence females in managing crops and males in deciding how much to spend on pesticides. Even though these factors are found to be statistically significant at 5% level, the corresponding coefficients are extremely small, and for the factor of importance of recommendation by extension, MNL model indicates that with this factor, roughly 22% more male farmers are more likely to take charge in deciding how much to spend on pesticides.

Conclusions:

The results of this paper provide a better understanding of intra household decision makings involved in a potential program to offer training in agricultural management practices with a focus on pest management practices in Ecuador, to address the general issue of does it matter who we ask in the survey. The method of mining contrast-set is employed as the main measure in this paper and multinomial logistic regression analysis is used for comparisons.

Findings suggest that generally, when only one respondent is interviewed, he or she is more likely to claim major responsibility to certain subjective questions. In particular, males in general tend to over-value their roles or involvements in household activities such as crop and pesticide managements and under-value their wives' participations regarding the subjective survey questions that relate to farm household decision-making processes, and this situation applies to either individually interviewed males or jointly interviewed males; females are found to be likely to over-value their roles and participations in selling crops, preparing and applying pesticides, and jointly surveyed females also tend to claim joint responsibilities. Even though both males and females tend to claim major responsibilities in questions such as preparing and applying pesticides in general, when only one female is asked, she is more likely to claim her sole responsibility than jointly interviewed females, and when both males and females were jointly interviewed, they made such agreement that preparing and applying pesticides are more male-related tasks. In Alumbre, individually interviewed males are much more likely to claim their solely responsibilities than females in household activities that relate to crop managements, pesticide purchases, and how much to spend on pesticides, while individually surveyed females also intended to claim major responsibilities on those activities, but not as much as males do. Thus, on these such of survey questions, in order to obtain more accurate responses, it is suggested that both males and females be interviewed.

Furthermore, upon the fact that none of the methods found such results to certain objective/subjective questions that people in any assigned contrasting groups responded significantly differently, thus, for such questions as crop productions, the importance of reduced costs in purchasing pesticides, how important is the cost of IPM practices and the importance of advices from neighbors, etc., females' responses do not differ significantly with the males' and thus, one gender is adequate to be surveyed on such questions, no matter this female or male respondent is individually surveyed or jointly surveyed. Meanwhile, for activities such as purchasing, preparing and applying pesticides, crop management and deciding how much to spend on pesticides, the individually interviewed males and jointly surveyed males do not have surprisingly different responses in both watersheds, suggesting that if interviewing a male, either individually or jointly surveyed male respondent may be enough for the survey, but this does not necessarily mean that the male responses are reliable, and female responses are also need to be taken.

Jointly interviewed males claimed sole responsibilities to all of the six decision-making related survey questions and in general, jointly interviewed females intended to claim these duties to be taken by their husbands, too, especially for who prepares pesticides and who applies pesticides. In Illangama however, both methods agree that jointly interviewed males tend to respond that they are in major charge of purchasing pesticides. Thus, compared to individually interviewed respondents, jointly interviewed survey responses are relatively more reliable, but more accuracy of the survey responses can be obtained by interview both jointly surveyed males and females, while in Illangama, for the question of who purchasing pesticides, both jointly interviewed males and females should be interviewed, but for other decision-making related questions, one jointly interviewed gender is adequate to survey.

Nevertheless, the participations by females in activities which relate to pesticide management cannot be neglected, and thus more accuracy may be gained by asking both male and female about this type of question on a survey, such as who decides how much money to spend on purchasing pesticides and who is charge of managing crops.

Pattern of household decision making and gender responsibility differ by different watershed – gendered impact on decision-making related questions and pesticide expenditures are more balanced in Illannaga than those in Allumbre, which may also imply that males from Allumbre tend to weigh more gender roles on themselves than the ones in Illannaga. Thus, in Illangama, regarding those survey questions, one gender is generally enough to be interviewed.

(This is not a final paper.)

Table 1. Level One Contrast Sets, Alumbre

Contrast Sets (δ = 0.15)	Contrasting Groups		P-values (α = 0.05)
	Male	Female	
Who Manages Crops = Interviewee	74.36%	30.85%	<0.0001
Who Manages Crops = Your Spouse	1.28%	27.66%	<0.0001
How Much to Spend on Pesticides = Interviewee	69.23%	30.85%	<0.0001
How Much to Spend on Pesticides = Your Spouse	3.85%	27.66%	<0.0001
Who Buys Pesticides = Interviewee	75.64%	34.04%	<0.0001
Who Buys Pesticides = Your Spouse	2.56%	30.85%	<0.0001
Who Prepares Pesticides = Interviewee	75.64%	15.96%	<0.0001
Who Prepares Pesticides = Your Spouse	0.00%	52.13%	<0.0001
Who Applies Pesticides = Interviewee	71.79%	15.96%	<0.0001
Who Applies Pesticides = Your Spouse	0.00%	48.94%	<0.0001
Loosing Bonferroni Inequality at α/10			
Who Sells Crops = Interviewee	61.54%	37.23%	0.001
Who Sells Crops = Your Spouse	5.13%	24.47%	0.001

Table 2. Level One Contrast Sets, Alumbre

Contrast Sets (δ = 0.15)	Contrasting Groups		P-values (α = 0.05)
	Joint Male	Joint Female	
Who Sells Crops = Interviewee	45.59%	17.65%	< 0.0001
Who Sells Crops = Your Spouse	5.88%	23.53%	< 0.0001
Who Manages Crops = Interviewee	58.82%	19.12%	< 0.0001
Who Manages Crops = Your Spouse	7.35%	38.24%	< 0.0001
How Much to Spend on Pesticides = Interviewee	52.94%	17.65%	< 0.0001
How Much to Spend on Pesticides = Your Spouse	8.82%	41.18%	< 0.0001
Who Buys Pesticides = Interviewee	66.18%	22.06%	< 0.0001
Who Buys Pesticides = Your Spouse	7.35%	36.76%	< 0.0001
Who Prepares Pesticides = Interviewee	86.76%	13.24%	< 0.0001
Who Prepares Pesticides = Your Spouse	2.94%	73.53%	< 0.0001
Who Applies Pesticides = Interviewee	80.88%	14.71%	< 0.0001
Who Applies Pesticides = Your Spouse	4.41%	73.53%	< 0.0001

Table 3. Level One Contrast Sets, Illangama

Contrast Sets (δ = 0.2)	Contrasting Groups		P-values (α = 0.05)
	Joint Male	Joint Female	
Who Buys Pesticides = Interviewee	66.67%	6.90%	< 0.0001
Who Buys Pesticides = Your Spouse	3.33%	55.17%	< 0.0001
Who Prepares Pesticides = Interviewee	96.55%	10.34%	< 0.0001
Who Prepares Pesticides = Your Spouse	0.00%	86.21%	< 0.0001
Who Applies Pesticides = Interviewee	96.55%	10.34%	< 0.0001
Who Applies Pesticides = Your Spouse	0.00%	86.21%	< 0.0001

Table 4. Level One Contrast Sets for Alumbre

Loosening Bonferroni Inequality at α/10			
Contrast Sets (δ = 0.15)	Contrasting Groups		P-values (α = 0.05)
	Female	Joint Female	
Who Sells Crops = Interviewee	37.23%	17.65%	0.001
Who Sells Crops = Jointly	28.72%	57.35%	0.001
Who Prepares Pesticides = Your Spouse	52.13%	73.53%	0.003
Who Applies Pesticides = Your Spouse	48.94%	73.53%	0.001

Table 5. Level One Contrast Sets for Illangama (Female vs. Joint Female)

Loosing Bonferroni Inequality at α/10			
Contrast Sets (δ = 0.2)	Contrasting Groups		P-values (α = 0.05)
	Female	Joint Female	
Who Manages Crops = Interviewee	32.35%	0.00%	0.003
Who Prepares Pesticides = Interviewee	43.75%	10.34%	0.003
Who Prepares Pesticides = Your Spouse	46.88%	86.21%	0.003
Who Applies Pesticides = Interviewee	46.88%	10.34%	0.002
Who Applies Pesticides = Your Spouse	43.75%	86.21%	0.002

Table 6. Pure Gendered Marginal Effects on Six Decision-Making Questions with MNL Models, Alumbre

Variables		Male vs. Female			Male vs. Joint Male			Female vs. Joint Female			Joint Male vs. Joint Female		
		Gender=1 if Male; 0 Female			Gender=1 if Male; 0 Joint Male			Gender=1 if Female; 0 Joint Female			Gender=1 if Joint Male; 0 Joint Female		
		dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|
Who Sells Crops	The interviwee	0.2419		<0.0001	0.1529		0.05	0.1755		0.0120	0.264		< 0.0001
	Your spouse	-0.2159	0.001	0.0010	-0.0074	0.099	0.8370	-0.0062	< 0.0001	0.9230	-0.1788	0.0010	0.0070
	You and your spouse	-0.0012		0.9860	-0.1811		0.0120	-0.2715		< .0001	-0.0986		0.247
Variables		Male vs. Female			Male vs. Joint Male			Female vs. Joint Female			Joint Male vs. Joint Female		
		Gender=1 if Male; 0 Female			Gender=1 if Male; 0 Joint Male			Gender=1 if Female; 0 Joint Female			Gender=1 if Joint Male; 0 Joint Female		
		dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|
Who Manages Crops	The interviwee	0.4162		< 0.0001	0.1565		0.036	0.1159		0.0960	0.3511		< 0.0001
	Your spouse	-0.3584	< 0.0001	0.0020	-0.0688	0.112	0.1530	-0.1049	0.1200	0.1380	-0.2939	< 0.0001	< 0.0001
	You and your spouse	0.0067		0.9170	-0.0828		0.2300	-0.0771		0.2760	-0.0359		0.6150
Variables		Male vs. Female			Male vs. Joint Male			Female vs. Joint Female			Joint Male vs. Joint Female		
		Gender=1 if Male; 0 Female			Gender=1 if Male; 0 Joint Male			Gender=1 if Female; 0 Joint Female			Gender=1 if Joint Male; 0 Joint Female		
		dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|
How Much to Spend on Pesticides	The interviwee	0.3562		< 0.0001	0.1595		0.034	0.1267		0.0660	0.3185		< 0.0001
	Your spouse	-0.2567	< 0.0001	0.0010	-0.0497	0.209	0.245	-0.1342	0.0290	0.0540	-0.3062	< 0.0001	< 0.0001
	You and your spouse	-0.0024		0.9690	-0.1061		0.1440	-0.0836		0.2380	-0.0017		0.9820
Variables		Male vs. Female			Male vs. Joint Male			Female vs. Joint Female			Joint Male vs. Joint Female		
		Gender=1 if Male; 0 Female			Gender=1 if Male; 0 Joint Male			Gender=1 if Female; 0 Joint Female			Gender=1 if Joint Male; 0 Joint Female		
		dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|
Who Buys Pesticides	The interviwee	0.3987		< 0.0001	0.0949		0.201	0.1080		0.1270	0.3798		< 0.0001
	Your spouse	-0.3245	< 0.0001	< 0.0001	-0.0495	0.434	0.229	-0.0652	0.0120	0.3640	-0.2745	< 0.0001	< 0.0001
	You and your spouse	0.0326		0.5230	-0.0272		0.6800	-0.1597		0.0120	-0.1062		0.1180
Variables		Male vs. Female			Male vs. Joint Male			Female vs. Joint Female			Joint Male vs. Joint Female		
		Gender=1 if Male; 0 Female			Gender=1 if Male; 0 Joint Male			Gender=1 if Female; 0 Joint Female			Gender=1 if Joint Male; 0 Joint Female		
		dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|
Who Prepares Pesticides	The interviwee	1.0505		0.9770	0.0048		1.0000	0.0119		0.8230	0.4269		< 0.0001
	Your spouse	-2.3800	< 0.0001	0.9830	-0.2035	0.001	0.9920	-0.2390	0.0010	0.0020	-0.4618	< 0.0001	< 0.0001
	You and your spouse	0.2505		0.9870	-0.0344		0.9820	-0.0276		0.4610	0.0246		0.2470
Variables		Male vs. Female			Male vs. Joint Male			Female vs. Joint Female			Joint Male vs. Joint Female		
		Gender=1 if Male; 0 Female			Gender=1 if Male; 0 Joint Male			Gender=1 if Female; 0 Joint Female			Gender=1 if Joint Male; 0 Joint Female		
		dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|
Who Applies Pesticides	The interviwee	1.004		0.9770	0.1107		0.9960	-0.0059		0.9110	0.4258		< 0.0001
	Your spouse	-2.3764	< 0.0001	0.9830	-0.3014	0.002	0.9900	-0.2722	< 0.0001	< 0.0001	-0.4660	< 0.0001	< 0.0001
	You and your spouse	0.2418		0.9860	-0.0244		0.9910	-0.0157		0.6550	0.0238		0.2120

Table 7. Pure Gendered Marginal Effects on Six Decision-Making Questions with MNL Models, Illangama

Variables		Male vs. Female			Male vs. Joint Male			Female vs. Joint Female			Joint Male vs. Joint Female		
		Gender1=1 if Male; 0 Female			Gender1=1 if Male; 0 Joint Male			Gender2=1 if Female; 0 Joint Female			Gender2=1 if Joint Male; 0 Joint Female		
		dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|
Who Sells Crops	**The Interviewee**	0.3995		< 0.0001	0.3853		0.002	0.2381		0.0220	0.2659		0.0090
	Your spouse	-0.098	0.023	0.4920	-0.0036	0.037	0.9680	0.049	0.0310	0.5740	-0.0338	0.0440	0.6570
	You and your spouse	-0.3016		0.0680	-0.3817		0.0080	-0.2870		0.004	-0.2321		0.04
		Male vs. Female			Male vs. Joint Male			Female vs. Joint Female			Joint Male vs. Joint Female		
		Gender1=1 if Male; 0 Female			Gender1=1 if Male; 0 Joint Male			Gender2=1 if Female; 0 Joint Female			Gender2=1 if Joint Male; 0 Joint Female		
		dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|
Who Manages Crops	**The Interviewee**	1.1616		0.992	0.1481		0.364	2.0414		0.9910	2.2813		0.9940
	Your spouse	-2.3810	0.033	0.9930	–	0.379	–	-0.8174	< 0.0001	0.9910	-2.1712	< 0.0001	0.9940
	You and your spouse	1.2194		0.9940	-0.1481		0.3640	-1.2240		0.9910	-0.1099		1.0000
		Male vs. Female			Male vs. Joint Male			Female vs. Joint Female			Joint Male vs. Joint Female		
		Gender1=1 if Male; 0 Female			Gender1=1 if Male; 0 Joint Male			Gender2=1 if Female; 0 Joint Female			Gender2=1 if Joint Male; 0 Joint Female		
		dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|
How Much to Spend on Pesticides	**The Interviewee**	0.9154		0.986	0.4282		0.973	1.9300		0.9910	1.4782		0.9900
	Your spouse	-1.8280	0.022	0.9900	-0.3274	0.027	0.995	-0.5787	0.0010	0.9910	-0.3426	< 0.0001	0.9460
	You and your spouse	0.9125		0.9920	-0.1008		0.9980	-1.3514		0.9910	-1.1356		0.9920
		Male vs. Female			Male vs. Joint Male			Female vs. Joint Female			Joint Male vs. Joint Female		
		Gender1=1 if Male; 0 Female			Gender1=1 if Male; 0 Joint Male			Gender2=1 if Female; 0 Joint Female			Gender2=1 if Joint Male; 0 Joint Female		
		dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|
Who Buys Pesticides	**The Interviewee**	0.3863		0.003	0.0991		0.557	0.2964		0.0080	0.4390		< 0.0001
	Your spouse	-0.2928	0.039	0.13	0.0436	0.569	0.524	-0.2138	0.0190	0.0510	-0.4299	< 0.0001	< 0.0001
	You and your spouse	-0.0936		0.5730	-0.1427		0.3750	-0.0826		0.4610	-0.0091		0.9360
		Male vs. Female			Male vs. Joint Male			Female vs. Joint Female			Joint Male vs. Joint Female		
		Gender1=1 if Male; 0 Female			Gender1=1 if Male; 0 Joint Male			Gender2=1 if Female; 0 Joint Female			Gender2=1 if Joint Male; 0 Joint Female		
		dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|
Who Prepares Pesticides	**The Interviewee**	0.7911		0.9890	-0.3206		0.9990	0.3179		0.0010	1.0471		0.9960
	Your spouse	0.1182	0.024	0.9980	0.7089	0.062	0.9950	-0.3675	0.0040	< 0.0001	-1.3081	< 0.0001	0.9970
	You and your spouse	-0.9093		0.9940	-0.3883		0.9980	0.0496		0.4490	0.2610		0.9970
		Male vs. Female			Male vs. Joint Male			Female vs. Joint Female			Joint Male vs. Joint Female		
		Gender1=1 if Male; 0 Female			Gender1=1 if Male; 0 Joint Male			Gender2=1 if Female; 0 Joint Female			Gender2=1 if Joint Male; 0 Joint Female		
		dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|	dy/dx	LR P>chi2	P>|Z|
Who Applies Pesticides	**The Interviewee**	0.7961		0.9890	-0.3206		0.9990	0.3410		< 0.0001	1.0471		0.9960
	Your spouse	0.1152	0.036	0.9980	0.7089	0.062	0.9950	-0.3882	0.0020	< 0.0001	-1.3081	< 0.0001	0.9970
	You and your spouse	-0.9112		0.9940	-0.3883		0.9980	0.0472		0.4600	0.2610		0.9970

" – " indicates zero observation.

Table 8. Gendered Marginal Effect Differences by Type of Question and Household Characteristics, Alumbre

Variables	Variable Discriptions	P>chi2	Who Sells Crops					
			Female		Male		Joint	
			dy/dx	P > |Z|	dy/dx	P > |Z|	dy/dx	P > |Z|
Age	Age of the interviewee (years)	0.009	0.0006	0.6990	0.0058	0.0010	-0.0055	0.0040
Edu	Years of education (years)	0.021	0.0047	0.4110	0.0080	0.2750	-0.0199	0.0100
Distance	Meters from house to road	0.028	0.0000	0.4230	0.0000	0.0110	0.0000	0.2620
ImpRec3	1 = Very important: recommendation from extension	0.016	-0.0762	0.0820	0.0595	0.2780	0.0838	0.1330
ACurva1	1 = Applies contour practicing	0.029	-1.8300	0.9930	1.3579	0.9890	1.1062	0.9910
FWorker	Number of female workers in farm	0.462						
HaProd	Hectares of land available for production	0.424						
HaOwn	Hectares of land own	0.297						
NotAware3	1 = Very important: informed of IPM practices	0.461						
ImpSale2	1 = somewhat important: recommendation by pest dealers	0.731	Statistically Insignificant at 5% by Likelihood Ratio Test					
Krotation	1 = Knows crop rotation	0.730						
Arotation	1 = Applies crop rotation	0.863						
Irrigation	1=Household has access to an irrigation system	0.078						
Kcurva	1= Knows contour practicing	0.210						

Variables	Variable Discriptions	P>chi2	Who Manages Crops					
			Female		Male		Joint	
			dy/dx	P > |Z|	dy/dx	P > |Z|	dy/dx	P > |Z|
HaOwn	Hectares of land own	0.041	-0.0255	0.0180	0.0234	0.0630	-0.0067	0.5560
Age	Age of the interviewee (years)	0.232						
Edu	Years of education (years)	0.618						
Distance	Meters from house to road	0.194						
FWorker	Number of female workers in farm	0.312						
HaProd	Hectares of land available for production	0.421						
ImpRec3	1 = Very important: recommendation from extension	0.256						
NotAware3	1 = Very important: informed of IPM practices	0.141	Statistically Insignificant at 5% by Likelihood Ratio Test					
ImpSale2	1 = somewhat important: recommendation by pest dealers	0.443						
KRotation1	1 = Knows crop rotation	0.242						
ARotation1	1 = Applies crop rotation	0.308						
Irrigation1	1=Household has access to an irrigation system	0.222						
KCurva1	1= Knows contour practicing	0.669						
ACurva1	1 = Applies contour practicing	0.130						

Variables	Variable Discriptions	P>chi2	How Much to Spend on Pesticides					
			Female		Male		Joint	
			dy/dx	P > |Z|	dy/dx	P > |Z|	dy/dx	P > |Z|
FWorker	Number of female workers in farm	0.040	-0.0048	0.8200	-0.0310	0.1510	0.0011	0.9590
HaProd	Hectares of land available for production	0.041	-0.0098	0.4480	0.0236	0.0440	0.0102	0.3510
ImpRec3	1 = Very important: recommendation from extension	0.001	-0.0709	0.0910	0.2154	< 0.0001	-0.0970	0.0640
Age	Age of the interviewee (years)	0.118						
Edu	Years of education (years)	0.819						
Distance	Meters from house to road	0.133						
HaOwn	Hectares of land own	0.881						
NotAware3	1 = Very important: informed of IPM practices	0.404						
ImpSale2	1 = somewhat important: recommendation by pest dealers	0.423	Statistically Insignificant at 5% by Likelihood Ratio Test					
KRotation1	1 = Knows crop rotation	0.794						
ARotation1	1 = Applies crop rotation	0.895						
Irrigation1	1=Household has access to an irrigation system	0.789						
KCurva1	1= Knows contour practicing	0.946						
ACurva1	1 = Applies contour practicing	0.549						

Table 8. Continued:

Variables	Variable Discriptions	P>chi2	Who Buys Pesticides					
			Female		Male		Joint	
			dy/dx	P > |Z|	dy/dx	P > |Z|	dy/dx	P > |Z|
Age	Age of the interviewee (years)	0.009	0.00060	0.69900	0.00580	0.00100	-0.00550	0.00400
Edu	Years of education (years)	0.021	0.00470	0.41100	0.00800	0.27500	-0.01990	0.01000
Distance	Meters from house to road	0.028	0.00001	0.42300	0.00003	0.01100	-0.00002	0.26200
ImpRec3	1 = Very important: recommendation from extension	0.016	-0.07620	0.08200	0.00003	0.01100	-0.00002	0.26200
ACurva1	1 = Applies contour practicing	0.029	-1.83000	0.99300	1.35790	0.98900	1.10620	0.99100
FWorker	Number of female workers in farm	0.462						
HaProd	Hectares of land available for production	0.424						
HaOwn	Hectares of land own	0.297						
NotAware3	1 = Very important: informed of IPM practices	0.461						
ImpSale2	1 = somewhat important: recommendation by pest dealers	0.731	Statistically Insignificant at 5% by Likelihood Ratio Test					
KRotation1	1 = Knows crop rotation	0.730						
ARotation1	1 = Applies crop rotation	0.863						
Irrigation1	1=Household has access to an irrigation system	0.078						
KCurva1	1= Knows contour practicing	0.210						

Variables	Variable Discriptions	P>chi2	Who Prepares Pesticides					
			Female		Male		Joint	
			dy/dx	P > |Z|	dy/dx	P > |Z|	dy/dx	P > |Z|
Age	Age of the interviewee (years)	0.009	0.00060	0.69900	0.00580	0.00100	-0.00550	0.00400
Edu	Years of education (years)	0.021	0.00470	0.41100	0.00800	0.27500	-0.01990	0.01000
Distance	Meters from house to road	0.028	0.00001	0.42300	0.00003	0.01100	-0.00002	0.26200
ImpRec3	1 = Very important: recommendation from extension	0.016	-0.07620	0.08200	0.05950	0.27800	0.08380	0.13300
ACurva1	1 = Applies contour practicing	0.029	-1.83000	0.99300	1.35790	0.98900	1.10620	0.99100
FWorker	Number of female workers in farm	0.462						
HaProd	Hectares of land available for production	0.424						
HaOwn	Hectares of land own	0.297						
NotAware3	1 = Very important: informed of IPM practices	0.461						
ImpSale2	1 = somewhat important: recommendation by pest dealers	0.731	Statistically Insignificant at 5% by Likelihood Ratio Test					
KRotation1	1 = Knows crop rotation	0.730						
ARotation1	1 = Applies crop rotation	0.863						
Irrigation1	1=Household has access to an irrigation system	0.078						
KCurva1	1= Knows contour practicing	0.210						

Variables	Variable Discriptions	P>chi2	Who Applies Pesticides					
			Female		Male		Joint	
			dy/dx	P > |Z|	dy/dx	P > |Z|	dy/dx	P > |Z|
Age	Age of the interviewee (years)	0.009	0.00060	0.69900	0.00580	0.00100	-0.00550	0.00400
Edu	Years of education (years)	0.021	0.00470	0.41100	0.00800	0.27500	-0.01980	0.01000
Distance	Meters from house to road	0.028	0.00001	0.42300	0.00003	0.01100	-0.00002	0.26200
ImpRec3	1 = Very important: recommendation from extension	0.016	-0.07620	0.08200	0.05950	0.27800	0.08380	0.13300
ACurva1	1 = Applies contour practicing	0.029	-1.83000	0.99300	1.35790	0.98900	1.10620	0.99100
FWorker	Number of female workers in farm	0.462						
HaProd	Hectares of land available for production	0.424						
HaOwn	Hectares of land own	0.297						
NotAware3	1 = Very important: informed of IPM practices	0.461						
ImpSale2	1 = somewhat important: recommendation by pest dealers	0.731	Statistically Insignificant at 5% by Likelihood Ratio Test					
KRotation1	1 = Knows crop rotation	0.730						
ARotation1	1 = Applies crop rotation	0.863						
Irrigation1	1=Household has access to an irrigation system	0.078						
KCurva1	1= Knows contour practicing	0.210						

Table 9. Gendered Marginal Effect Differences by Type of Question and Household Characteristics, Illangama

Variables	Variable Discriptions	P>chi2	Who Sells Crops					
			Female		Male		Joint	
			dy/dx	P > |Z|	dy/dx	P > |Z|	dy/dx	P > |Z|
Age	Age of the interviewee (years)	0.949	Statistically Insignificant at 5% by Likelihood Ratio Test					
Edu	Years of education (years)	0.854						
Distance	Meters from house to road	0.102						
FWorker	Number of female workers in farm	0.891						
HaProd	Hectares of land available for production	0.376						
HaOwn	Hectares of land own	0.986						
ImpTech3	3 = Very important: technical advices	0.348						
NotAware3	3 = Very important: informed of IPM practices	0.784						
Irrigation1	1=Household has access to an irrigation system	0.546						
ExtVisit1	1 = Visited by extension	0.299						
KCurva1	1= Knows contour practicing	0.676						
ACurva1	1 = Applies contour practicing	0.766						
ImpSale2	2 = somewhat important: recommendation by pest dealers	0.518						

Variables	Variable Discriptions	P>chi2	Who Manages Crops					
			Female		Male		Joint	
			dy/dx	P > |Z|	dy/dx	P > |Z|	dy/dx	P > |Z|
Age	Age of the interviewee (years)	0.727	Statistically Insignificant at 5% by Likelihood Ratio Test					
Edu	Years of education (years)	0.512						
Distance	Meters from house to road	0.429						
FWorker	Number of female workers in farm	0.165						
HaProd	Hectares of land available for production	0.729						
HaOwn	Hectares of land own	0.701						
ImpTech3	3 = Very important: technical advices	0.565						
NotAware3	3 = Very important: informed of IPM practices	0.594						
Irrigation1	1=Household has access to an irrigation system	0.068						
ExtVisit1	1 = Visited by extension	0.189						
KCurva1	1= Knows contour practicing	0.361						
ACurva1	1 = Applies contour practicing	0.823						
ImpSale2	2 = somewhat important: recommendation by pest dealers	0.920						

Variables	Variable Discriptions	P>chi2	How Much to Spend on Pesticides					
			Female		Male		Joint	
			dy/dx	P > |Z|	dy/dx	P > |Z|	dy/dx	P > |Z|
KCurva1	1= Knows contour practicing	0.041	-0.9605	0.9980	-2.5611	0.9960	3.5215	0.9940
Age	Age of the interviewee (years)	0.973	Statistically Insignificant at 5% by Likelihood Ratio Test					
Edu	Years of education (years)	0.861						
Distance	Meters from house to road	0.543						
FWorker	Number of female workers in farm	0.266						
HaProd	Hectares of land available for production	0.789						
HaOwn	Hectares of land own	0.990						
ImpTech3	3 = Very important: technical advices	0.956						
NotAware3	3 = Very important: informed of IPM practices	0.850						
Irrigation1	1=Household has access to an irrigation system	0.810						
ExtVisit1	1 = Visited by extension	0.862						
ACurva1	1 = Applies contour practicing	0.358						
ImpSale2	2 = somewhat important: recommendation by pest dealers	0.999						

Table 9. Continued:

Variables	Variable Discriptions	P>chi2	Who Buys Pesticides					
			Female		Male		Joint	
			dy/dx	P > |Z|	dy/dx	P > |Z|	dy/dx	P > |Z|
Age	Age of the interviewee (years)	0.570						
Edu	Years of education (years)	0.247						
Distance	Meters from house to road	0.351						
FWorker	Number of female workers in farm	0.982						
HaProd	Hectares of land available for production	0.565						
HaOwn	Hectares of land own	0.134						
ImpTech3	3 = Very important: technical advices	0.688	Statistically Insignificant at 5% by Likelihood Ratio Test					
NotAware3	3 = Very important: informed of IPM practices	0.523						
Irrigation1	1=Household has access to an irrigation system	0.616						
ExtVisit1	1 = Visited by extension	0.883						
KCurva1	1= Knows contour practicing	0.865						
ACurva1	1 = Applies contour practicing	0.327						
ImpSale2	2 = somewhat important: recommendation by pest dealers	0.189						

Variables	Variable Discriptions	P>chi2	Who Prepares Pesticides					
			Female		Male		Joint	
			dy/dx	P > |Z|	dy/dx	P > |Z|	dy/dx	P > |Z|
Age	Age of the interviewee (years)	0.454						
Edu	Years of education (years)	0.975						
Distance	Meters from house to road	0.829						
FWorker	Number of female workers in farm	0.656						
HaProd	Hectares of land available for production	0.698						
HaOwn	Hectares of land own	0.266						
ImpTech3	3 = Very important: technical advices	0.900	Statistically Insignificant at 5% by Likelihood Ratio Test					
NotAware3	3 = Very important: informed of IPM practices	1.000						
Irrigation1	1=Household has access to an irrigation system	0.360						
ExtVisit1	1 = Visited by extension	0.991						
KCurva1	1= Knows contour practicing	0.793						
ACurva1	1 = Applies contour practicing	0.968						
ImpSale2	2 = somewhat important: recommendation by pest dealers	0.365						

Variables	Variable Discriptions	P>chi2	Who Applies Pesticides					
			Female		Male		Joint	
			dy/dx	P > |Z|	dy/dx	P > |Z|	dy/dx	P > |Z|
Age	Age of the interviewee (years)	0.458						
Edu	Years of education (years)	0.995						
Distance	Meters from house to road	0.827						
FWorker	Number of female workers in farm	0.592						
HaProd	Hectares of land available for production	0.699						
HaOwn	Hectares of land own	0.146						
ImpTech3	3 = Very important: technical advices	0.918	Statistically Insignificant at 5% by Likelihood Ratio Test					
NotAware3	3 = Very important: informed of IPM practices	1.000						
Irrigation1	1=Household has access to an irrigation system	0.417						
ExtVisit1	1 = Visited by extension	0.959						
KCurva1	1= Knows contour practicing	0.727						
ACurva1	1 = Applies contour practicing	0.993						
ImpSale2	2 = somewhat important: recommendation by pest dealers	0.410						

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