# Valuing the Environmental Benefits from GM Products Using an Experimental Procedure: Lessons from the United States and the Philippines

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**Thesis submitted to the faculty of Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of**

**Master of Science**
**In**
**Agricultural and Applied Economics**

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**December 15, 2006**

**Blacksburg, Virginia**

**Keywords**
**Experimental Economics, Economic Impact Assessment, Philippines, Biotechnology, Environmental Benefits**

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**Abstract**

This thesis develops an experimental procedure to value the environmental benefits from two pre-production genetically modified (GM) products, MVR tomatoes and Bt eggplant. The procedure explicitly tells subjects the GM nature of the products, and frames the value as an actual donation to the scientific organization pursuing the product research. The procedure is tested in the United States and the Philippines. The tests suggest that United States students give significantly different values than Filipino farmers with Filipino farmers valuing the environmental benefits much higher than United States students. The tests also suggest that slight changes in procedures can significantly affect values. Subjects use information learned during the experiment to form their valuations. For example, Filipino farmers significantly increase their values as the procedure progresses.

# Acknowledgements

Filipino hospitality will never cease to amaze me. I will never forget the kindness that was showered upon me during my research there. I would like to thank the staff at IRRI, PhilRice and ISAAA for making my visit pleasant and aiding my research. In particular, I thank Dr. Irene Tanzo, Dr. Hermie Rapusas, Dr. Desiree Hautea, Mrs. Cuyno, Dr. Dong Arida, Dr. Jose Yorobe, Dr. Serge Francisco, Sonny Domingo, Panfilo De Guzman, and Dr. Randy Hautea for their unrelenting dedication to the development of the Philippines. Another thanks goes to Daisy Mongado for translating and her help throughout the research process.. I also thank the Filipino students who participated in my experiment, and the Filipino farmers who taught me more than I could ever imagine or learn in a classroom. I also thank the drivers at PhilRice who made my trips safe and PhilRice's socio-economic team for a wonderful trip to Corregidor Island.

My appreciation is also extended to the Virginia Tech and Bridgewater students who participated in this research. I thank Dr. Dixie Reaves for granting me access to her marketing class and Virginia Tech's Ag-Econ club. She provides a daily example of what college education should be like. I thank coaches Shane Stevens and Lori Schrock for granting me access Bridgewater College's track and field team. I will never forget the lessons learned at Jopson Field.

The AAEC faculty and staff has also been great to work with. Their dedication to students and research cannot be matched. I thank Dr. Jaren Pope and Dr. Nick Kuminoff for being late additions to this thesis. Their suggestions and energy made this thesis much better. I also thank Dr. Dan Taylor, Dr. George Norton, Dr. Jeff Alwang, Dr. Brad Mills, Dr. Kurt Stephenson, Dr. Leonard Shabman, Dr. Sheryl Ball, Dr. Darrell Bosch, Dr. Tia Hilmer, and Dr. Aris Spanos for teaching stimulating classes. Randy Flinchum, Marilyn Echols, Sharon Cox, Jill Albert and the rest of the AAEC staff has also helped me tremendously.

A special thanks goes to Dr. George Norton for his patience, mentorship, and example. I cannot thank him enough.

I thank USAID's Agricultural Biotechnology Support Project II (Leader Award Number GDG-a-00-02-00017-00) for their financial support.

I thank my colleagues and friends who have helped me during this thesis. The conversations and support that I received from Monica Licher, Sonia Aziz, Debi Marsh, Melanie Victoria, Jackie Bonabana, Jie Luo, Xiang Xue, Yan Liang, Daisy Mongado, Vanessa Victoria, Alexandra Andino, Jennifer Ames, Jessica Bayer, Ewa Kleczyk, Sibel Atasoy, Eftila Tanellari, Aaron Blacka Doyle, Emily Blevins, Guy Hareau, Sibusiso Moyo, Jake Ricker-Gilbert, Russell Knight, Matt Wright, Steve Buck, Nic Louisos, Richard Yao, Bledar Kodra, David Jennings, Atanu Rakshit, Owen Wagner, Zelalem Chala, Elton Mykerezi, Darin Young, Josh Edwards, Brian Whitacre, Greg Halich, Eric Sarver, Bill Xue, Stephen Aultman, Genti Kostandini, Wei Chen, and Scott Reed will never be forgotten.

Finally, I thank my family for their unconditional love and support.

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# Chapter 1: Introduction

## I.1 Introduction to the Research

Scientists in the Philippines are currently developing two genetically modified (GM) products, multiple virus resistant (MVR) tomatoes and eggplant fruit and shoot borer (EFSB) resistant eggplant (Bt eggplant).[1] These products could increase farmers' income and decrease environmental pressures. Before these products are made publicly available, they must be approved by these countries' regulatory agencies. This study is part of an impact assessment that will help regulators decide if MVR tomato and Bt eggplant should be approved for widespread use.

The specific contribution of this study is to develop a technique to quantify the value individuals place on potential environmental benefits generated by the MVR tomato and Bt eggplant. Some of these products' potential benefits could be missed if environmental improvements are not assessed. Growing population pressures have increased the need for greater quantities of consistent food and agricultural income sources. These increased needs could lead to greater environmental pressures previously associated with increased agricultural production. MVR tomato and Bt eggplant have the potential to increase food production and farmers' income while decreasing environmental damage from inputs such as pesticides. Combining MVR tomato and Bt eggplant's potential environmental benefit with other potential impacts will help regulators to make informed decisions about the products' future.

[1] Genetic modification and biotechnology will be used interchangeably in this study. The definition provided by the Encarta encyclopedia for biotechnology is "the manipulation of biological organisms to make products beneficial to human beings." With this broad definition, genetic modification is really a subset of biotechnology as it involves specifically manipulating genes (DNA) in a laboratory setting to create products for humans.

## I.2 Research Difficulties

Accounting for MVR tomato and Bt eggplant's environmental value is difficult because of the controversy surrounding GM products (Rousu, et al., 2003) and (Rousu, et al., 2003). Previous studies on GM products already in production show that they will decrease environmental pressures, but the debate centers around the longevity and extent of these benefits (Huang, et al., 2002), (Trigo and Cap, 2003), and (Schutte, 2003). Some individuals have formed strong negative opinions about GM crops (Rousu et al. 2003). These preferences make the valuation process more difficult, because generic valuations of environmental benefits cannot be used in studying GM products. An individual could value the potential environmental benefits from reduced pesticide use, but not value these benefits if the reduction comes through the use of GM products. Some people feel that the unfavorable risks of GM are too significant no matter what the extent of the benefits. Wallace Huffman (2003) compares the situation to nuclear power plants; people desire fewer carbon dioxide emissions, but not necessarily from nuclear generators. This study does not evaluate the correctness of these opinions about biotechnology, but any technique that values GM's environmental benefits must consider the repercussions of this situation. A benefit estimate that ignores the divergent views surrounding GM, could distort the true preferences of society concerning biotechnology.

This problem is confounded because many individuals have little or no information concerning GM products. Some people have no experience with GM technologies while others consider themselves well informed. These information asymmetries place a burden on the researcher to develop a valuation technique that explains GM in a manner that allows uninformed individuals to have a basic level of knowledge before forming their value.

Another difficulty in measuring the value individuals place on environmental benefits

involves there being no markets to generate valuations of positive changes in environmental states.[2] Individuals are unable to demonstrate their preferences by purchasing environmental improvements. To obtain the value individuals place on environmental benefits, economists ask them to hypothetically state their preferences. Instead of individuals revealing their values in a non-hypothetical marketplace by making purchases, economists select a sample of individuals from the population (subjects) and extrapolate from subjects' actions or answers the value they place on a specific environmental benefit. Economists question stated preference techniques because they generate practical and theoretical difficulties. These difficulties have been examined by numerous economists, and many recommendations have been made. The recommendations emphasize that subjects need to feel confident about the values they state in the hypothetical situation.

### I.3 Three Stated Preference Techniques

Three stated preference techniques are present in the literature. All three calculate their benefit estimates in a willingness-to-pay (WTP) measure. WTP represents the amount of money a person or group would spend to change from their present state to the proposed state. In this study, the proposed state is one where MVR tomatoes and Bt eggplant are produced.

The oldest stated preference technique is the contingent valuation method (CVM). This technique consists of a survey asking subjects their WTP for a proposed environmental improvement. From this question, an estimated WTP is aggregated across the population and reported as the benefit measure. CVM has been adjusted over the years, but it is still questioned

[2] There is a vast literature concerning revealed preferences in which researchers extrapolate people's values for environmental benefits from their actions. See Champ, P. A., K. J. Boyle, and T. C. e. Brown. *A primer on nonmarket valuation*. Economics of Non-market Goods and Resources, vol. 3. Dordrecht; Boston and London: Kluwer Academic, 2003. More specifically see Boyle's chapter "*Introduction to Revealed Preference*".

by economists because of its potential biases (Balistreri and et al., 2001).

An alternative designed to improve upon CVM is the choice experiment (CE). A CE consists of giving subjects the choice between multiple sets of the proposed environmental state's attribute levels with one attribute being an amount to be paid (Hanley, et al., 1998). The subject is then asked to choose the set of attribute levels they prefer. This procedure is repeated numerous times with different attribute levels for each subject, and WTP is calculated from these choices and presented as the benefit estimate. Supporters of CE accuse CVM of oversimplifying the problem and not allowing subjects to conceptualize their decisions (Ryan and Wordsworth, 2000).

Experimental economists criticize both CVM and CE because of their hypothetical nature. Their suggestion is to use an experimental auction (EA) where subjects place values on environmental improvements in a contrived setting, but are obligated to pay these values (Brookshire and Coursey, 1987). This enforcement removes the hypothetical nature from the technique. The controlled setting also allows the researcher to prevent some unobservable factors from affecting values that are difficult to control for in CVM or CE.

All three methods have distinct qualities and resource requirements. Also, all three raise questions that the researcher needs to consider before a final technique is chosen.

**I.4 Objectives**

This thesis's objective is to develop and evaluate an easily replicable and inexpensive stated preference technique that elicits individuals' values for MVR tomato and Bt eggplant's potential environmental benefits. Currently, tomatoes require intense pesticide applications to prevent viral infections. These applications damage the environment and put human health at

risk. MVR tomatoes would reduce pesticide applications and increase environmental quality. Similarly, EFSB infestations cause significant yield losses to eggplant farmers, and currently, the primary way to control for EFSB is through frequent pesticide spraying. Bt eggplant would reduce pesticide applications leading to environmental benefits. The general objective for this project concerns designing the evaluation technique for Bt eggplant and MVR tomatoes. Future studies will use the designed technique to formulate specific WTP values for Bt eggplant and MVR tomatoes as well as other products currently in development.[3]

### I.4.1 Specific objectives

1. To create a technique for eliciting the value that individuals place on a potential GM product's environmental benefits

2. To test the technique using MVR tomato and Bt eggplant technology's potential environmental benefits

## I.5 Organization for the Rest of Thesis

Creating a technique involves four steps. The first step requires consulting previous literature. A full review of the literature concerning environmental benefit valuation is beyond the scope of this thesis, but a brief discussion of previous work is found in Chapter 2. The second step involves choosing a technique. The chosen technique and its rationale is documented in chapter 3. During the third step, the researcher tests the chosen technique. The fourth chapter details these tests, and describes the lessons learned. The final step of incorporating the lessons learned from the tests to create and apply a final instrument used to generate a specific valuation is not undertaken, but suggestions for the final instrument and

[3] Other products like Bt corn have already been approved by Filipino regulatory agencies. This research concerns itself only with MVR tomatoes and Bt eggplant which have not been approved yet.

conclusions are offered in the fifth chapter.

# Chapter 2: Literature Review

## II.1 Introduction

This chapter briefly reviews previous literature on environmental benefit valuation. This review aids in developing a technique to elicit the values individuals place on the environmental benefits related to MVR tomato and Bt eggplant. Because benefit valuation has used a large variety of techniques, this review is not intended to be an exhaustive critique of previous literature, but the goal is to synthesize previous literature in order to make recommendations for the elicitation technique described in the next chapter.

## II.2 Framing Issues

Economists typically evaluate situations ex post, after the event being studied occurs, and from this evaluation, they make predictions for the future. Decisions have already been made, and nothing is hypothetical. Stated preference studies do not have this ex post luxury, because researchers and policy makers are interested in ex ante valuations before the proposal is enacted. Researchers must generate their own data through experimental techniques, but unlike natural sciences, subjects in these experiments are humans. The researcher cannot be certain that experimental results will carry directly into the real world. This ex ante nature of the problem combined with the general unpredictably of humans is the researcher's major concern, and all stated preference studies must take steps to deal with the difficulties introduced by the hypothetical nature of their problem.

The primary concern of economists using a stated preference technique is that an examined individual might relay values to the researcher, but then value the proposed state

differently when it comes to fruition. Experimental economists use the term parallelism in discussing the relationship between experimental results and the 'real world' (Friedman and Sunder, 1994). They recognize that the laboratory or survey cannot perfectly mirror reality, but it should offer external validity where results are related to real world occurrences (Friedman and Sunder, 1994). Practitioners of CVM have made design changes to make their studies more parallel with real decisions, while CE and EA were created in response to the lack of external validity generated by CVM. The term for these design issues is framing which represents how the elicitation mechanism is presented to the subject. Correct framing is imperative if externally valid results are to be obtained from a stated preference study (Rolfe, et al., 2002).

One of the first framing criticisms of traditional CVM is that it gives the respondent no value reference. Marketplaces post prices and allow information to flow between the buyer and the seller. This process generates information that subjects use to formulate values. Early CVM studies used an open-ended payment question that gave participants no suggestions of any values (Bateman and et al., 2002). CVM's common improvement is to use a dichotomous choice question which gives the consumer a price for the proposed benefits that the potential consumer can either accept or reject (Bateman and et al., 2002) . This process is continued (dependent on the subject's response) until the subject rejects a price. CE essentially uses this method to observe WTP also, but in a CE other attributes concerning the proposed state are also varied, while in CVM the price is the only attribute that varies. Dichotomous choice mechanisms and other techniques that give subjects bid references face criticisms. First of all, biases can be introduced if the suggested prices are unreasonable. One could choose a starting price that is so high that it eliminates many bidders that do prefer the proposed state at lower prices. Also, some compliance bias or 'yea saying' could enter the study if people felt obligated to accept at least

some offer (Bateman et. al. 2002). EA typically do not give the subject any pre-bid reference like the open-ended payment question, but many EA involve multiple rounds where participants see other subjects' bids. Economists who support EA contend that this feedback is enough reference and mirrors market institutions. The researcher must thoughtfully choose the value reference given to subjects to avoid biasing results.

Another framing issue concerning stated preference studies is the amount and nature of the information about the proposal given to the subject. The answer to this question must be decided independently for each particular study. If the proposal is not controversial, then CVM studies do not relay specifics of the proposal. For example, two CVM studies examining the environmental benefits of integrated pest management (IPM) calculate WTP without emphasizing IPM to respondents (Mullen, et al., 1997) and (Cuyno, et al., 2001). When the proposal being studied is more controversial or novel, more information about the proposal is needed. For example, Lusk (2003) uses CVM to study the WTP for health benefits from GM vitamin A enriched (golden) rice and uses two information treatments, an advertisement prepared by the Council for Biotechnology Information and a neutral paragraph prepared by Lusk that emphasized the political review processes that GM products must go through. Lusk reports there was no statistical difference in WTP between these two types of information treatments. CE gives more information than most CVM studies because it examines attributes other than price, but the communication between the researcher and subject still must make subjects feel comfortable with their decisions. A well researched area concerning biotechnology is the effect that different types of information has on EA values (Huffman, et al., 2003). One of these studies examines the effect of different labels conveying the probability of containing GM products on WTP for subjects. Another study by Lusk et al. (2004) considers the effect of

different information packets describing health, environmental, or developing country benefits from GM on values. Rousu, Huffman et al. (2003) examine which information providers have the greatest effect on WTP. The common conclusions of these studies suggest that the type of information and the sequencing of this information do matter in eliciting WTP values. Huffman (2003) determines that negative GM information from environmental groups decreases WTP by a larger amount than GM companies' positive information increases WTP. Huffman (2003) also reports that third party reports tend to moderate bids away from extremes but the public is split on who should provide this information. For this research, the type of information given to subjects is important because some are not informed about GM, while other subjects consider themselves informed but might be misinformed. Unfortunately, previous literature does not provide a definite answer to what information is needed, but it provides numerous suggestions.

How and where the instrument is administered raises more framing questions. CVM and CE are formatted as mail, telephone, or in-person surveys (Bateman and et al., 2002). EA usually uses a laboratory to generate results, but some experiments have been conducted in the field where subjects are inexpensively identifiable (Lusk, et al., 2001). EA requires subjects to meet the researcher instead of the researcher finding the subjects like in CVM and CE. This situation can make it more difficult to find a random sample. All of these administration techniques have different costs and lead to different results. Subjects submit different values depending on the format, and therefore, each format has its own biases (Bateman and et al., 2002). These biases can be mitigated, but they cannot be eliminated. If a proposed situation can be construed as complicated, it is best to have someone (a facilitator) the respondent can contact while eliciting his or her value (Bateman and et al., 2002). A difficulty with human surveyors or auctioneers is that unless the same person is used for every subject, experimental control can be

lost and values can become dependent on the particular surveyor or auctioneer (Friedman and Sunder, 1994) . Mail surveys are less likely to be returned and non-responses cause problems for the researcher's interpretation of results. Whittington et al. (1992) discusses the importance of giving subjects time to make their decisions. Their developing country example concludes that allowing longer response times changes WTP. Choosing the best format comes from balancing cost considerations with specifics of the study. Again the literature does not provide a best format, but highlights the trade-offs between different formats.

The final difficulty to be discussed is the payment vehicle. Environmental improvements can be financed in different ways. Taxes, fees, donations, or increases in overall living expenses could finance any specific proposal. CVM and CE usually choose one of these payment vehicles to elicit the bid from the subject. This mechanism makes the situation more realistic to subjects. Some studies do use vague payment vehicles, but this technique is not common and only recommended in limited circumstances (Bateman et al. 2002). The payment vehicle chosen does affect results as exemplified by Mullen et al. (1997), where an income tax payment vehicle yielded unusable results but an increase in subject's grocery bills generated significant results. American studies have usually shown a greater tendency for subjects to be tax averse, while the tax vehicle is more common in European studies. Since actual payment is required in an EA, the payment vehicle is not as important. The subject is revealing his or her WTP through paying for the environmental benefits by actually donating to a charity or purchasing a good that encompasses the environmental benefits (Brookshire and Coursey, 1987) and (Boyce, et al., 1992). It is important to consider how in actuality the proposal is going to be financed, because using this payment vehicle leads to fewer concerns about parallelism.

### II.2.1 Conclusions about Framing

To determine if external validity exists in a technique, actual payments must be observed. Unfortunately, projects yielding environmental benefits are usually financed by governments and paid for by taxes. These projects never enter a market, and actual payments by individuals are never observed. This difficulty creates the need for stated preference studies, but it also makes assessing a study's parallelism impossible.

Some researchers recommend using an EA as the comparative non-hypothetical measure (Lusk, 2003) and (Carlsson and Martinsson, 2001). This method assumes that the EA is exactly parallel to the real world conditions that surround the proposal. This assumption is far-reaching when one considers the contrived nature of an EA, especially when the proposal is abstract to subjects like with environmental benefits (Harrison, 1996). Actions in a laboratory do not necessarily carry over into the real world. EAs are less hypothetical than CVM and CE, but it would be an overstatement to conclude that EA are free of all bias. No stated preference study is going to perfectly reflect preferences, but careful attention needs to be paid to framing to make the study externally valid. The previous issues are just a few of the framing decisions that must be made during this study.

## II.3 Conclusions on Previous Literature

When a researcher implements a stated preference technique, the goal is for subjects to have the relevant information needed to make an informed decision. To determine the nature and extent of this information, a researcher must do pre-testing on potential subjects. Pre-implementation testing is emphasized in previous literature. A common recommendation is to use focus groups before designing the technique to elicit opinions and ideas that are pertinent to

the study (Davies and Laing, 2002). Due to the varying opinions and information levels surrounding GM, a wide array of testing must be done in this study. This pre-implementation work will be the major contribution of this study.

It would be difficult to conduct a traditional CVM study given the specific problem of this study. Subjects need to realize that the environmental benefits they are valuing come from GM crops. They also need information about biotechnology and the specific product because of their relatively novel nature. Since this study is not concerned with the effects of different kinds of information, a statement similar to Lusk's (2003) where he emphasized that GM products must be approved by regulatory agencies will suffice. CVM, CE, and EA have their own advantages and disadvantages, but EA is preferred because subjects make non-hypothetical decisions while being directly observed by the researcher. The greatest difficulty in creating an EA is creating a composite good that encompasses the environmental benefits associated with GM, but at the same time is concrete enough for subjects to understand. Previous studies have centered on consumer goods and focused on agribusiness decisions rather than environmental benefits. These studies find a negative WTP for GM consumer products not adding specific health benefits (Huffman, et al., 2003), (Lusk and et al., 2004), and (Burton and Pearse, 2002). This study's solution emphasizes the environmental benefits from a potential product currently being researched and requiring subjects to donate their values to the organization pursuing this research. By framing the elicitation procedure around the environmental benefits from a GM product instead of the product itself, this study is unique.

The main conclusion drawn from the literature is that there is no perfect valuation technique. For example, Shabman and Stephenson (1996) found that three different valuation techniques generated three significantly different results concerning the benefits from flood

prevention. A researcher would be foolish to think that his or her technique did not suffer from some bias. The lack of a perfect technique does not diminish this study's importance or relieve the researcher from considering potential biases, but allows the researcher to recognize that trade-offs will be made in the creation of the technique. It also obligates the researcher to recognize these trade-offs when reporting his results. The common theme in the stated preference literature is that estimated WTP is dependent on the technique used.

### II.4 What Next?

Since this study is concerned with designing a technique, justifying and pre-testing its framing is the study's major contribution. The framing mechanism and justification will be presented in the next chapter. The results of pre-testing will reported in the fourth chapter. The literature provides the questions for these next chapters, but it does not give any clear answers.

# Chapter 3: The Instrument

## III.1 Introduction

This chapter explains the EA technique created by this study. Before the specific technique is explained, the major framing difficulties facing the technique are discussed. It is also necessary to discuss the difference between experimental economics and marketing studies as these differences relate to this study's EA technique. After this discussion, a basic outline of the technique is explained, and finally, a description of what was done for this study concludes the chapter.

## III.2 Framing Difficulties

The major difficulty facing this study is uncertainty. MVR tomatoes and Bt eggplant's long-term effects are not known. The exact environmental benefits cannot be realized until the technology enters widespread production. Since MVR tomatoes and Bt eggplant have not been released, the stated preference technique cannot fully describe the environmental benefits. The proposed state can be estimated, but it is not certain. Previous studies have addressed ex ante environmental benefits, but most times they quantified risk levels and converted subjects' generic valuations after the survey was administered (Cuyno, et al., 2001) and (Mullen, et al., 1997). Subjects could never identify any uncertainty, because they were given specific questions with uncertainty being implicitly analyzed by the researcher. For example, in studies concerning IPM, a subject would be asked how much they would be willing to pay for a decrease from a high risk pesticide to a low risk pesticide. The subject is given verbal definitions of what the movement from one level to the next means, but not how this change actually comes about in

nature. The researcher then combines other studies conducted by natural scientists on the proposed state's specific environmental benefits with subjects' answers to calculate WTP.

In this study, subjects must know how the change comes about in nature. Individual opinions on GM products vary; different individuals place different values on potential benefits from GM products. Even though scientific consensus must determine that the technology's risks are minimal before it is put into production, some individuals may deem the GM technology to be of no or very little value. Therefore they may not value the technology's potential environmental benefits. This research does not pass judgment on the worthiness of these different valuations, but the instrument must alert bidders they are valuing environmental benefits from biotechnology products.

The combination of different opinions about biotechnology and the specific products not being released yet makes it impossible to know exactly what will happen when MVR tomatoes and Bt eggplant are approved. By using an EA, subjects are informed of the uncertainty and they generate their bid accordingly. The burden of addressing uncertainty is given to the subjects instead of the researcher. Subjects formulate their own values based on their own knowledge.

This situation does not relieve the researcher from providing product information and a description of the products' potential environmental benefits. Information describing the product and its potential effects must be given to ensure subjects understand what they are valuing. By using an EA, the amount and type of information can be controlled by the researcher. EA also allow the researcher to vary information treatments and determine the effect different treatments have on valuation (Lusk and et al., 2004). With CVM, the only variables that can be controlled for are demographics collected by the researcher, but with an EA, the researcher can explicitly control for other variables also.

The instrument also allows subjects to use personal information that cannot be easily identified by researchers. If a subject feels strongly that the potential hazards of GM outweigh any potential environmental benefits or has tremendous faith in GM, he can account for this belief in his value. In previous studies where subjects could not identify how the environmental benefits were generated, this information could not be used in their valuation.

Subjects can also account for others bids. They can implicitly use other subjects' information to formulate their subsequent values. This better mirrors the real world where decisions cannot always be kept secret. This public nature of the valuation process separates the technique from CVM and CE where individuals make private choices without any feedback from peers.

This type of valuation procedure is different from previously conducted environmental benefit valuations. Some previous studies, especially CVMs, have focused on valuating the environmental benefit itself without discussing what creates the environmental benefit or the uncertain nature of environmental benefits. The approach used in this study, building on CE and EA literature, attempts to give subjects a more complete view of what in actuality they are valuing. It admits that benefits are created by biotechnology, and that these benefits are not certain. No instrument can give complete information, but this technique helps subjects conceptualize the complexities of the situation.

### III.2.1 Conclusion on Framing

Valuing environmental benefits from MVR tomatoes and Bt eggplant is a complicated matter. The situation itself is surrounded by many uncertainties. The researcher does not know the extent of the benefits. The only way to be certain of these benefits is to have a widespread proliferation of the technology. In other words, one can only be certain ex post, but values are

needed ex ante to make sure worthy technologies are approved and explored while unworthy technologies are disregarded. The instrument designed allows for subjects to make their own assumptions about uncertainties and place the value on the benefits they deem appropriate.

### III.3 Traditional Experimental Economics Versus Marketing Studies

Using an EA for environmental benefit valuation blends two distinct areas of economic research. Marketers use EA to generate valuations for specific products. The goal of their studies is to produce quantitative WTP information. Their research question concerns the potential profitability of the product. This goal is contrasted to traditional economic experiments designed to test economic theories or behavioral hypotheses. Subjects play contrived economic games or are put in specific economic situations, and their actions support or refute economic hypotheses. The goal is not to produce quantitative information, but to test the validity of economic theories and examine behavior.

Environmental benefit valuations are applied studies. The goal is not to test economic theories but generate information for policy makers. They have aspects of a marketing study, but are not concerned with specific private goods but public goods like environmental benefits which are sometimes hard for subjects to conceptualize. Experimental economics has focused on how different institutions affect public good valuation. Their experiments examine textbook economic issues like free-riding in a controlled setting. For example, a provision point institution where contributors get there money back if a certain contribution level is not met can be compared to an institution where contributors do not get their money back (Holt, 2004). Here contributors are given fixed preferences by the researcher. The important issue is how the provision point mechanism affects contributions, not the individuals' preference for the public

good. Environmental benefit valuations are mainly concerned with generating WTP estimates, but researchers can also be interested in how institutional changes affect WTP.

This study combines the prominent features of marketing and traditional experimental economics research. It recognizes the main goal is to generate quantitative information for policy makers, but it also examines how different treatments suggested by economics affect values. It has similarities to the studies completed by Lusk where experimental auctions generate both quantitative WTP information and theoretical information about how different treatments affect WTP (Lusk, 2003), (Lusk and et al., 2004). In another example, researchers sent surveys soliciting donations for a university capital campaign (List and Lucking-Reiley, 2002). They used one treatment where a contributor's gifts would be fully refunded if a specified amount of money was not collected and another where the contributor's gift would not be refunded. They also varied the amount of "seed money" (money already donated) that was reported to potential contributors. Using this method, they were able to produce information concerning people's willingness to contribute to the university and comment on the effects different treatment methods had on WTP. These treatments provide information not only about WTP but how different mechanisms affect WTP. The instrument designed in this study leads to quantitative estimates, but also allows the researcher to examine the effects that different treatments have on these quantitative estimates.

Experimental techniques allow the researcher to examine many different questions. The objectives of the research must reduce the questions to a manageable quantity. The testing done for this experiment highlights a few examples of how different treatments can be used to examine a few questions about different possible effects on WTP. It does not provide an exhaustive list, but it does provide examples that could be pursued in more detail through later

research.

### III.4 The Technique

The following describes the basic experimental auction procedure. The next section will describe slight variations used in the different tests conducted by the researcher.

#### 1. Assignment of Subject Numbers

The first step in the technique is to assign subjects unique numbers and give them value sheets labeled with their numbers. Subjects will write their values on these sheets. The value sheets combined with a subject number allows an anonymous connection between subject's values and their demographic information collected in the next step.

#### 2. Collecting Demographic Information

In this step, the researcher records demographic characteristics from subjects. Some important characteristics include age, gender, and income. The exact characteristics will depend on what the researcher deems important and the group being studied by the researcher. For example, different characteristics should be collected from those involved in the agriculture industry than from consumers. This demographic information must be labeled by subject numbers to ensure connection with the subject's values collected later in the process. This step can also be conducted after the experiment is completed.

#### 3. Description of the Product

In this step, the researcher describes the product being valued. For this research, the GM nature of the product and that the product is still in the development phase are the important characteristics that must be described.

The exact mechanism used for description depends on the resources available and where

the experiment is located. An information packet can be distributed if the subjects are literate. In this case the facilitator must allow subjects enough time to thoroughly read the packet. The facilitator should also verbally reemphasize the products important characteristics. If packets are impossible, visual aides can be used to describe the product. A video or posters could be used in conjunction with a facilitator to relay information to subjects if the required technologies are available.

**4. Subjects Given an Endowment**

At this stage, subjects are given an endowment for participating in the experiment. The endowment does not have to be physically given to the subject at this time. Subjects can be told they have an endowment that they will receive after the experiment. The subject should be aware the endowment is solely for participating in the experiment.

**5. The Valuation Process**

During this stage, subjects should understand how their submitted values are going to be enforced. It should also be emphasized that the submitted values are only for the environmental benefits induced by the product.

The facilitator should describe the auction process being used. The goal of this stage is for subjects to understand the process. Subjects need to know how the values they submit will be enforced and exactly what they are valuing. Since subjects submit multiple values they must understand these values are not cumulative, and each value represents the amount they are willing-to-pay for the benefits on a one time basis.

**6. Subjects Submit Values**

After everyone understands the valuation process, subjects submit values, and the facilitator relays the group's value information back to subjects. For example, all values could be

read aloud and posted or descriptive statistics on the values could be shared with the subjects. This submission process repeats for a number of rounds that the researcher has predetermined, and the facilitator does not have to tell the subjects how many rounds will be completed.

**7. Enforcement**

After the researcher completes the predetermined number of rounds, the actual values must be enforced. Since the environmental benefits cannot be paid for directly, some composite good must be created so the subjects have to actually pay one of their values. In this case, a donation to the organization pursuing GM research was chosen as the appropriate composite good. Depending on time and financial constraints the number of enforced values can differ.

**8. Exit Survey**

After the experiment ends, the researcher should conduct some type of exit interview with subjects. This can be done in an open forum or by a written survey. The goal of these exit processes is to see how well subjects understood what was going on in the experiment. It is also an opportunity to get suggestions and opinions about the experiment, product, and research in general. These exit surveys can provide the researcher with important information not collected by the experiment itself.

## III.5 What Was Done In This Study

This next section states what was done in this research. (Copies of the instructions can be found in the appendices.) Tests of the technique following this basic outline were done on student groups in the United States and the Philippines and farmer groups in the Philippines. Tomatoes seemed more identifiable to American students while most farmer subjects grew eggplant in the selected Filipino region. The specific groups were all chosen because of

convenience. Future tests should try to collect random samples, but for these tests, random samples would have been more costly, and one of the goals was to design a cost-effective procedure. The United States tests will be treated separately from the Filipino tests, because the procedure differed in some respects between the two countries.

In the United States, the first group (Group 1) consisted of a forty-one person college class in agricultural marketing. The second group (Group 2) was a twenty-four member college track team. The third group (Group 3) was a seventeen member Agricultural Economics club. Group 1 and Group 3 were from a large public university, while Group 2 came from a small private liberal arts college. These groups were neither randomly selected nor representative of the student population. All three experiment settings were homogeneous. The experiments were conducted in classrooms and most external factors were the same for each group. The settings were similar to a traditional behavioral laboratory.

In the Philippines, the researcher tested the technique on a group of post-graduate college students (Filipino Students Group) preparing for an agricultural certification exam. The second Filipino group (Seminar Group) consisted of local farmers who had attended a seminar on the benefits of IPM. The third Filipino group (Cooperative Group) were participants in a farmers' cooperative meeting. The fourth Filipino group (Extension Group) were farmers meeting with extension agents at a government building. The fifth group (Meeting Group) consisted of a local meeting of farmers. All of these groups were organized by extension agents, and the primary reason for meeting was not the experiment but some other extension goal. The Filipino Students Group had around twenty subjects, while the other four groups had around fifteen people each. These experimental settings were heterogeneous. Each group's experiment was conducted in different settings, and a different set of external factors such as weather, noise, and location

could have affected values between groups. The Filipino Students Group had a similar setting to the U.S. Tests, but the other four groups were conducted as field experiments.

**1. Assignment Of Subject Numbers**

In the United States and the Philippines, subject numbers were non-repeating randomly generated numbers between 1 and 99. The numbers were randomly assigned to subjects as they entered the experiment and printed on their value sheets and demographic information. In the United States, subjects also had subject number tabs. These tabs were placed into a container and used later to select which subjects' values would be enforced. The reason for using randomly assigned numbers is to ensure subjects understand their values are anonymous to other subjects. The values are also anonymous to the facilitator until the value enforcement.

**2. Collecting Demographic Information**

Since the instrument was still in the testing stage, collecting all the relevant demographic information was not deemed cost-effective. No demographic information was collected from Group 1 or the Filipino Students Group. The main goal of these first tests were to see how the valuation instrument in each country worked.

The demographic information collected in the United States from Groups 2 and 3 consisted of a single page filled out by the subject. The single page comprised of simple questions about academic status and prowess, knowledge of GM, rural versus urban upbringing, and expenditure patterns. The subjects were also asked if they approved of biotechnology. Because four subjects participated in both Group 1 and Group 3, it was necessary to ask if the subjects were in Group 1. Since these were tests, the questions were not far-reaching and were intended to better understand the experimental process. The demographics also allowed the researcher to estimate how much time the experiment would require.

In the Philippines, facilitators had to ask and record the demographic information due to the illiteracy of some farmers. Again the demographic questionnaire was limited to a page. Since most subjects were farmers, more farm specific questions such as farm income and what crops they grew were asked. They were also asked if they approved of biotechnology. The basic demographic information of sex, age, and income were also collected.

**3. Description of the Product**

In the United States, an information packet concerning MVR tomatoes was produced. This information packet told subjects how tomatoes can currently be infected by viruses and the only way to prevent these viruses is through heavy pesticide spraying. The adverse environmental effects of heavy pesticide spraying was also explained. It went on to describe MVR tomatoes and their potential for reducing pesticide sprays on MVR tomatoes. The students were given about five minutes to read the packet. The facilitator then asked if the subjects had questions and answered any questions raised. A facilitator would then read a specific paragraph from the packet that reemphasized that the potential environmental benefits came from GM technologies. Following Lusk (2003), the facilitator also read a sentence from the packet stating that before these technologies would be available to the public they would have to be approved by regulatory agencies. The subjects were not directly told by the facilitator that MVR tomatoes would mainly benefit South and Southeast Asia, but the packet included project information that highlighted these facts.

In the Philippines, all directions were spoken by the facilitator due to some subjects' illiteracy. In these tests, an epidemiologist or an extension agent stated the potential environmental benefits from reducing pesticide usage of Bt eggplant. A video highlighting the benefits of Bt corn was also shown to subjects. The video introduced the subjects to a similar

technology and its possible benefits. Most farmers had been introduced to Bt corn because it was a heavily debated topic in the Philippines, but only one farmer had planted Bt corn. The facilitator also emphasized that the products will not be put into production until they were approved by Filipino regulatory agencies.

**4. Subjects Given an Endowment**

In the US tests, subjects were told in the packet, and the facilitator emphasized, that they were given an endowment of $15 ($10 for Group 1) solely for their participation. In the Philippines subjects were told that they had an endowment of 500 Filipino pesos (about $10). Because of translation, it was difficult for the United States researcher to determine if subjects understood that the endowment was solely for their participation.

These values should represent the opportunity costs for the subject participating in the experiment (Friedman and Sunder, 1994). The endowments used may have been high given that the tests were conducted with subjects were already at the place of the experiment. The endowments could also be varied in the future to see how different allotments affect values.

**5. The Valuation Process**

In the United States tests, the packet included written directions on the valuation process. Subjects were told their values represented the amount they would be willing to pay just for the environmental benefits from MVR tomatoes. Subjects were told that some values would be enforced and if they submitted values higher than their endowment they would have to pay the difference to the facilitator. In Group 1, subjects were arbitrarily split into two sections. This demarcation aided the flow of the experiment and limited the amount of downtime for subjects. A randomly selected number of the subjects in Groups 2 and 3 received value information from the previous experiments. These subjects knew the high, low, and average

value from the groups who had previously participated in the experiment. Subjects were also told the enforced values could be thought of as donations to the organization pursuing MVR tomato research.

In the Philippines, the facilitator read all directions on the valuation process to subjects. The facilitator had written instructions similar to what was included in the American information packet. But since the instructions had to be translated into Tagalog, the facilitator made some changes to fit the language.[4] Subjects were told their values represented the amount they would be willing to pay just for the environmental benefits from Bt eggplant. Subjects were not allowed to write a value over 500 pesos. The researcher did not want to make Filipino farmers use their own money. Taking money from farmers seemed to oppose the poverty reduction mission of extension agents.

**6. Subjects Submit Values**

In the United States, subjects submitted values on the provided value sheet by placing them into a plastic container. This container was collected by a facilitator who put the values into a pre-made spreadsheet. Automatically capturing the data saves time and reduces errors (Friedman and Sunder, 1994). After all values were entered, the facilitator read the highest, lowest, and average value calculated by the spreadsheet. Subjects were never told how many values they were going to submit. In the US tests, the valuation process was ended after three rounds in Group 1 and 2 and four rounds in Group 3, but all subjects had five value sheets.

In the Philippines, subjects submitted values on a value sheet and put them in a container. The values were then spoken aloud and put into a spreadsheet that was projected so all subjects

[4] One example of translation issues concerned the use of "environmental benefits" versus "reduced pollution." Translators decided that "reduced pollution" translated better than "environmental benefits." Translators held different opinions about how dialect issues would affect subject understanding. The final translation contained "proper" Tagalog and did not contain any dialect specific content.

could see everyone's values. The values were not connected with subject numbers making them completely anonymous to subjects. By using this method, the researcher had to reenter the data to link it with subject numbers at a later time. The value sheets were also shuffled in the container before being posted. The spreadsheet calculated the average, high, and low values, and these were also spoken aloud by the facilitator. In the Filipino tests, the valuation process ended after four rounds. Again, subjects were not told how many values they were going to submit, and some subjects had more than four value sheets.

**7. Enforcement**

Enforcement was conducted by randomly selecting a number of subjects (one subject in Group 1 and Group 2, four subjects in Group 3) by pulling their subject tabs from the container and then randomly selecting one valuation round by picking a round number from an envelope. The selected subjects received their endowment, but had to donate their submitted value from the selected round to the organization pursuing MVR tomato research. This organization was described in the packet.

After the fourth values were submitted and mixed, three value sheets (only one in the Filipino Student Group) were randomly selected. Again, subjects were not told this would be the final round of values, and some subjects had more than four value sheets. The selected subjects were given their endowment but had to donate the value they submitted in the final round to the organization pursuing the Bt eggplant research.

Randomly selecting values to enforce saves money. In future experiments researchers could select one value to enforce from all subjects, but the random selection ensures each subject has an equal opportunity of receiving the endowment and paying their value. It provides the correct incentives for subjects to value the environmental benefits honestly (Friedman and

Sunder, 1994).

**8. Exit Survey**

There was an extended open forum after Group 1 in the United States. Subject's specific concerns will be relayed in the next chapter. Since the experiment was conducted in a classroom, an open discussion took place until the class was released. This discussion centered on ways to improve the experiment. For Groups 2 and 3, Group 1's suggestions were internalized into the experiment, and most post-experiment discussion concerned the MVR tomato product. These sessions were shorter than Group 1's session.

In the Philippines, there was only a short time for discussion with the Filipino Student Group because they had to continue studying for their exam. With the farmers the discussions centered around Bt eggplant, Bt corn, and Filipino policy in general. These discussions lasted longer than in the United States and helped the researcher to better understand the problems facing Filipino farmers, but there were few suggestions about the experiment process. Most recommendations came from the extension agents and scientists who helped facilitate and observe the experiment. These suggestions will be discussed in the next chapter.

## III.6 Conclusion on Technique

Using an EA with this research's specific problem is the best way to meet the objectives set forth by this study. It provides a technique that is replicable and can be inexpensive. It also confronts some of the problems that have arisen from previous stated preference research. It is more parallel to economic decisions made in the real world. The hypothetical nature found in CVMs and CE have been removed from the decision.

The technique also allows the researcher to best tackle the major difficulty faced in his

specific problem. Subjects know that the benefits they are valuing come about from GM and can use this information when they submit a value. It would be difficult to correct for this difficulty with any other technique.

Also by using an EA, opportunities not available in CVM and CE studies have been created. It allows the researcher to ask more research questions; quantitative WTP data can be complemented with testing the effect different treatments have on WTP. Also, the possibility to earn money keeps subjects interested and makes their decisions more realistic. In conclusion, EA makes the valuation data more reliable and provides greater possibilities for testing researcher's hypotheses.

**III.7 What Next?**

As expected, the tests of the technique did not go perfectly, but the tests did provide important lessons for future experiments. The next chapter will discuss the difficulties confronted by the tests and provide some suggestions on how to improve the experiments. It will also discuss some of the quantitative results of the tests.

# Chapter 4: Test Results

## IV.1 Introduction

The fourth chapter is split into two sections. The first section provides a qualitative review of the tests completed in this study. It states what went well and what did not go well at each stage of the experiment. The second section discusses the quantitative results of the experiments. Both sections provide evidence of what could be improved and serve as guidance for future studies.

## IV.2 Qualitative Assessment

The first section analyzes the lessons learned from each of the steps described in the previous chapter. It will be broken down into the United States tests versus the Philippines tests, and specific groups are mentioned when they generated unique issues.

### 1. Assignment of Subject Numbers

Assigning subject numbers and providing value sheets was not difficult in the United States, but it did require substantial preparation. There were no distribution problems with Groups 2 and 3. Since the values were entered into the computer as the experiment was being conducted, any problems could be identified rapidly.

In the Philippines, subject number distribution went well. It would have been even better if values could be entered with the subject numbers, as in the U.S. Tests, but since the computer displayed the values to subjects, connecting the values to subjects would have compromised anonymity.

The subject number keeps subject's values anonymous while organizing the data for post-

experiment quantitative analysis. Since future experiments will probably be completed in the field, the results of the experiments may need to be recorded on paper making subject numbers and preparation key to keeping the data organized. Many modern laboratory experiments assign each subject a computer. The computer collects all of the data and electronically separates subjects. This automation is not available to most field experiments conducted in developing countries. Experimenters and facilitators must carefully prepare their experiments to avoid confusing subjects with their demographic information and values.[5]

**2. Collecting Demographic Information**

Collecting demographic information proved difficult. The American students rushed through the questions, perhaps due to the informality of the tests. Since not all students were being paid because of the randomized payoffs, subjects had less incentive to put forth effort.[6] Also, by collecting the demographic information first, subjects did not know their specific endowment. The researcher mentioned "a potential to make money" in Group 2 and Group 3 but did not mention specifics until the experiment started. The problem was confounded by the demographic questions themselves. Most of the questions were simple, but one question "How much do you spend in a week?" raised questions in Groups 2 and 3. As with all surveys, questions should be screened to avoid confusion. This research did not adequately screen the demographic questions, and some of the questions confused some subjects.

The lesson from the United States tests was that it takes time to collect information. Subjects must be given sufficient time to answer questions. It is also unavoidable that some subjects will finish earlier than other subjects. After subjects turned in their questionnaires, they

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[5] Two minor problems reiterate the necessity for careful planning. In Group 1, the researcher erred and gave two participants the same subject number. In the Meeting Group, a subject tore the subject number off his or her value sheet. Both of these problems were quickly and easily corrected, but they serve as evidence of why the experimenter must carefully prepare.

[6] Subjects could leave at anytime, but they were not recruited by the experimenter.

started reading the information packet. Some subjects had more time to read through the packet than other subjects. This could be corrected by not giving subjects the information packets until all questionnaires were collected. The effects of different reading times could not be determined, but experimental control could have been lost if some subjects became distracted or had more time to read while waiting for other subjects to finish. The experiment should try to explicitly control for all possible effects on the subject.

In the Philippines, collecting demographic information was complicated by illiteracy and language difficulties. A number of extension agents helped with information collection. Their help increased the accuracy of the collected data as subjects were able to ask specific questions directly to the surveyors, but it made the experiment last longer. It could also introduce surveyor bias into the demographic information. This study did not connect surveyors with specific subjects' demographic information, but future studies should control for surveyor bias. There could also be greater costs involved with stand-alone experiments than with experiments conducted within previously organized meetings. The extension agents who conducted the surveys had to be at the meetings anyway, and surveyors did not have to be hired. If surveyors had to be hired, this would add to the expense of the experiment, but it could possibly aid the researcher in controlling for surveyor bias by hiring experienced surveyors.

In the Philippines, subjects also had to wait while all of the surveys were collected. Since they were not given information packets, subjects did not have extra time to acquire information, but they did have to sit and wait. Most subjects did not have to wait long because there was an adequate number of surveyors to collect all of their answers, but if the number of surveyors decreased or the number of subjects increased, then subjects might have to wait an extended period of time. Again waiting could affect values if subjects became distracted or irritated with

the experiment taking so much time.

Collecting demographic information consumes most of the experiment's time. The researcher wants to collect the information as efficiently as possible, because if subjects become bored or disinterested, experimental control will be lost (Friedman and Sunder, 1994). One suggestion is to collect half of the subjects' information before the experiment and the other half's information after the experiment. It might also be possible to collect some demographic information during subject recruitment. Another suggestion is to keep demographic questions to a minimum. Subjects can become fatigued if surveys are long. A researcher wants subjects to be actively participating for most of the experiment (Lei, et al., 2001). Boredom can affect values if subjects lose patience with the experiment.

**3. Description of the Product**

It is doubtful that all U.S. subjects thoroughly read the packets. No American subjects asked for more information, and they accepted the factuality of the packet. Visual aides or testimonials from experts could have helped those subjects less inclined to thoroughly read, but the experimenter did not want subjects to feel like they were watching an advertisement. There is a fine line between keeping subjects interested and overloading them with information, especially information that subjects could deem as biased. The best way to attack these information issues is to test different information treatments and determine the effects each treatment has on values.

The Bt corn video helped the Filipino subjects conceptualize the potential environmental benefits, but it also alerted farmers to potential increases in profit. It will always be difficult to separate farmers' values for environmental benefits from their expected profit increases from a new technology. The farmers were told that their values were only for the environmental

benefits, but the farmers were visibly excited about how Bt corn and Bt eggplant could increase profit. Farmers commented on how "full" and "beautiful" Bt corn looked in the video. New products meant greater profits as well as environmental benefits from reduced spraying. It will be difficult for farmers to distinguish between these two values. The video kept farmers interested in the experiment. The boredom concerns from the United States Tests were mitigated by the video in the Philippines.

Some subjects in the Extension Group did raise questions about the detrimental effects of biotechnology before the video was shown. Some subjects voiced their concerns towards biotechnology, and extension agents told of how local farmers had previously rejected Bt corn. The facilitator told the subjects that their concerns were noted, and repeated that before the Bt eggplant were to become publicly available, it must be approved by Filipino regulatory authorities. The facilitator also told the subjects that their concerns could be reflected in the values they would submit later in the experiment. The experimenter also made a written note of the subjects' concerns for future reference when analyzing the data. By allowing subjects to ask questions, the researcher runs the risk of a question affecting the experiment and subjects' values. For example, an argumentative subject could have questioned biotechnology and called the video or information packet biased. These arguments could affect other subjects' values also. In this case, the researcher should make notes of this situation and report it in his results. It is better to allow subjects to ask procedural questions to clarify their understanding than to silence them in order to prevent the possibility of an opinionated subject affecting the results.

As more information becomes available about these products, distributing information will be easier. For example, a Bt eggplant and MVR tomato video would aide the process. A good scenario would be to create a specific video for Bt eggplant or MVR tomatoes. This would

be costly and require a collaborative effort, but it would allow researchers to focus information on environmental benefits. The major criticism of using the Bt corn video was it was a general overview of Bt corn and aimed at farmers. It did not just focus on Bt corn's environmental benefits but all positive aspects of the product. Future videos could focus on environmental benefits and be geared to both producers and consumers.

**4. Subjects Given an Endowment**

Some members of Group 1 did not understand the endowment. Neither the directions nor the facilitator explained the nature of the endowment well enough to ensure complete understanding. This was corrected for Groups 2 and 3, but there might have been some subjects who still did not understand the endowment. The underlying problem was the convenience samples. If subjects were recruited to participate in the experiment, then the endowment would make more sense to them. From the recruitment process they would understand that they were being paid to participate in a research experiment. But in the tests, some subjects did not like "getting something for nothing." They felt that they did not earn the endowment, and felt obligated to give at least some of the endowment back to the researcher. But even in Group 1, some subjects kept all of their endowment for themselves (they valued the benefits at zero). Subjects who complained in the exit interview about not understanding what the endowment represented still submitted values. This situation is worrisome but probably unavoidable. Subjects do not like to ask questions. Overall, the researcher has to assume most subjects understood what the endowment represented. The endowment would also have been clearer if every subject had one value enforced. Some Group 1 subjects complained that they did not understand the random enforcement mechanism and that confused them about the endowment. Both the written and verbal directions were improved for Groups 2 and 3. But again, some

subjects might have been confused by random enforcement. This confusion can be rectified by paying all subjects.

In the Philippines it was unclear if subjects understood the endowment. Unlike the United States tests, subjects did not question the endowment after the experiment. Extension agents and native Filipinos suggested cultural issues existed when subjects did not like that they were given money for nothing in return, but the actual subjects did not register complaints that suggested a misunderstanding of the endowment. As will be discussed in the next section, the Filipino subjects' actions were much different than the United States subjects. It is difficult to determine the exact cause of these differences, but it might have been due to a misunderstanding of the endowment. If this was the case, the problem could be solved by conducting more pre-tests and working on translations to ensure subjects understood the meaning of the endowment.

One suggestion that could apply to both groups was either handing out fake money that could be converted to real money after the experiment or issuing the real endowment before the process began.[7] The fear with handing out the real endowment is that subjects will leave or lose interest in the experiment. It also does not work well with the repetition of value rounds, because subjects might think their values were cumulative and not independent. Also if all denominations were not issued, subjects' values would be limited to the denominations they had. The fake money might help subjects understand and could be tried in future experiments, but it should also be thoroughly pre-tested to ensure other problems do not arise.

**5. The Valuation Process**

A few students did not understand the valuation process in Group 1. Admittedly, the

[7] The "fake money" suggestion was made by Dr. Serge Francisco at a research meeting before the Filipino tests. The major problem with fake money is it would require a significant amount of denominations. The researcher would also have to have separate set of "fake money" for every round to ensure the subjects understood the values were not cumlative.

facilitator did not explain the process well. The biggest problem came from subjects not understanding what they were valuing. In Groups 2 and 3 the facilitator emphasized that the value represented a donation to the organization pursuing MVR tomato research, but the donation would only be used to help create the MVR tomato and its environmental benefits. Emphasizing environmental benefits was not as important in the U.S. Tests, because subjects were only told of environmental benefits and they did not grow tomatoes (except for one subject)[8]. The subjects only had information on MVR tomato's environmental benefits, and no other consumer benefits were mentioned. The subjects had no reason to think of any other benefits besides the environmental ones, because they were strictly consumers of the product and not producers.

Some students suggested that they needed something more concrete to value. They wanted to value the final tomato and one subject submitted values on a "per pound at the grocery store" basis. This problem arises with all stated preference studies. Environmental benefits are abstract to subjects, and many are not comfortable placing monetary values on something so abstract. Emphasizing that subjects' values represented a donation made the process clearer to subjects, but it did not solve all subjects' worries. Also the donation did not perfectly isolate the environmental benefits. It was technically impossible to specifically earmark the donations so they only went for the environmental benefits of the MVR tomatoes. The donations could only go to "finishing the MVR tomato" and not to securing the environmental benefits from the MVR tomato. But the donation seemed the best way to formalize the subjects' value into something concrete.

Like with the endowments, the Filipino farmers' level of understanding was difficult to

[8] This subject admitted to valuing MVR tomatoes for the amount of labor it could reduce and not the environmental benefits. This admission suggests that Filipino farmers might value products for their non-environmental benefits as well.

decipher. The extension agents and facilitators thought most subjects understood the process, and subjects did not complain in the exit interview. But the researcher could not fully determine the Filipino subjects' understanding of the valuation process. Again language and cultural issues made interpreting the Filipino tests more difficult than the United States tests.[9]

Subjects learned about the valuation process as they participated in the experiment. This learning makes determining the number of rounds important. Some subjects' early values might be affected by their lack of understanding and therefore, be different from their latter values just because of better understanding. It would have been beneficial to complete a few more rounds in each experiment. Again, the final number of rounds could be determined by using different treatments with a different number of rounds and see how this affects values. As the rounds progressed, especially in Group 1, some gamesmanship entered the valuation process. Subjects were competing to be the "highest valuer" and section A was competing with section B in Group 1. The extent of this gamesmanship can not be objectively measured, but it concerned the researcher. It is probably more evident with student subjects, and probably aided by the convenience samples. Subjects knew each other and were not randomly selected from the population. The potential for gamesmanship illuminates the experimenter's need to keep subjects interested in the experiment. It also represents how unforeseeable factors can enter into an experiment and reduce experimental control.

**6. Subjects Submit Values**

Subjects did not have trouble submitting values, but the researcher still had to rehearse the process. In Group 1, the experimenter did not bring a third container for Group B's values (one container was used for subject number tabs, the other was used for Group A's values.) Group A's values had to be emptied before Group B could begin the process. Also the researcher

[9] Understandably, the United States students were more comfortable criticizing the experiment than Filipinos.

has to be careful to repeat the same way of collecting and storing all of the paper generated by the experiment. In the United States and the Philippines, all value sheets were placed in envelopes labeled with the specific round, and demographic surveys were collected in folders. Another experimental process that had to be rehearsed was how the value container was passed around the experiment. In Groups 1 and 3, the facilitator stood in front of the room and subjects walked to the front to submit their values. In Group 2 and for the Filipino groups a facilitator walked the container around the room. These differences came about mainly because of how many helpers the facilitator had. In the Philippines extension agents wanted to help and in Group 2 the track coach wanted to help. Subjects could have felt pressured to quickly write their values if the helpers started to collect values before the subject had fully thought through their decision. These issues sound trivial, but they serve as examples of the details an experimenter must consider. In future experiments, to maintain experimental control, the details of the methods should be standardized for all experiments.

**7. Enforcement**

Enforcement went well. In the United States, the facilitator had prepared envelopes with all possible money combinations. Once the subjects were selected, they were paid in front of other subjects. The facilitator exchanged the full endowment but subtracted the value from the round selected. The whole process was informal. Receipts were limited to the subjects signing the back of the value sheets. In future experiments, to maintain proper accounting, the process should be formalized with explicit receipts (especially as greater amounts of money are spent.) Since these were tests and not all subjects were being paid, the researcher thought it was important that everyone knew that some subjects did get paid but wanted to make the payment process as fast as possible. The researcher wanted to minimize the time he kept subjects.

In the Philippines, the enforcement procedure was conducted similar to the United States Tests. But after all the fourth values were collected, three value sheets were selected. Unlike in the United States Tests where the round was randomly selected also, only fourth round values were selected in the Philippines. Using this method seemed easier to explain and took one step away from enforcement. Not randomizing what round was enforced could make subjects' early values throwaways since they have no chance of being enforced, but this problem was averted by not telling subjects how many rounds were going to be played. In the United States and Philippines, subjects were never told when the experiment was going to end. Again the best way to determine what rounds to enforce would be to run different treatments and see what effect enforcing different rounds had. A question arises whether the final values are 'better' representations of subjects' values or not. This question will be discussed later by looking at the quantitative data, but from a procedural standpoint it is easier to just enforce the last value but not tell subjects when the last value will be. From a theoretical standpoint the researcher wants all values to have an equal probability of being enforced, because then they can be viewed similarly. If the subject's first value has no chance of being enforced, it is questionable to compare it to a value that could be enforced.

The subject who was selected in the Filipino Student Group asked for more information on the organization she was donating the money to. Fortunately, the researcher had this information available. No U.S. subjects asked for more information about their donations. These findings serve as a warning to future experimenters to have information ready for inquisitive subjects, but these tests did not find many subjects who wanted to learn more about who was creating MVR tomato and Bt eggplant.

Paying all subjects could aide subjects' understanding of enforcement. Paying everyone

allows the researcher to be formal and collect all of the relevant information without guilt, because subjects are being explicitly compensated for their time. It also keeps subjects more interested in the experiment. The random payoff mechanism confused some subjects, and paying everyone would help subjects understand the process. Paying everyone would also decrease the incentive to compete with other subjects, but if costs are a concern, random enforcement offers a cost-saving alternative.

**8. Exit Survey**

The most informative part of these tests were the exit interview. In Group 1, many recommendations were made to improve the experiment. The biggest complaint concerned the abstract nature of the experiment. Some subjects wanted to value the tomato itself. They also questioned the idea if environmental benefits could be put in monetary terms and suggested it was a political decision. One subject suggested that the research be put to a vote. Groups 2 and 3 offered fewer suggestions. Their lack of suggestions was partly due to time constraints but the directions did improve from Group 1 to Groups 2 and 3. Some subjects in Groups 2 and 3 still made comments about the abstract nature of the experiment.

In the Philippines most questions centered on Bt eggplant and Bt corn. The facilitator did not engage subjects in a conversation concerning the experimental design. The Filipinos were open about their thoughts on biotechnology and the problems facing Filipino farmers. One farmer said that Bt eggplant would only yield temporary profits and questioned the usefulness of the research. He suggested Filipino infrastructure problems were more important than a specific crop. Many farmers from the Extension Group expressed their concern with biotechnology in general. They were openly skeptical of the long-run value of biotechnology. Farmers in general appreciated biotechnology's potential, but did not necessarily see it as a solution to their major

problems. Another consensus was that the Filipino farmers did care about the environment and wanted to spray fewer pesticides on their eggplants. The Filipino exit interviews challenged the researcher to think about the general problem in different ways, but due to time, language and cultural constraints, the researcher did not get any suggestions on the instrument.

A written exit survey would have been beneficial. The facilitator took notes, but it was hard to quantify the responses. Especially in the Philippines with the Bt corn video, it would have been interesting to determine if the video changed perceptions about biotechnology in general. It would also have been interesting to get more Filipino opinions on the instrument itself. A good exit survey can help the researcher assess parallelism. It can also lead to suggestions on how the experiment can be improved.

**IV.2.1 Conclusion**

These tests did not go perfectly, but they did provide evidence that the method worked; the technique elicited values that individuals place on GM product's environmental benefits. The major lesson learned is that any experimenter is going to have to carefully prepare before conducting an experiment. He or she will have to scout the setting of the experiment and rehearse everything. This thesis provides a guide of what to do, but each experiment will face unique difficulties. The best advice is to attempt to control for every possible scenario and record notes on anything extraordinary that happens in the experiment. If many experiments are done, external effects can be controlled for in the final results. For example, a thunderstorm interrupted one Filipino group. The researcher noted this in his log. If the results were very different from this group, then the loudness of the thunderstorm could have affected subjects understanding of the directions. By noting the thunderstorm, the researcher can explicitly test its effect against other experiments. It is recognized that perfect control cannot occur especially in

the field. Inevitably, something uncontrollable will happen, but through careful planning, control should be strived for to ensure that any conclusions are as accurate as possible. Future experiments should take the mistakes made in these tests and use them to improve on the instrument.

The most important lesson from the tests is that subjects need to feel comfortable with their decisions. Facilitators must be knowledgeable and professional but cannot be too rigid. A complaint from Group 1 was that the facilitator was unsure of himself and did not clearly answer questions. In the Philippines, an extension worker suggested to the researcher that even though a facilitator reading directly from a written instruction sheet adds control to the experiment, some subjects would feel like they were part of a rehearsed play and try to intentionally irritate the facilitator. The facilitator and researcher must be careful to try and not put any unnecessary thoughts into subjects' heads. The best way to make sure subjects feel comfortable is to test the procedure and listen to subjects in the exit interview.

Overall the results of the experimental tests led to expected results. One cannot tell if subjects fully understood the valuation process or enforcement, but subjects' actions led the researcher to believe that most subjects understood the premises of the experiment, and the values they submitted represented their WTP for environmental benefits.

### IV.3 Quantitative Results

The quantitative results from the tests are limited. As with most economic experiments, fewer subjects were tested than in a traditional CVM or CE study. Also, since the experiments were conducted as tests, they were not conducted with the same control as finalized experiments. For example, instructions changed from Group 1 to Groups 2 and 3, and in the Philippines, the

facilitator became better with the instructions as the experiments progressed. Also in the Philippines, different scientists introduced the Bt corn video and Bt eggplant's environmental benefits to the groups, and demographic information was not collected from Group 1 or the Filipino Student Group. Also none of the samples were random. Basically, the researcher cannot make strong statistical conclusions, because each Group's experiments differed from one another. (Full regression results are located in Appendix D.) This lack of experimental control necessitates reporting statistics from within each group and location and not only aggregate statistics. For the United States Tests, statistics for each test will be reported, and then some aggregating conclusions will be made. Since the Filipino Student Group provides a link between the United States students and the Filipino farmers, the results of this test will be discussed separately. Finally, the Filipino farmers' results will be discussed.

### IV.3.1 United States Tests' Descriptive Statistics

As mentioned before, the three United States tests occurred in a laboratory like setting. Group 1 and Group 3 occurred in college classrooms. Group 2 occurred in a hallway that had benches and tables allowing subjects to write. Group 2 and Group 3's instruction booklets and procedures were very similar, while Group 1's procedure was somewhat different. The next section relays each subject's values and provides descriptive statistics of each experiment. More emphasis is put on Group 1's results, since they provided the most unique results of the United States Groups and provide the most suggestions for future experiments.

## Group 1

**Table 4.1**
**Group 1's Values**

| Section A | | | |
|---|---|---|---|
| Subject # | Value 1 | Value 2 | Value 3 |
| 16 | $7.00 | $8.00 | $8.50 |
| 19 | $9.00 | $9.99 | $25.01 |
| 22 | $8.00 | $9.00 | $8.50 |
| 26 | $12.50 | $3.75 | $13.39 |
| 27 | $2.00 | $4.00 | $10.00 |
| 31 | $0.00 | $0.00 | $0.00 |
| 34 | $10.00 | $10.00 | $10.00 |
| 51 | $8.00 | $10.00 | $11.00 |
| 54 | $0.05 | $0.05 | $0.05 |
| 56 | $5.00 | $5.00 | $5.00 |
| 61 | $5.00 | $5.00 | $5.00 |
| 64 | $9.50 | $22.50 | $38.50 |
| 66 | $6.00 | $16.27 | $17.62 |
| 79 | $5.00 | $5.00 | $5.00 |
| 83 | $3.00 | $5.00 | $0.01 |
| 84 | $5.00 | $0.00 | $1.00 |
| 91 | $5.00 | $6.00 | $5.50 |
| 96 | $20.00 | $25.00 | $25.00 |
| Average | $6.67 | $8.03 | $10.50 |
| Max | $20.00 | $25.00 | $38.50 |
| Min | $0.00 | $0.00 | $0.00 |
| % of $10 | 66.69% | 80.31% | 105.04% |

| Section B | | | |
|---|---|---|---|
| Subject # | Value 1 | Value 2 | Value 3 |
| 2 | $28.00 | $28.00 | $28.00 |
| 4 | $9.95 | $1.15 | $0.07 |
| 5 | $2.25 | $1.32 | $0.01 |
| 8 | $2.00 | $3.00 | $4.00 |
| 10 | $20.00 | $20.00 | $20.00 |
| 14 | $2.00 | $2.50 | $2.25 |
| 15 | $20.00 | $15.00 | $15.00 |
| 17 | $11.00 | $10.00 | $7.00 |
| 18 | $1.00 | $5.62 | $8.21 |
| 24 | $2.00 | $2.74 | $4.52 |
| 32 | $5.00 | $8.00 | $10.00 |
| 41 | $0.30 | $0.30 | $0.30 |
| 59 | $6.00 | $5.00 | $9.99 |
| 65 | $10.00 | $10.00 | $10.00 |
| 69 | $7.00 | $11.00 | $8.01 |
| 75 | $8.00 | $7.00 | $8.00 |
| 78 | $4.15 | $7.00 | $7.44 |
| 89 | $10.00 | $10.00 | $10.00 |
| 90 | $9.00 | $9.00 | $9.00 |
| 90 | $10.00 | $8.00 | $6.00 |
| 92 | $2.00 | $2.00 | $2.00 |
| 98 | $20.00 | $20.00 | $20.00 |
| 99 | $6.00 | $5.00 | $2.00 |
| Average | $8.51 | $8.33 | $8.34 |
| Max | $28.00 | $28.00 | $28.00 |
| Min | $0.30 | $0.30 | $0.01 |
| % of $10 | 85.07% | 83.32% | 83.39% |

**Figure 4.1**
**Group 1's Frequency Chart**

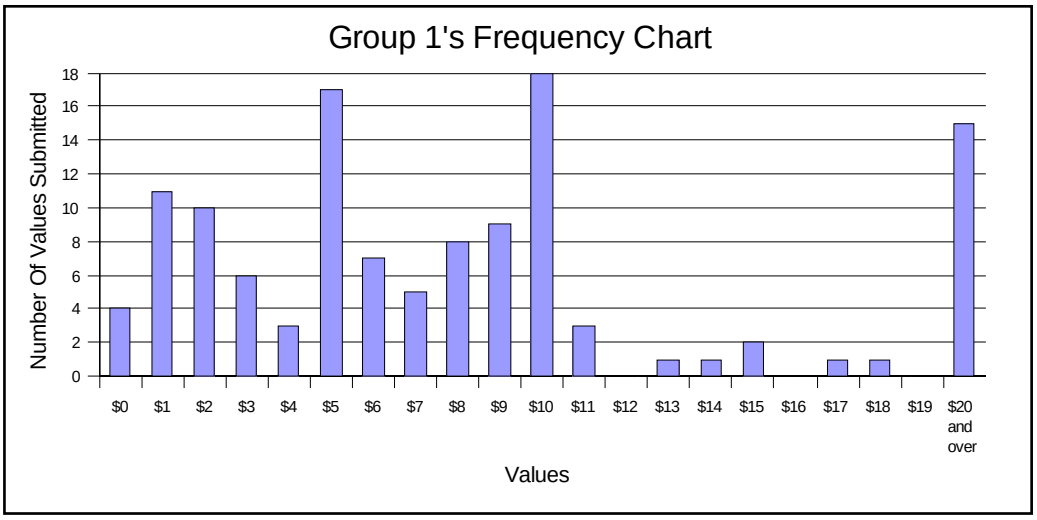


**Table 4.2**
**Group 1's Summary Statistics**

| | |
|---|---|
| Mean | $8.40 |
| Standard Error | 0.66 |
| Median | $7.00 |
| Mode | $5.00 |
| Standard Deviation | 7.28 |
| Kurtosis | 2.41 |
| Skewness | 1.46 |
| Range | $38.50 |
| Minimum | $0.00 |
| Maximum | $38.50 |
| Count | 123 |
| Confidence Level(95.0%) | ($7.10 to $ 9.70) |

Since Group 1 was large, subjects were split into two sections A and B. Overall, Group 1's values were different from those of Group 2 and Group 3. Subjects' values were significantly higher than the two other American groups. Twelve subjects valued the MVR tomato higher than the $10 endowment, and the average of Section A's third value was $10.50. These values were unexpected. Since this was the first test, the quality of instructions was poor which made it

difficult for subjects to fully understand the experiments. As mentioned earlier, a few subjects complained that they did not understand exactly what was happening in the experiment.

The instructions were improved from Group 1 to Groups 2 and 3, but other issues besides the instructions could have also led to the higher values. First, the professor stayed in the classroom. Her staying in the room could have possibly made subjects values higher, because students wanted to please the professor instead of earning potential money. Under this hypothesis, the randomized payoffs could have lost dominance, and the subjects were valuing benefits other than MVR's environmental benefits that the experimenter could not control (Friedman and Sunder, 1994). Also the endowment was lower and there were more subjects in Group 1 than Group 2 or Group 3. The expected reward from submitting a zero value was only 24 cents. Subjects knew the probability of being selected was low and the expected reward was minimal, and might have decided that the "values did not matter." With this hypothesis, the experiment became hypothetical to subjects.

Twelve subjects valued the benefits over the endowed $10. After the experiment, the researcher asked why subjects valued the benefits over the endowment. One subject admitted to gamesmanship and said if he was selected he would not have paid the excess above the endowment. This gamesmanship could have been increased by splitting the class into two sections. It seemed some individuals in each group were competing with members in the other group to have both the highest value and the highest group average. But one subject genuinely thought that the benefits were worth more than the endowment and said she was prepared to pay if selected. Again even though the values were high, it seemed that most subjects' valuation was well thought out and represented an honest attempt at placing a value on the potential benefits of the product.

Group 1 provides examples of how external effects can enter an experiment. The only way to properly determine if the professor and splitting the class into sections affected values is to run control experiments without professors and sections. These possible treatments would test behavioral hypotheses that are impossible to test with CVM and CE.

The distribution of values from Group 1 was not normal. The average ($8.40) was above the median ($7) and mode ($5). Also the skewness and kurtosis coefficients show the distribution is not normal and skewed to lower values. The variance measures (standard deviations and standard errors) were also bigger in Group 1 than the other Groups. This non-normal distribution suggests two groups of subjects; one large group who has low willingness to sacrifice potential winnings for environmental benefits and one smaller group with high willingness to sacrifice potential winnings.

**Group 2**

**Table 4.3**
**Group 2's Results**

| Subject # | Value 1 | Value 2 | Value 3 |
|---|---|---|---|
| 4 | $5.00 | $5.00 | $5.00 |
| 6 | $1.00 | $1.00 | $1.00 |
| 16 | $1.00 | $2.00 | $1.00 |
| 23 | $3.00 | $9.00 | $4.00 |
| 35 | $7.00 | $5.00 | $7.00 |
| 36 | $15.00 | $8.00 | $10.00 |
| 38 | $6.00 | $8.00 | $10.00 |
| 42 | $1.00 | $2.00 | $5.00 |
| 43 | $5.00 | $5.00 | $5.00 |
| 46 | $15.00 | $10.00 | $5.00 |
| 50 | $14.00 | $13.00 | $12.00 |
| 56 | $5.00 | $5.00 | $10.00 |
| 59 | $1.00 | $3.00 | $3.00 |
| 63 | $3.00 | $10.00 | $10.00 |
| 67 | $8.50 | $6.38 | $4.50 |
| 70 | $5.00 | $2.00 | $3.00 |
| 72 | $10.00 | $9.00 | $8.00 |
| 74 | $1.00 | $1.50 | $1.75 |
| 75 | $5.00 | $5.00 | $5.00 |
| 81 | $5.00 | $5.00 | $15.05 |
| 83 | $2.50 | $1.00 | $1.50 |
| 84 | $10.00 | $15.01 | $12.50 |
| 89 | $5.00 | $15.00 | $1.00 |
| 91 | $5.00 | $5.00 | $5.00 |
| 92 | $12.00 | $6.50 | $15.25 |
| Average | $6.04 | $6.30 | $6.42 |
| Max | $15.00 | $15.01 | $15.25 |
| Min | $1.00 | $1.00 | $1.00 |
| % of $15 | 40.27% | 41.97% | 42.81% |

**Figure 4.2**
**Group 2's Distribution**

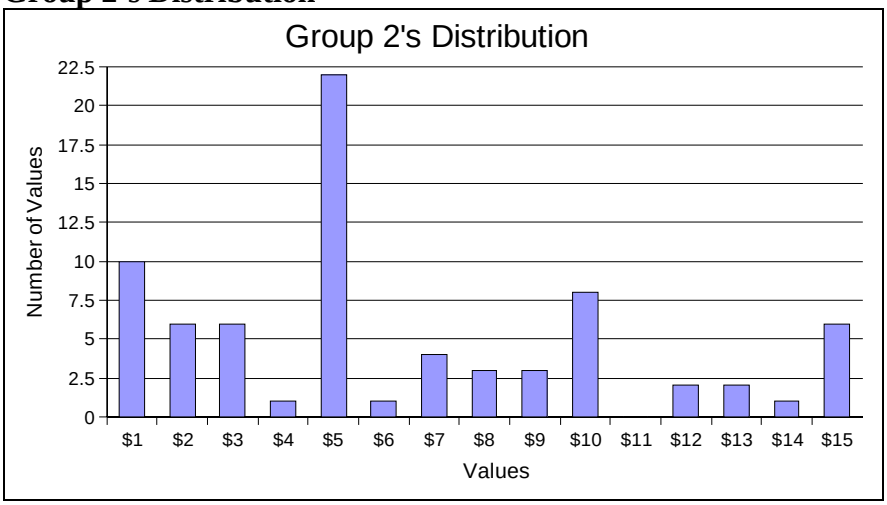


**Table 4.4**
**Group 2's Summary Statistics**

| | |
|---|---|
| Mean | $6.25 |
| Standard Error | 0.49 |
| Median | $5.00 |
| Mode | $5.00 |
| Standard Deviation | 4.23 |
| Kurtosis | -0.46 |
| Skewness | 0.68 |
| Range | $14.25 |
| Minimum | $1.00 |
| Maximum | $15.25 |
| Count | 75 |
| Confidence Level(95.0%) | ($5.28 to $6.22) |

For Group 2, the researcher expected more gamesmanship because of the competitive nature of track team. The teammates were familiar and competitive with one another. The researcher worked hard for anonymity by only reporting average, high and low values, but subjects could compete to submit the highest value or beat the average. Fortunately, the researcher's concerns about rampant gamesmanship were not realized. Group 2's values were

lower than Group 1's but higher than Group 3's. Most individuals did not change their values, but some subjects (81, 89 and 92) did have wide fluctuations. Only three subjects (81, 84, 92) valued the benefits from the MVR tomato over the $15 endowment. No subjects valued the product at $0 in Group 2, even though a pre-experiment question led to the experimenter to specifically tell subjects that zero values were acceptable.

The distribution of values was again skewed to the low end. The average ($6.25) was above the median and mode ($5). Like with Group 1, also the skewness and kurtosis coefficients imply that the distribution of values were not normal but skewed to lower values. But with Group 2, there were not as many subjects with high values. If this type of distribution transfers to total populations shows the importance of random sampling. If too many people from one side of the distribution are sampled, then aggregate values could be over or underestimated.

## Group 3

**Table 4.5**
**Group 3's Results**

| Subject # | Value 1 | Value 2 | Value 3 | Value 4 |
|---|---|---|---|---|
| 4 | $3.00 | $1.76 | $0.30 | $2.00 |
| 6 | $5.00 | $10.09 | $15.09 | $10.09 |
| 8 | $9.25 | $4.00 | $5.25 | $6.00 |
| 9 | $0.00 | $0.00 | $0.00 | $0.00 |
| 18 | $8.00 | $10.00 | $12.50 | $15.00 |
| 23 | $5.00 | $3.00 | $2.50 | $2.00 |
| 36 | $9.50 | $9.50 | $10.00 | $10.00 |
| 38 | $1.00 | $1.00 | $1.00 | $1.00 |
| 57 | $5.00 | $7.50 | $8.00 | $9.00 |
| 59 | $3.00 | $12.75 | $11.07 | $10.32 |
| 70 | $7.00 | $4.00 | $4.00 | $4.00 |
| 74 | $10.00 | $8.00 | $8.00 | $8.00 |
| 75 | $5.00 | $1.00 | $2.00 | $2.00 |
| 79 | $5.00 | $3.50 | $5.00 | $4.00 |
| 83 | $3.00 | $3.00 | $3.00 | $0.00 |
| 84 | $6.00 | $8.00 | $10.00 | $6.50 |
| 89 | $3.00 | $2.00 | $1.00 | $1.00 |
| 92 | $1.50 | $2.00 | $2.00 | $2.50 |
| Average | $4.96 | $5.06 | $5.60 | $5.19 |
| Max | $10.00 | $12.75 | $15.09 | $15.00 |
| Min | $0.00 | $0.00 | $0.00 | $0.00 |
| % of 15 | 33.07% | 33.74% | 37.30% | 34.60% |

**Figure 4.3**
**Group 3's Distribution**

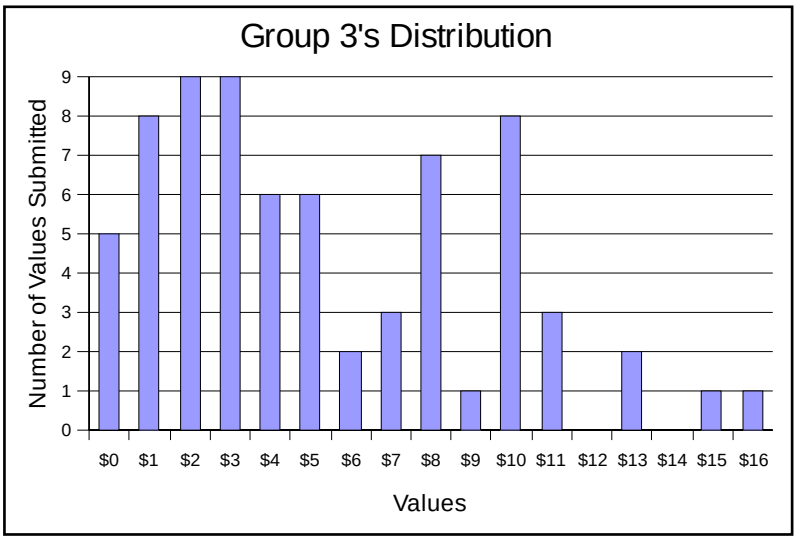


**Table 4.6**
**Group 3's Summary Statistics**

| | |
|---|---|
| Mean | $5.20 |
| Standard Error | 0.46 |
| Median | $4.00 |
| Mode | $3.00 |
| Standard Deviation | 3.92 |
| Kurtosis | -0.55 |
| Skewness | 0.6 |
| Range | $15.09 |
| Minimum | $0.00 |
| Maximum | $15.09 |
| Count | 72 |
| Confidence Level(95.0%) | ($4.28 to $6.12) |

Group 3's values were lower than Group 2's. The average ($5.20), median ($4) and mode ($3) were below Group 2's. Group 3's values also did not have as much variability as the previous Group 1 and 2, but some subjects did change their values across rounds. Group 3 demonstrated less gamesmanship than Group 1 and 2. There did not seem to be as many one-

cent increment values that were just above the maximum or average. Subjects did know each other, but the combination of a smaller number of subjects, some subjects previously participating in Group 1, and the increased chance to be selected (three subjects were selected instead of one) probably reduced the competition between subjects. Also, only one subject (6) valued the benefits from MVR tomato higher than the $15 endowment. One can see the distribution was similar to Group 2's. Again the distribution is heavily skewed to lower values.

**IV.3.1 Comparison of United States Tests**

The most prominent descriptive feature of Group 1, Group 2, and Group 3 is the distribution being skewed to lower values. Some students were willing to give all of their endowment back to help finalize MVR tomato research while other students were willing to give only a small proportion of their endowment. If these distributions carry over to the non-student population, then these results emphasize the importance of random samples for future valuations. If the low value or high valued groups are over or under sampled then the results will over or undervalued the environmental benefits. It will be important to distinguish the separating features of these two groups in future tests.

From Group 1 to Group 3, fewer students valued the product over their endowment. This could be due to improved directions, but Group 3 had fewer subjects and more values enforced than Group 2 and Group 1. The expected value of submitting low values increased from Group 1 to Group 3. If subjects were “playing the odds” submitting higher values in Groups 1 and 2 was less costly than in Group 3. Two sample t-tests for means showed that Group 2 and Group 3's values were marginally statistically different at the six percent level (one sided test). All three groups' results are inconsistent with game theory's prediction of complete free riding where all subjects would submit zero values. Some subjects did submit $0 value for MVR tomato's

benefits, but zero values were rare and did not occur in Group 2. This result implies subjects do care about the environment and are willing to sacrifice potential income for new products that reduce environmental pressures even if these products used GM technology. Since subjects actually had to sacrifice potential income, these results do not face the criticisms about hypothetical bias that CVM and CE do. These results also emphasize that endowments and how subjects are paid do matter. It would be interesting to examine the effect that paying all subjects would have on valuations, because these preliminary tests suggest that payment specifics do matter and increased payments decrease values.

Subjects also changed their values between rounds. A CVM could not report these value changes. The changes might be noise caused by randomness, and the aggregate changes between rounds in the United States were never statistically different than zero, but an alternative hypothesis is subjects might learn during the experiment and rely on other subjects (through the reported statistics) to form their latter values. These group effects could be important not only for the experiment, but also in reality. The extent of advertising and "fads" shows the importance of others opinions on preferences and values on private purchases and also, people cannot obtain public goods like environmental benefits without the support of their peers. CVM and CE ask subjects to make a private decision. An EA makes the decision public, and this public nature makes the decision more parallel with reality.

There were slight increases in values across rounds (except between Values 3 and 4 in Group 3), but besides Group 1's Section B, these trends were not statistically significant. These changes lead to the question of what value the researcher should use. The first value is comparable to CVM studies, while the last value incorporates the implicit information learned by the subject during the experiment. For econometric analysis, the researcher would like to use as

many values as possible. Since aggregate changes across rounds in the United States tests were relatively small, it could be argued that the changes even themselves out and are just noise. (As will be explained later, this result does not carry over to the Filipino tests.) The researcher tried to make every round have the same incentives. Each round had an equal probability of being enforced and subjects were told it was always in there best interest to value honestly. But even with this knowledge, subjects submitted different values. Good theoretical and practical arguments can be made to use the first, final or all values, but the advantage of using an EA over CVMs and CEs is that all of these values are collected and the differences can be analyzed.

An OLS regression of Groups 2 and 3's values against their demographic characteristics and experimental treatments yields some predictable results.[10] The regression reports that subjects having a GPA above 3.5 valued the MVR tomato benefits lower than students with lower GPAs. It also shows subjects who had completed more semesters in college had higher values. Also students who grew up in urban areas valued the benefits higher. These are plausible relationships. Students with higher GPAs might be more inquisitive about GM benefits. Urban students might have greater concern about pesticide risk than rural subjects due to the lack of familiarity with farm safety practices. But with low sample sizes and the lack of emphasis in the formulation of demographic questions, drawing any broad conclusions is suspect. As mentioned before, determining the significant characteristics that increase values is important to realizing the proper samples and not skewing results, but further testing must be done before these characteristics can be determined.

The more interesting results from the OLS regression is that subjects who knew the averages, highs and lows from prior studies valued the product significantly higher than other

[10] A regression that explicitly accounted for the panel nature of the data was also run, but this regression did not yield significantly different results than OLS.

subjects. Also Group 3 subjects who had participated in Group1 and had experiment experience had lower values. The prior study result supports the idea that subjects use others' information to form values. The experiment experience is more difficult to interpret. Those subjects who participated twice might have better understood the procedure, had less doubt actual payments were going to be given, and valued the product less. This interpretation suggests the directions need to be improved to ensure that subjects understand the procedure. A common recommendation in the literature is to run a practice valuation to help subjects see how the process works (Huffman, et al., 2003). Another interpretation is that subjects with experiment experience felt as if they had already valued the MVR tomato, and adjusted their values as if their previous donations had already been given. One subject who also participated in Group 1 told the researcher after Group 3 that he lowered his values explicitly because of the higher expected value in Group 3. Again, since the number of subjects who participated in both groups were relatively small, future tests need to affirm the validity of these differences.

**IV.3.2 Conclusions on the United States Tests**

The lessons from the United States tests center on the fact that different experimental designs, no matter how slight, affect values.[11] The United States results are in line with most previous literature on non-market valuation. Different frames lead to different results. Group 1's values were higher than the other two Groups. This could have been due to poor directions, the professor staying in the room, low expected rewards from zero valuations, or maybe other factors. These other factors can also affect CVM and CE, but with an EA, values were not hypothetical making subjects' decisions more realistic. Also by collecting more than one value, changes can be examined, and hypotheses on why these changes come about can be formed and

[11] These changes might also be attributed to the non-randomness of the samples. The common characteristics of subjects within each group could have generated the differences between average values between groups, but it is doubtful that this explains all of the changes.

tested. By doing an EA, one can explicitly test whether increased expected returns from lower values by doing more experiments with different expected returns. EA gives researchers the ability to not only produce quantitative information but also examine behavioral hypotheses and better understand why subjects submit their values.

A question raised by the United States tests that must be answered by future studies concerns whether students are representative of total populations. Traditional experimental economists claim students are good proxies for the population in experiments that test theories, but it is doubtful this relationship holds when one is doing this type of valuation research. In an informal survey before Group 1, one student told the researcher: "I have $30,000 in student loans. My Dad still pays for my dinner. Do you think I ought to be making donations to MVR tomatoes?" Another student respondent placed a one time hypothetical value at $50, but also stated she did not have $50. These United States student results might not carry over to the whole population, but the procedure should also work on "real people." A researcher would not be surprised if non-student subjects submitted different values, but he or she would be surprised if they did not understand the procedure. These tests demonstrate that the procedure did elicit values for environmental benefits, but future experiments will have to choose subjects and samples most relevant to their studies.

Another question raised from the United States tests concerns the meaning of the submitted values.[12] Since the values are induced, subjects are given an endowment and do not

[12] This study and previous literature conceptualize that the subject's submitted value equals his or her WTP for the environmental benefits plus an error:

Value = WTP + Error

The error consists of biases and other benefits and costs not directly associated with the environmental benefits. For example, James Andreoni (1989, 1990, and 1995) proposes that a portion of public good donations can be attributed to "warm glow." In essence people derive utility from the act of donating and not necessarily just from the public good. Gary Becker (1974) also proposed that donations also resulted from "a desire to avoid the scorn of others or

have to use their own money. It can be argued that these values do not represent classic WTP, since ability to pay is not explicitly considered. It is clear that subjects would probably act different if they had to use their own money, but for MVR tomatoes and Bt eggplant, the approach used in this study does offer some external validity. Government officials and researchers have already determined the product could be useful and money has already been spent to start developing these GM products. Through taxes, some of the subjects' money has already been spent on the product. The question is not whether to develop the product, but given that the product is being developed, how much do people value the environmental benefits generated by the product. The submitted values represent the relative importance of the research and environmental benefits compared to private wealth. A meaningful way to report the values is as the percentage of the given endowment. If subjects give some or all of their endowment back, they prefer donating to help bring about environmental benefits to the extra wealth of keeping the endowment. Admittedly, the values are not homegrown and do not represent classic WTP, but the values do show actual monetary sacrifices that CVM and CE do not offer. Also by using induced values, subjects' ability to pay does not limit the experiment. People with low incomes who do value environmental benefits can demonstrate their preferences. This feature is important if the instrument is used in developing countries where extra income is limited, and an overall goal of the GM research is to increase income.

The overriding conclusion from the United States tests is the instrument designed for this thesis produced results that were consistent with previous research. The instrument is a viable alternative to traditional CVM and CE surveys. Improvements can be made, but the instrument did elicit individual values for MVR tomatoes.

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receive social acclaim" The results of this study's experiments provide an opportunity to examine Andreoni and Becker's propositions, but this examination is beyond the objectives of this thesis.

### IV.4 Comparison of the Filipino Tests

The Filipino Tests did not provide as many suggestions on the instrument as the Untied States Tests, but Filipinos did value Bt eggplant significantly different than the United States students. The Filipino Tests did not provide the opportunities to use different treatments due to language difficulties and a condensed schedule for the tests, but they did provide the opportunity to examine how the experiment could be conducted in a developing country.

**Filipino Students Group**

**Table 4.7**
**Filipino Students' Group Results**

| Subject # | Value 1 | Value 2 | Value 3 | Value 4 |
|---|---|---|---|---|
| 6 | 50 | 100 | 120 | 150 |
| 17 | 30 | 50 | 100 | 200 |
| 23 | 200 | 50 | 210 | 100 |
| 35 | 200 | 100 | 200 | 50 |
| 36 | 100 | 50 | 80 | 100 |
| 38 | 250 | 150 | 500 | 350 |
| 43 | 20 | 200 | 250 | 300 |
| 46 | 70 | 150 | 180 | 250 |
| 59 | 200 | 200 | 100 | 300 |
| 63 | 20 | 200 | 50 | 150 |
| 72 | 250 | 500 | 500 | 500 |
| 74 | 50 | 100 | 120 | 150 |
| 75 | 50 | 20 | 50 | 50 |
| 79 | 100 | 50 | 50 | 150 |
| 81 | 100 | 50 | 50 | 100 |
| 89 | 300 | 350 | 400 | 500 |
| 91 | 300 | 280 | 500 | 400 |
| Average | 135 | 153 | 204 | 224 |
| Max | 300 | 500 | 500 | 500 |
| Min | 20 | 20 | 50 | 50 |
| % of 500 | 26.94% | 30.59% | 40.71% | 44.71% |

**Figure 4.4**
**Filipino Student Group's Distribution**

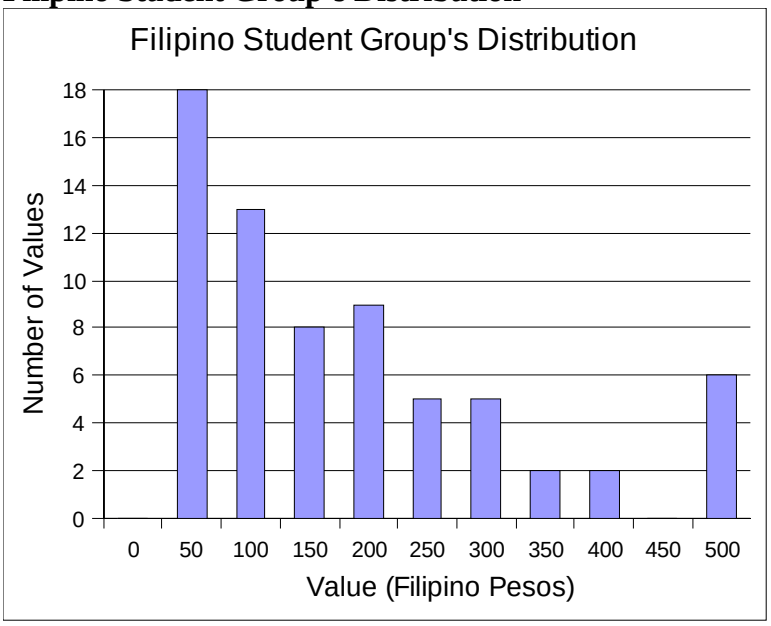


**Table 4.8**
**Filipino Student Group Summary Statistics**

| | |
|---|---|
| Mean | 178.68 |
| Standard Error | 16.9 |
| Median | 150 |
| Mode | 50 |
| Standard Deviation | 139.36 |
| Kurtosis | 0.26 |
| Skewness | 1.06 |
| Range | 480 |
| Minimum | 20 |
| Maximum | 500 |
| Sum | 12150 |
| Count | 68 |
| Confidence Level(95.0%) | (144.94 to 212.48) |

The Filipino Student Group demonstrated similar characteristics to United States tests, but the Filipino students did significantly increase their values from the first round to the final round which foreshadowed results from the Filipino farmers. The Filipino student's distribution showed the same skewness towards lower values that the United States students did. No students valued the products over 500 pesos, as it was emphasized that any values over 500 pesos would have to be paid to the researcher. The Filipino Students also got a written copy of the directions in English. News reports, personal communication, and the Bt eggplant video suggest that younger and educated Filipinos distrusted the potential benefits of biotechnology more than older Filipinos, but the student subjects' final values were almost forty-five percent of their endowment.

The student group provides a link between the American students and the Filipino farmers. As will be seen with the Filipino farmers' results, values tended to increase as the rounds progressed, but like with the United States students, the mean submitted value was less than 50 percent of their endowment while the Filipino farmers gave significantly more that 50 percent of their endowment.

**Table 4.9**
**Seminar Group's Results**

| Subject Number | Value 1 | Value 2 | Value 3 | Value 4 |
|---|---|---|---|---|
| 16 | 100 | 100 | 500 | 500 |
| 23 | 500 | 500 | 500 | 500 |
| 34 | 50 | 500 | 450 | 500 |
| 36 | 200 | 200 | 500 | 400 |
| 42 | 100 | 450 | 500 | 500 |
| 43 | 400 | 500 | 500 | 500 |
| 46 | 200 | 350 | 400 | 450 |
| 50 | 250 | 250 | 500 | 450 |
| 59 | 500 | 500 | 500 | 500 |
| 74 | 400 | 400 | 500 | 500 |
| 75 | 300 | 350 | 225 | 229 |
| 79 | 375 | 400 | 500 | 495 |
| 84 | 200 | 200 | 250 | 300 |
| 89 | 350 | 350 | 350 | 400 |
| 91 | 50 | 100 | 100 | 300 |
| Average | 265 | 343.33 | 418.33 | 434.93 |
| Maximum | 500 | 500 | 500 | 500 |
| Minimum | 50 | 100 | 100 | 229 |
| % of 500 | 53.00% | 68.67% | 83.67% | 86.99% |

The Seminar Group (as did the other Filipino farmers) showed different tendencies than the previous student groups. The group's values were skewed to the higher values and not lower values. This group was conducted in a meeting hall, and the Bt corn video was projected onto a white screen. It was the first time the facilitator and natural scientists had conducted the experiment, but no major difficulties were encountered. Even though the valuation exercise was

done at the end of a day long seminar, most subjects seemed to stay interested in the experiment. The subjects lived in the same locality and were familiar with each other, but the competition found in the United States Tests was not seen with the Filipino farmers. As was common with all the farmer groups, the subjects were very interested in the Bt corn video.

**Table 4.10**
**Cooperative Group's Results**

| Subject Number | Value 1 | Value 2 | Value 3 | Value 4 |
|---|---|---|---|---|
| 6 | 500 | 500 | 500 | 500 |
| 17 | 500 | 500 | 500 | 400 |
| 35 | 300 | 500 | 499.99 | 497.2 |
| 36 | 300 | 500 | 400 | 500 |
| 42 | 500 | 500 | 500 | 500 |
| 43 | 495 | 500 | 500 | 500 |
| 46 | 100 | 300 | 400 | 400 |
| 59 | 200 | 500 | 500 | 500 |
| 63 | 500 | 500 | 500 | 500 |
| 70 | 500 | 500 | 500 | 500 |
| 74 | 100 | 250 | 400 | 450 |
| 75 | 500 | 500 | 499.95 | 500 |
| 79 | 400 | 500 | 500 | 500 |
| 81 | 400 | 490 | 497 | 500 |
| 81 | 400 | 500 | 500 | 500 |
| Average | 380 | 469 | 480 | 483 |
| Maximum | 500 | 500 | 500 | 500 |
| Minimum | 100 | 250 | 400 | 400 |
| % of 500 | 75.93% | 93.87% | 95.96% | 96.63% |

The Cooperative Group's values started higher and stayed higher than the rest of the groups. The experiment occurred at the Cooperative's outdoor meeting place. The video was shown on a laptop screen. Since all the farmers in the Cooperative grew corn, they were excited

about the Bt corn video, and most of the discussion after the experiment centered on Bt corn and its potential.

**Table 4.11**
**Extension Group's Results**

| Subject Number | Value 1 | Value 2 | Value 3 | Value 4 |
|---|---|---|---|---|
| 6 | 100 | 100 | 100 | 300 |
| 16 | 100 | 200 | 500 | 500 |
| 17 | 5 | 100 | 100 | 500 |
| 34 | 400 | 500 | 500 | 500 |
| 35 | 10 | 500 | 300 | 500 |
| 36 | 20 | 100 | 150 | 500 |
| 38 | 5 | 100 | 395 | 500 |
| 63 | 50 | 200 | 450 | 500 |
| 67 | 400 | 500 | 400 | 500 |
| 70 | 100 | 25 | 50 | 100 |
| 72 | 500 | 500 | 500 | 500 |
| 75 | 100 | 500 | 500 | 500 |
| 79 | 300 | 500 | 500 | 500 |
| Average | 160.77 | 294.23 | 341.92 | 453.85 |
| Maximum | 500 | 500 | 500 | 500 |
| Minimum | 5 | 25 | 50 | 100 |
| % of 500 | 32.15% | 58.85% | 68.38% | 90.77% |

The Extension Group's values were lower than the other Filipino farmer's groups. The farmers in the area had previously decided not to plant Bt corn, and at the beginning of the experiment, they were openly hostile to GM products. This experiment was conducted in a municipal meeting room. The video was again shown on a laptop screen, and there was a loud basketball game going on outside of the experiment making it hard to hear the video. The group's first values were much lower than any of the other Filipino farmer groups, but the final

values increased to a point where they were similar to the other groups.

**Table 4.12**
**Meeting Group's Results**

| Subject Number | Value 1 | Value 2 | Value 3 | Value 4 |
|---|---|---|---|---|
| 34 | 0 | 200 | 300 | 400 |
| 38 | 500 | 500 | 500 | 500 |
| 46 | 495 | 495 | 495 | 495 |
| 50 | 5 | 500 | 500 | 500 |
| 67 | 450 | 250 | 300 | 500 |
| 72 | 300 | 300 | 300 | 300 |
| 74 | 400 | 400 | 450 | 500 |
| 81 | 500 | 500 | 500 | 500 |
| 84 | 250 | 260 | 401 | 500 |
| 89 | 500 | 500 | 500 | 500 |
| 91 | 1 | 400 | 350 | 500 |
| Average | 309.18 | 391.36 | 417.82 | 472.27 |
| Maximum | 500 | 500 | 500 | 500 |
| Minimum | 0 | 200 | 300 | 300 |
| % Of 500 | 61.84% | 78.27% | 83.56% | 94.45% |

The Meeting Group was similar to the farmer groups with values increasing across rounds and subjects willing to part with a large percentage of their endowment. This experiment was conducted in a community meeting room, and again the Bt corn video was shown on a laptop screen. A loud thunderstorm did strike during the middle of the experiment and decreased the subject's ability to hear, but a microphone was used to amplify the computer's sound.

**Figure 4.5**
**Filipino Farmer Groups' Distributions**

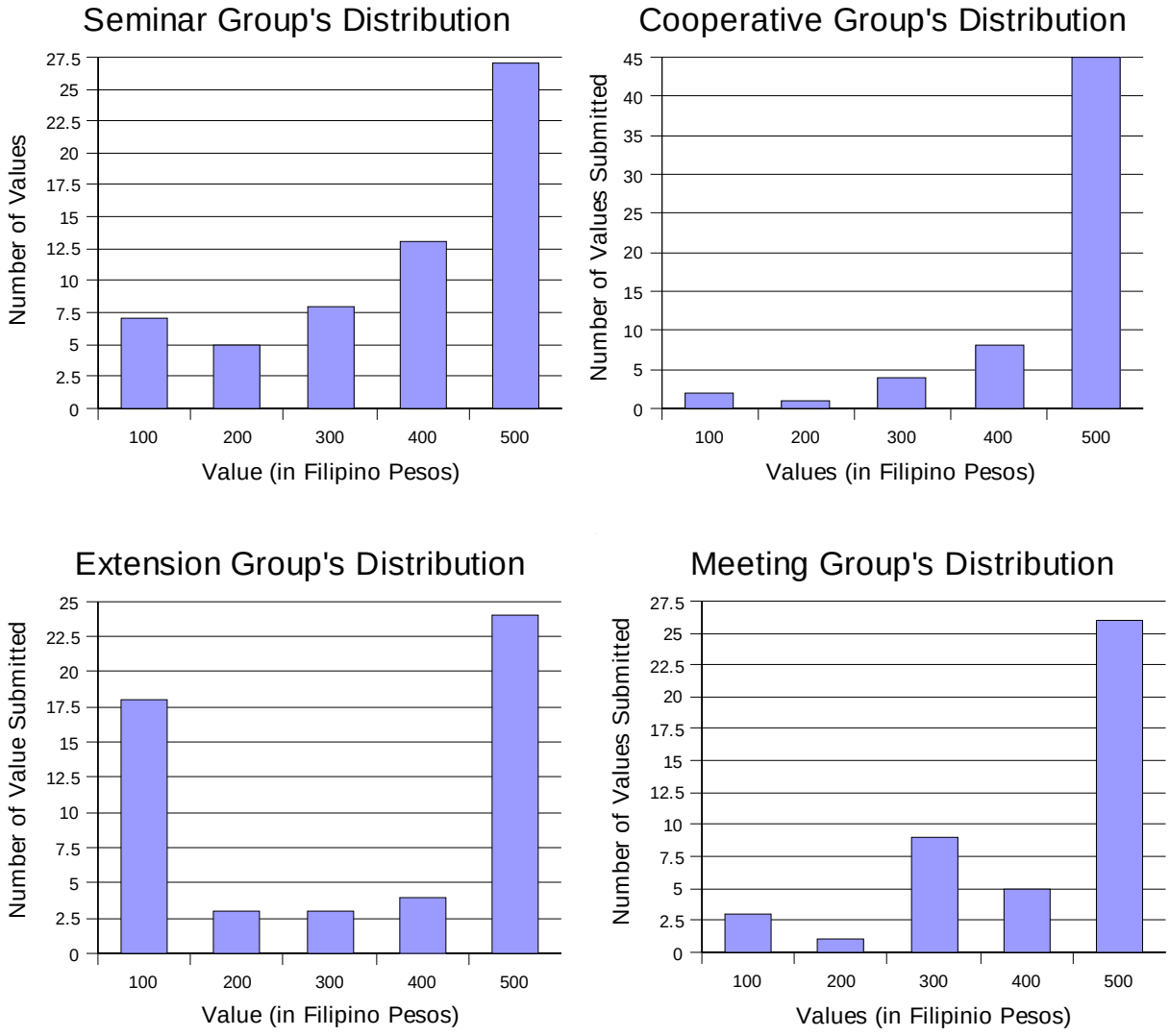

**Table 4.14**
**All Filipino Farmers' Summary Statistics**

| | |
|---|---|
| Mean | 383.61 |
| Standard Error | 10.60 |
| Median | 495 |
| Mode | 500 |
| Standard Deviation | 155.82 |
| Kurtosis | -0.10 |
| Skewness | -1.12 |
| Range | 500 |
| Minimum | 0 |
| Maximum | 500 |
| Count | 216 |
| Confidence Level(95.0%) | (362.71 to 404.51) |

The most noticeable difference between the Filipino farmers and the students from the United States and the Philippines was the amount of the values. Many farmers were willing to sacrifice their entire endowment for the potential environmental benefits from Bt eggplant while the average student was never willing to give more than half of his or her endowment back. There are a number of potential causes for this difference. One explanation might be that subjects did not understand the experiment, but the facilitator and extension workers who helped oversee the experiments thought that most subjects did understand the experiment. Another possible cause was that Filipino farmers cared more about what their peers were submitting than United States students. Every first round had at least one subject submitting a value of their total endowment, and since all values were read aloud, all subjects knew the values their fellow subjects submitted. Filipinos who submitted low values in the first round might have responded to the subjects who submitted high values in the early round by submitting higher values in later rounds.[13] The most peculiar group was the Extension Group that had previously rejected Bt corn. Their values started off low, but quickly rose to subjects' full endowment. The only

[13] The Filipino facilitator and extension workers suggested many Filipinos have a strong cultural desire to please other people. They suggested the farmers' values might have been biased upward to please the extension workers, the United States researcher, and other subjects who oversaw the experiments.

explanation from the Extension Group's exit interview was that reducing pesticide usage was important, and their opinion about GM somehow changed during the experiment. None of the subjects explained their increases in a satisfactory manner, and it seemed some subjects were heavily influenced by their peers' values. Another possible explanation is that even though subjects were concerned about the potential adverse effects from GM technologies, they were more concerned about the damaging effects of pesticide spraying. Thirty seven percent of subjects had been sick from pesticide spraying and eighty two percent thought pesticides harmed the environment. This research does not provide any definite answers to why the Filipino farmers' increased their values across rounds valued Bt eggplant, but the experiments emphasized "group effects" where values did systematically increase over rounds as subjects became aware of their fellow subjects' values.

Another feature of the Filipino tests was that the experimental groups had different initial values. The Extension Group had lower initial values than the other groups. These values did increase as the rounds progressed, but it seems some groups had much different initial beliefs than other groups. This result suggests that localities do not have similar preconceived notions about GM products. If these differences are not accounted for by future researchers, values could be skewed if regions were not sampled randomly. It seems that opinions about GM are more localized in the Philippines than in the United States.

A regression of Filipino values on Filipino demographic features did not yield significant results (R-squared of only 5 percent) and suggested that the most significant factors describing values were group effects. The variables with significant explanatory power were the subjects' previous values and the group in which the subject participated. The Extension Group was significantly lower and the Cooperative Group was significantly higher than the Seminar and

Meeting Groups (two sample t tests). In all groups values trended upward from the first to final value, and this trend held more explanatory power than any of the collected demographic features. Also final values were very similar and did not offer much variability. This lack of variability made it difficult to get meaningful results from regressions. These results all point towards Filipinos' decisions being less individualistic than United States students.

### IV.4.1 Conclusions on Filipino Tests

The Filipino results reemphasize the questions of what round of values is the most informative and the importance of sampling that were asked after examining the United States tests. Since values significantly increased across rounds, completely different estimations would be made if first values were used instead of final values. Similar to the United States tests, different subjects had different values, and improper sampling could lead to biased results. Future experiments should conduct the experiments with non-farming Filipinos to see if the farmers' preferences carry over to the rest of the Filipino population.

The Filipino tests also showed the researcher that conducting field experiments in developing countries creates technical and procedural difficulties that are not encountered in laboratory experiments conducted in the United States. Issues such as electricity to power the laptop and proper roofing to protect the computer from rain became issues that would not be a problem in developed countries. Other weather related issues and outside noise made it difficult for subjects to hear directions in the Philippines. These types of outside effects were never issues in the United States tests, but future researchers must consider these possibilities when research is being done in the field in developing countries.

Watching the Bt corn video certainly helped subjects conceptualize the potential of Bt eggplant and kept them interested in the experiment, but it could have also increased values. The

video discussed not only environmental benefits but also potential profit increases. The video cannot explain why values increased between rounds though, since it was only shown at the beginning of the experiment. In future experiments, it would be interesting to test how not watching the video or watching an anti-GM video changed subjects' values.

The main inference from these Filipino results is that Filipino farmers acted much differently than United States and Filipino students. They were willing to sacrifice a much larger percentage of their endowment than the other groups tested. Future studies must confirm these results, but they suggest that farmers who grow eggplant have a strong desire to reduce pesticide spraying no matter if it is from GM products or not.

### IV.4 The Next Chapter

To properly test the differences between Filipino farmers and United States students, one would have to standardize the procedure between the two countries and run more experiments. This step is not done in this research, but this research provides a foundation for future experiments. The procedure developed in this research is an easily replicable and inexpensive method to elicit environmental benefit values from MVR tomato and Bt eggplant. The procedure is unique because unlike CVM and CE, values are not hypothetical and behavioral hypotheses can be tested. The next chapter will further these general conclusions and make suggestions for future studies.

# Chapter 5: Conclusions and Recommendations

## V.1 Introduction

This chapter draws some general conclusions and suggests some possible extensions for future research.

## V.2 General Conclusion

The general conclusion from this research is that results change depending on how the valuation procedure is framed. For example, the United States students changed their values between rounds, and even though these changes were not significantly different than zero, these changes represented subjects collecting information from their peers to formulate their values. In the Philippines, group effects led subjects to significantly change their values. CVM and CE might miss these group effects and lead to different valuations. Also this research shows that changing what information is presented to subjects (like giving them the results from previous experiments), endowments, groupings, and how many times subjects participate in the experiment might lead to different values. Like previous stated preference literature, this research shows that there is no perfect frame, but by using EA, the researcher can more explicitly examine the effects of different frames.

Another broad conclusion from this study is that people in both the developed and developing world care about environmental benefits even if these environmental benefits are derived from GM technologies. Both the United States and Filipino subjects were willing to sacrifice a significant amount of their endowment to aide GM research that would generate

environmental benefits. Since these values represent actual decisions to sacrifice monetary rewards and not hypothetical answers to survey questions, these values provide strong evidence that subjects want environmental improvements even if they come from GM products.

The final conclusion is that these preferences are not homogenous across subjects. Some subjects strongly want GM's environmental benefits and are willing to sacrifice a significant amount, while others are only willing to sacrifice very little. These differences are prevalent in the debate surrounding GM products, but this research suggests that people's values for GM's environmental benefits can be affected by public opinion. Values might change over time, and like with the Extension Group, these changes might occur rapidly when subjects see their peers' values. Heterogeneous preferences also emphasize the importance that future researchers collect random samples, because over or under sampling certain segments of society could lead to biased aggregate values and give policy makers incorrect information.

### V.3 Future Experiments

This research suggests many opportunities for future experiments. Due to the objectives of the project, the tests done in this research could not make any strong conclusions, because they were not run exactly the same and experimentation was deemed more important than experimental control. The first recommendation for future experiments is to replicate the procedures developed here with more diverse subjects. For example, United States farmers or non-student consumers could be used and these results could be compared to these tests done in this study. In the Philippines, the experiments could be conducted on non-farming subjects. By replicating the experiment on more random samples, the procedure's ability to elicit values can be better verified. Group effects and the demographic features that are associated with

individual GM values could also be better distinguished. Also, future tests could increase experimental control by finalizing directions, experimental protocol, and exit interviews to properly determine if the results from this study were due to randomness and misunderstandings caused by poor directions or if these results could be replicated.

This replication could also fully examine the treatments discussed in this research and other treatments. For example, running multiple experiments where some subjects knew previous groups values and some did not, would allow future researchers to better determine the effects of this information. Other treatments could include the effects of sectioning subjects into different groups or changing subjects' endowments. Another treatment could determine the effect of paying subjects in front of the group versus subjects being paid in private. The replication of the experiment with different subjects and treatments would allow future researchers to better understand the valuation decision. This replication would also allow for better estimates of society's WTP to pay for the environmental benefits from potential GM products.

In developing countries, future experiments could be conducted during focus groups and extension efforts similar to the groups ran in these tests. By conducting experiments in these settings, sampling costs will be lowered as trained facilitators and potential subjects will already be at the setting, and the chance to earn money might increase participants' willingness to participate and learn from the extension programs. The ability to collect a significant amount of information in a short period of time could benefit both researchers and extension efforts.

The final conclusions about future experiments are that using an EA offers opportunities that traditional CVM and CE studies do not offer. It allows researchers to examine issues in many different ways, and ask research questions that cannot be asked by traditional CVM and

CE. The hypothetical nature of CVM and CE will always raise questions, and CVM and CE will always have a difficult time distinguishing why subjects place the values they do and cannot test for possible effects on these values like EA.

### V.4 Extensions

A limitation of this research is that it does not examine the difference between WTP for GM products and non-GM products. Future experiments could ask subjects to value benefits from both GM products and non-GM products and report the difference between these values. For example, donations to MVR research could be compared to donations for research on better organic practices or safer pesticides.[14] These experiments could also have a control group where a description of how the environmental benefits come about in nature is not specified. By distinguishing between technologies, a researcher could determine the differences in subjects' preferences for types of research. These experiments would further develop previous literature that has already studied people's preferences for GM products (Baker and Burnham, 2001). A possible hypothesis is customers prefer research that focuses on better practices (like organic farming) to reduce pesticide usage over GM products that provide similar reductions. An experiment designed similarly to the one in this research but with added treatments could explicitly test this hypothesis.

Another possible extension from this research applies to marketing. When MVR tomatoes and Bt eggplant are finished, they will have to be marketed to farmers, and experiments could help determine the best marketing practices to encourage farmers to buy the product. For example, different information treatments or package designs could be given to determine the

[14] Research is also being done on non-GM varieties of tomatoes and eggplant. Donations to this non-GM research could be directly compared to donations to GM research.

effect on the willingness to purchase. This information could be useful when the final product is finished and ready to distribute to the public. These information experiments could also further previous research that studied the effects that different information had on valuations (Huffman, 2003), and (Huffman, et al., 2003).

The results from the Filipino farmers suggest that a major contribution to technology diffusion could be group effects. Some individuals might initially be skeptical,[15] but there seemed to be a strong tendency for individuals to follow other individuals who were not as skeptical.[16] An experiment could be designed to see if this type of behavior carries through to technology adoption. Also the Cooperative Group's consistently high values suggest that adoption might be centered on organizations and local leaders. A hypothesis could be that in the Philippines the adoption decision is not an individual decision but a group decision.

### V.5 Allocation Experiment

A subject from the Group 1 and other observers suggested another type of experiment that allows subjects to explicitly identify the substitutes available to purchase with their endowment. An allocation experiment could be established where subjects have the opportunity to not only donate to GM research and non-GM research, but also buy everyday goods. For example, Filipino farmers could also be able to purchase traditional seeds or other common foodstuffs. Richard Sippel (1997) did a similar experiment when he tested the axioms of revealed preference (Sippel, 1997) With this allocation experiment, the meaning of the endowment would be clarified and subjects would be better able to distinguish the opportunities their endowments allow. The major difficulty in this type of experiment is setting prices and

[15] In the experiment, these individuals could be subjects who submitted low values in early rounds.
[16] These subjects submitted higher values.

selecting substitutes. For example, arbitrage opportunities could affect results if the experiment set prices too low. Again pre-testing would have to be done to ensure that the prices and substitutes were reasonable. Also the allocation experiment would make it more difficult to replicate values and distinguish group effects.

### V.6 Final Conclusions

Hopefully, the technique designed in this thesis will be used by future researchers to generate information that will aide policy making. The technique provides the opportunity for researchers to not only place values on the environmental benefits from GM products, but also examine how and why people place these values in non-hypothetical settings. These how and whys could also provide important information to policy makers.

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## Appendix A: Sample of United States Instructions

Introduction

Tomato production throughout the world is hindered by viruses, as viral infections commonly destroy tomato crops. Presently, the only mechanism for controlling this problem is through the spraying of numerous chemical pesticides which kill the insects that spread these viruses. These pesticides must be applied regularly and in significant quantities to diminish the likelihood of viruses infecting tomato crops.

Pesticides used to prevent tomato viruses have been shown to harm their surrounding environment. Studies have documented damage to animals, fish, and beneficial insects. In addition, pesticides have been shown to contaminate water supplies. Pesticide damage can also spoil recreational areas making them less desirable to visitors. Accidental misuse of pesticides can cause both short-term and long-term injury to human applicators and bystanders. These adverse effects of pesticides used on tomatoes can be mitigated through proper use practices, but the overall risks to the environment and human health cannot be eliminated.

There are two general ways that pesticides harm the environment. Firstly, the quantity and intensity of pesticide applications can do damage. A greater number of applications or greater intensity of individual applications will lead to greater environmental damage. Currently, tomato production requires intense and frequent applications to prevent viral infestations. Secondly, the toxicity of individual pesticides varies among the different pesticides used in tomato production. Simply put, more toxic pesticides do more environmental damage than less toxic pesticides. Today, the toxicity of pesticides used in tomato production is relatively high.

Currently, scientists are using genetic modification technology (GM) to create a variety of tomato that is resistant to the most common viruses. This resistance will decrease the number of pesticide applications and allow for the use of less toxic pesticides. Every country has established scientific and political institutions to thoroughly evaluate GM products and their overall risks before they are accepted and put into widespread use, and numerous GM crops are presently grown throughout the world. This GM tomato technology will have to gain the approval of these institutions before it is available for widespread use.

The following procedure will ask you to consider the value you place on the potential environmental benefits brought forth by this prospective technology. The decisions you make in the following exercise will enhance future policy discussions concerning GM tomatoes.

Definitions

**Fewer** pesticide applications mean that farmers will be able to spray pesticides significantly less than they do presently and/or they will be able switch to less toxic pesticides that do less environmental damage than the pesticides currently used.

A **reduction** in the environmental pressures caused by pesticides means that the present environmental damage will be significantly reduced. The damage to streams, animals, and human health within a proximity to tomato farms will be eased. Overall environmental quality in those areas surrounding tomato production will improve by a considerable factor over their current state.

**It is recognized that these are broad statements, but like most technologies in the developmental phase, it is hard to describe the exact benefits from GM tomato technology until it enters widespread implementation. It is clear that the completed technology will improve environmental quality in tomato producing areas but the discrete benefits cannot be determined until the project is completed. Similar GM technologies used in other crops have been documented to reduce pesticide use and have decreased environmental pressures.**

Instructions

At the end of this exercise three individuals from the group will be randomly selected to receive $15 for their participation today. **This $15 is specifically for your participation.**

In a few moments, an auction will take place, the 'good' being auctioned is the possible environmental benefits from the GM tomato technology discussed in the introduction. Tomatoes grown with this GM technology will require **fewer** pesticide applications than currently grown tomatoes, and this reduction in pesticide use will **reduce** current environmental pressures in tomato producing regions.

In a moment, the auctioneer will ask you to submit a bid on the sheet provided for how much you are willing to pay for the environmental benefits associated with this GM tomato technology. **You can bid an amount greater than $15, but you must be aware that the randomly selected individuals will be obligated to pay one of their bids to a non-profit scientific organization that is pursuing this GM tomato research**. The credentials of the organization conducting this research are listed at the end of the packet you have received. **Your donation will only go towards finalizing GM tomato research**.

After all bids have been collected, the auctioneer will call out the highest, lowest, and average bids. Other participants will not know your individual bid.

This process will repeat itself for a number of rounds. **Each round represents a separate bid. The rounds are not cumulative.** The auctioneer will alert you when the auction is finished. He will then randomly select, by pulling three subject numbers out of a box, the individuals who will be paid for their participation. After this, the binding round will be chosen by rolling a die. **The selected individuals will be paid $15 for their participation, but they must donate their bid from the round chosen to the aforementioned scientific organization.**

**It is clearly in your best interest to bid honestly in all rounds.**

In February, a similar exercise was conducted here at Virginia Tech. The high bid from this exercise was $38.50, the average bid was $8.48, and the low bid was $0.

Two weeks ago, a similar exercise was conducted at another Virginia college. The high bid from this exercise was $15.25, the average was $6.25, and the low bid was $1.

Brief Description of the Non-Profit Organization

The following documentation gives a brief overview of the project that your bids will paid to in this experiment. The project is managed by Cornell University and funded by the United States Agency for International Development (USAID). It is a large project that pursues many different objectives concerning developing countries and biotechnology. *This brochure as well as additional information about the project can be found at www.absp2.cornell.edu.**

**Your donation will be earmarked specifically for finalizing the GM tomato research discussed in this experiment.**

***The italicized sentence was not part of the original packet, but the author wanted to emphasize to readers that this packet was public information and not privileged.**

# The Agricultural Biotechnology Support Project II

## *Supporting Agricultural Development through Biotechnology*

### *Mission Statement*

The developing world can benefit from advances in biotechnology, but much needs to be done to make bio-engineered products available in forms that farmers can use. ABSPII believes that farmers and consumers worldwide should have the opportunity to make informed choices about using bio-engineered products. Our consortium will support the development of expertise in our target countries in the areas of research, policy development, licensing, and outreach, to help reduce poverty and hunger through agricultural biotechnology.

### *Project Scope and Activities*

ABSPII focuses on the safe and effective development and commercialization of bio-engineered crops as a complement to traditional and organic agricultural approaches in developing countries. The project will help boost food security, economic growth, nutrition and environmental quality in East and West Africa and in Indonesia, India, Bangladesh and the Philippines. Funded by the United States Agency for International Development (USAID) and led by Cornell University, ABSPII is implemented by a consortium of public and private sector institutions.

To implement ABSPII we:

- Conduct highly-participatory priority setting to ensure that product development is focused on real needs;
- Develop ”Product Commercialization Packages” for each crop by geographical site that integrate activities on technology development, policy (including intellectual property), outreach and communication, and marketing and distribution;
- Create an enabling environment for regulatory and legal authorities;
- Foster public-private partnerships to boost mutual incentives and self-sustained, long-term investments;
- Promote improved science-based public awareness of bio-engineered crops;
- Monitor and evaluate the impact of ABSPII activities.

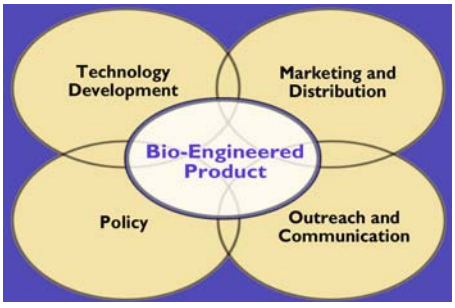
### *Anticipated Outcomes*

During the project, we expect:

- Increased agricultural productivity;
- Improved research and development capacities within collaborating institutions;
- Increased understanding by scientists and policy-makers of markets, regulatory environments and commercialization requirements of bio-engineered crops;
- Increased public awareness and understanding of bio-engineered crops that meet public needs;
- Enhanced environments for public-private partnerships in the areas of intellectual property licensing and regulatory approval.
- In addition, the long-term goals of ABSPII are to:
- Increase agricultural outputs among adopters of new products;
- Improve nutrition due to the availability of more secure and varied food sources;
- Expand rural economies due to both increased farm productivity and to improved market opportunities.

### *Interaction with USAID’s other Collaborative Agricultural Biotechnology Initiative (CABIO) projects*

ABSPII will identify and support other USAID initiatives to promote safe and effective agricultural biotechnology in Africa and Asia. For example, successful commercialization of bio-engineered crops will depend upon satisfactory biosafety regulation. Therefore, a special relationship will be developed with USAID’s Program for Biosafety Systems (PBS) project that focuses on strengthening national and regional capacities in biosafety. The biotechnology impact assessments conducted by ABSPII will provide forward-looking evaluations of the market-level consequences of biotechnology products that will provide a basis for interactions with other USAID-supported trade and development initiatives, intellectual property), outreach and communication, and marketing and distribution



## *ABSPII Consortium Partners*

***U.S. Public Institutions***

- American University of Beirut
- Michigan State University
- Ohio State University
- Pennsylvania State University
- Tuskegee University
- University of California, Berkeley
- University of California, Davis
- University of Minnesota
- Virginia Polytechnic and State University (Virginia Tech)

***National and Regional Partners***

- ASEAN Committee on Science and Technology Sub-Committee on Biotechnology
- Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA)
- Bangladesh Agricultural Research Institute (BARI)
- Department of Agriculture - Policy, Planning and Research; Bureau of Agricultural Research (DA-BAR); Biotechnology Project Implementation Unit (DA Biotech-PIU), Philippines
- Department of Science and Technology - Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (DOST-PCARRD)
- Forum for Agricultural Research in Africa (FARA)
- Kenya Agricultural Research Institute (KARI)
- Kenya Plant Health Inspectorate Service (KEPHIS)
- National Agricultural Research Organization (NARO), Uganda
- Philippine Rice Research Institute (PhilRice)
- Research Institute for Agricultural Biotechnology and Genetic Resources, Indonesia
- Tamil Nadu Agricultural University (TNAU), India
- University of Cape Town, South Africa
- University of Tsukuba, Japan
- United Nations University/Institute of Advanced Studies
- University of the Philippines, Los Baños (UPLB)-Chancellor's Office and Institute of Plant Breeding
- Western and Central African Council for Agricultural Research and Development (CORAF)

***Private Sector Entities***

- Alpha Seed (South Africa)
- Asia Pacific Seed Association (APSA)
- Crop Technology Consulting, Inc. (CTC)
- Development Alternatives Inc., (DAI)
- East-West Seeds (Indonesia)
- Maharashtra Hybrid Seed Company (MAHYCO) (India)
- Nunhems Seeds (Bayer)
- Sathguru Management Consultants (SMS) (India)
- Seminis Seeds

***CGIAR Centers and Other International Institutions***

- Asian Vegetable Research and Development Center (AVRDC)
- International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
- International Institute for Tropical Agriculture (IITA)
- International Plant Genetic Resources Institute (IPGRI)
- International Rice Research Institute (IRRI)
- International Service for the Acquisition of Agri-Biotech Applications (ISAAA)

***NGOs and Foundations***

- American Association for the Advancement of Science (AAAS)
- African Agricultural Technology Foundation (AATF)
- A Harvest Biotech Foundation International (AHBFI)
- Boyce Thompson Institute (BTI)
- Donald Danforth Plant Science Center
- McKnight Foundation Collaborative Crops Research Program

**Four Regional Centers** are being established under ABSPII to facilitate technology development and transfer.
**The Center for South Asia** is managed by K.Vijay Raghavan of Sathguru Management Consultants, India (vijay@sathguru.com).
**The Southeast Asia Center** is situated at the Institute of Plant Breeding, University of the Philippines, Los Baños and managed by Dr Desiree Hautea (hautea@lgn.csi.com.ph).
**The West Africa Center will** be managed by Dr Walter Alhassan (walteralhassan@hotmail.com) and a **Center for East Africa** will be established in the near future.


**For more information, please contact:**

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**Please visit our website at**

**www.absp2.cornell.edu**

A B II S P


US Agency for International Development

*ABSPII is funded by the U.S. Agency for International Development*
*Leader Award No. GDG-a-00-02-00017-00*

# Appendix B: Sample United States Survey

**Please Circle or Write in Appropriate Answers**

**How many semesters have you been enrolled at Bridgewater College?**

**What is your overall grade point average (GPA)?**

- ☐ Below 2.0
- ☐ Between 2.0 and 2.5
- ☐ Between 2.5 and 3.0
- ☐ Between 3.0 and 3.5
- ☐ Above 3.5

**Is your parents' permanent residence in a rural or urban area?**

☐ Rural area ☐ Urban area

**Are you male or female?**

☐ Male ☐ Female

**On average, how many dollars do you spend weekly?**

**How would you describe your knowledge of genetic modification technologies (GM)?**

- ☐ No Knowledge of GM
- ☐ Limited Knowledge of GM
- ☐ Well Informed about GM

**How would you describe your knowledge of pesticides in general?**

- ☐ No Knowledge of Pesticides
- ☐ Limited Knowledge of Pesticides
- ☐ Well Informed about Pesticides

**Are you ever been involved in the agriculture industry?**

☐ Yes ☐ No

**How informed are you about environmental issues?**

- ☐ No Knowledge of Environmental Issues
- ☐ Limited Knowledge of Environmental Issues
- ☐ Well Informed about Environmental Issues

## Appendix C: Facilitator's Instructions in The Philippines

Facilitator's Instructions

Introduction

Eggplant production throughout the Philippines is hindered by the eggplant fruit and shoot borer (EFSB), which causes significant yield losses. This problem is currently managed through frequent spraying of chemical pesticides which pollute the environment.

Pesticides used to fight EFSB have been shown to harm human health and pollute the environment. Studies have documented damage to animals, fish, and beneficial insects. Misuse of pesticides can cause both short-term and long-term injury to human applicators and to consumers.

Currently, scientists are using genetic modification technology (GM) to create a eggplant variety that is resistant to the EFSB. The process used to create this new variety is similar to the process used to create Bt corn. This resistance will decrease the number of pesticide applications on eggplant crops.

The Philippines has established scientific and regulatory processes to thoroughly evaluate GM products and their overall risks before they are accepted and put into use. This GM eggplant technology will be subject to these processes.

The following procedure will ask you to indicate the value you place on the potential health benefits and the reduced pollution of Bt eggplant.

Instructions

In a few moments, you will be asked to place a value on the potential health benefits and reduced pollution of the Bt eggplant technology discussed earlier. Eggplants grown with this technology will require fewer pesticide applications than currently grown eggplants.

You will be asked to write on a piece of paper how much you are willing to pay for the potential health benefits and reduced pollution associated with this Bt eggplant. After you have written your value, place it in the box at the front of the room. Once everyone has finished, the facilitator will read these values aloud. This process will repeat itself a number of times. Each piece of a paper represents a separate value and is not considered cumulative.

At the end of this meeting, the facilitator will choose three people. These people will receive 500 pesos, but they will have to donate one of their values to the organization pursuing Bt eggplant research. If the chosen person places a value above 500 pesos, they will have to pay the facilitator the excess above 500 pesos. If the chosen person places a value less than 500 pesos, then the facilitator will pay the subject the difference between their value and 500 pesos.

# Appendix D: Regressions

## United States Tests Regression

| | |
|---|---|
| Multiple R | 0.54 |
| R Square | 0.30 |
| Adjusted R Square | 0.24 |
| Standard Error | 3.58 |
| Observations | 147 |

ANOVA

| | df | SS | MS | F |
|---|---|---|---|---|
| Regression | 11 | 725.94 | 65.99 | 5.15 |
| Residual | 135 | 1729.39 | 12.81 | |
| Total | 146 | 2455.33 | | |

| | Coefficients | Standard Error | t Stat | P-value |
|---|---|---|---|---|
| Intercept | 1.72 | 0.91 | 1.90 | 0.06 |
| Prior Study | 2.74 | 0.66 | 4.17 | 0.00 |
| Semesters | 0.71 | 0.15 | 4.71 | 0.00 |
| GPA 3.5 | -2.07 | 0.90 | -2.31 | 0.02 |
| Urban | 1.74 | 0.80 | 2.17 | 0.03 |
| Male | 0.28 | 0.67 | 0.41 | 0.68 |
| Higher Expected Value | 0.12 | 1.03 | 0.12 | 0.90 |
| Well Informed about GM | 0.44 | 1.24 | 0.36 | 0.72 |
| Well Informed about Pesticides | 0.99 | 1.12 | 0.89 | 0.38 |
| Well Informed about Environmental Issues | 0.97 | 0.87 | 1.11 | 0.27 |
| Involved in Agricultural Industry | -1.70 | 1.00 | -1.70 | 0.09 |
| Experiment Experience | -3.03 | 1.22 | -2.49 | 0.01 |

## Filipino Farmers Regression

Fuller and Battese Method Estimation

Dependent Variable: Values

Model Description

| | |
|---|---|
| Estimation Method | Fuller |
| Number of Cross Sections | 54 |
| Time Series Length | 4 |

Fit Statistics

| | | | |
|---|---|---|---|
| SSE | 2021717.967 | DFE | 205 |
| MSE | 9862.0389 | Root MSE | 99.3078 |
| R-Square | 0.0539 | | |

Variance Component Estimates

| | |
|---|---|
| Variance Component for Cross Sections | 9873.019 |
| Variance Component for Time Series | 5700.771 |
| Variance Component for Error | 9862.039 |

Hausman Test for Random Effects

| DF | m Value | Pr > m |
|---|---|---|
| 0 | . | . |

Parameter Estimates

| Variable | DF | Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | 265.9974 | 90.6977 | 2.93 | 0.0037 |
| Male | 1 | 68.6858 | 38.6442 | 1.78 | 0.0770 |
| Age | 1 | 1.132179 | 1.4652 | 0.77 | 0.4406 |
| Vegetable_Area | 1 | -6.63686 | 21.9142 | -0.30 | 0.7623 |
| College | 1 | -10.349 | 44.1670 | -0.23 | 0.8150 |
| Owner | 1 | 44.96906 | 36.7298 | 1.22 | 0.2222 |
| Years_in_Vegetable_Farming | 1 | -2.93795 | 1.5567 | -1.89 | 0.0605 |
| Sickness | 1 | 35.58928 | 32.2778 | 1.10 | 0.2715 |
| Pesticide_Harm | 1 | 18.68868 | 43.2682 | 0.43 | 0.6662 |
| Training | 1 | -19.4724 | 36.8462 | -0.53 | 0.5977 |
| Knowledge_of_Bt_Corn | 1 | 47.09284 | 32.6099 | 1.44 | 0.15 |

Parameter Estimates

| Variable | DF | Estimate | Standard Error | t Value | Pr > \|t\| | Label |
|---|---|---|---|---|---|---|
| TS1 | 1 | -179.726 | 19.1118 | -9.40 | <.0001 | Time Series Effect 1 |
| TS2 | 1 | -84.1889 | 19.1118 | -4.41 | <.0001 | Time Series Effect 2 |
| TS3 | 1 | -43.5789 | 19.1118 | -2.28 | 0.0239 | Time Series Effect 3 |
| Intercept | 1 | 389.6234 | 51.0145 | 7.64 | <.0001 | Intercept |