ADOPTION AND UPTAKE PATHWAYS OF GM/BIOTECH CROPS BY SMALL-SCALE, RESOURCE-POOR FILIPINO FARMERS

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Published by: College of Development Communication, UP Los Baños (CDC-UPLB)
The International Service for the Acquisition of Agri-biotech Applications (ISAAA)
SEAMEO Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA)

Citation: Torres, Cleofe S., Romel A. Daya, Ma. Teresita B. Osalla, and Juvy N. Gopela. 2013. Adoption and Uptake Pathways of GM/Biotech Crops by Small-Scale, Resource-Poor Filipino Farmers. College of Development Communication, International Service for the Acquisition of Agri-biotech Applications (ISAAA) SEAsiaCenter, and SEAMEO Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA): Los Baños, Laguna, Philippines.

ISBN: 978-971-95921-0-5

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FOREWORD

For years, the task of getting the farmers out of the vicious cycle of poverty has been an unfulfilled challenge. Despite the many technologies developed in the farming sector, success stories have been quite few. Statistics about poverty point to the farmers, corn farmers included, as among the poorest of the poor.

This grim picture is now changing. In the last seven years or so, when corn farmers in the country started planting varieties of biotech corn, life in the farm has taken another color. Houses are now concrete and furnished with appliances like television and refrigerator. Motorcycles loaded with farm inputs, farm implements, goods from the market, horde of family members, and even construction supplies frequent the route of rugged roads, particularly in the upland areas. Sending children to college has become a dream come true for many families. Women at younger age are becoming farm entrepreneurs. And most significant is that corn farmers can sleep well at night. Such testimonies do not just come from a handful of biotech corn farmers; majority have the same stories to tell.

The evidences of community transformation as borne out by this study further affirm what an earlier similar study covering only Luzon has generated. They clearly speak that the promise of a better life for corn farmers is now being fulfilled. Indeed, biotech crops can be an option for change. But at the end of the day, farmers themselves decide on what is best for them and their families.

This monograph is a tribute to the small-scale and resource-poor biotech corn farmers who have allowed us to capture their narratives on how adoption of biotechnology can be a life changing experience. May this also serve as inspiration to biotech scientists and concerned development workers: your work is not in vain.

Cleofe S. Torres
Project Leader

Randy A. Hautea
Global Coordinator
ISAAA

Gil C. Saguiguit , Jr.
Director, SEARCA

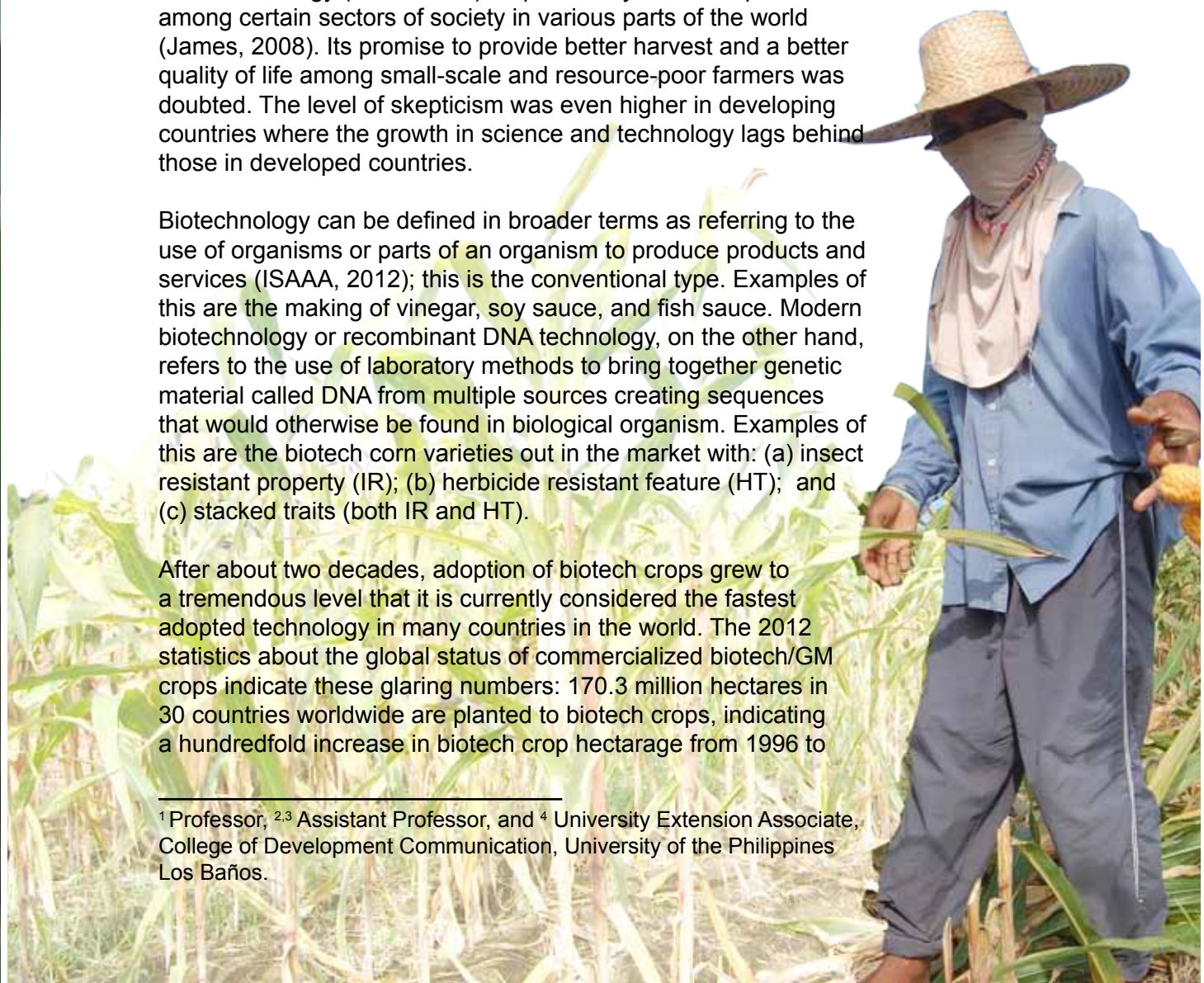
ADOPTION AND UPTAKE PATHWAYS OF GM/BIOTECH CROPS BY SMALL-SCALE, RESOURCE-POOR FILIPINO FARMERS

By Cleofe S. Torres[1], Romel A. Daya[2],
Ma. Teresita B Osalla[3], and Juvy N. Gopela[4]

INTRODUCTION

Background and Rationale

As early as the 1990s, the introduction of genetically modified or biotechnology (GM/biotech) crops already faced skepticism among certain sectors of society in various parts of the world (James, 2008). Its promise to provide better harvest and a better quality of life among small-scale and resource-poor farmers was doubted. The level of skepticism was even higher in developing countries where the growth in science and technology lags behind those in developed countries.



Biotechnology can be defined in broader terms as referring to the use of organisms or parts of an organism to produce products and services (ISAAA, 2012); this is the conventional type. Examples of this are the making of vinegar, soy sauce, and fish sauce. Modern biotechnology or recombinant DNA technology, on the other hand, refers to the use of laboratory methods to bring together genetic material called DNA from multiple sources creating sequences that would otherwise be found in biological organism. Examples of this are the biotech corn varieties out in the market with: (a) insect resistant property (IR); (b) herbicide resistant feature (HT); and (c) stacked traits (both IR and HT).

After about two decades, adoption of biotech crops grew to a tremendous level that it is currently considered the fastest adopted technology in many countries in the world. The 2012 statistics about the global status of commercialized biotech/GM crops indicate these glaring numbers: 170.3 million hectares in 30 countries worldwide are planted to biotech crops, indicating a hundredfold increase in biotech crop hectarage from 1996 to

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2012 (James, 2012). This is a strong evidence that millions of farmers have decided to plant biotech crops despite the debates that have been haunting these crops for years (James, 2012). The fast and wide adoption of biotech crops has been attributed to their substantial and sustainable socio-economic and environmental benefits (James, 2012). This finding is also reinforced by the results of the 2011 study in Europe confirming that biotech crops are safe. Biotech crops that are currently planted in various parts of the world include maize, soybean, cotton, canola, sugarbeet, alfalfa, papaya, soybean, squash, poplar, tomato, and sweet pepper.

The Philippines represents a significant stake in the global market of biotech crops as it is one of the 30 countries in the world using biotechnology. Together with India and China, it is one of the three countries using crop biotechnology in Asia (James, 2009). At present, biotech corn is the only biotech crop commercially planted in the Philippines beginning in 2003. Other biotech crops for potential planting in the country include Bt eggplant, Golden Rice, and papaya with delayed ripening trait.

The literature indicates that a number of studies have already been conducted focusing on the socio-economic impact of the biotech crops adoption in Asia: Yorobe and Quicoy (2006), Gonzales (2007), Huang et al. (2005), and Bennett et al. (2006).

The country report for the Philippines published by the ISAAA (2012) estimates the annual increase in the adoption of biotechnology corn at a steady 5 per cent since it was first commercialized in 2003. ISAAA reports that “the farm level economic benefit of planting biotech maize in the Philippines in the period 2003-2008 is estimated to have reached USD 88 million.”

A study on economic impact of Bt corn in the Philippines reveals the following findings (Yorobe and Quicoy, 2006):

- Yield and income of Bt corn farmers are significantly higher than those of the non-Bt corn farmers.
- Expenditure on insecticide is significantly lower among Bt corn farmers.

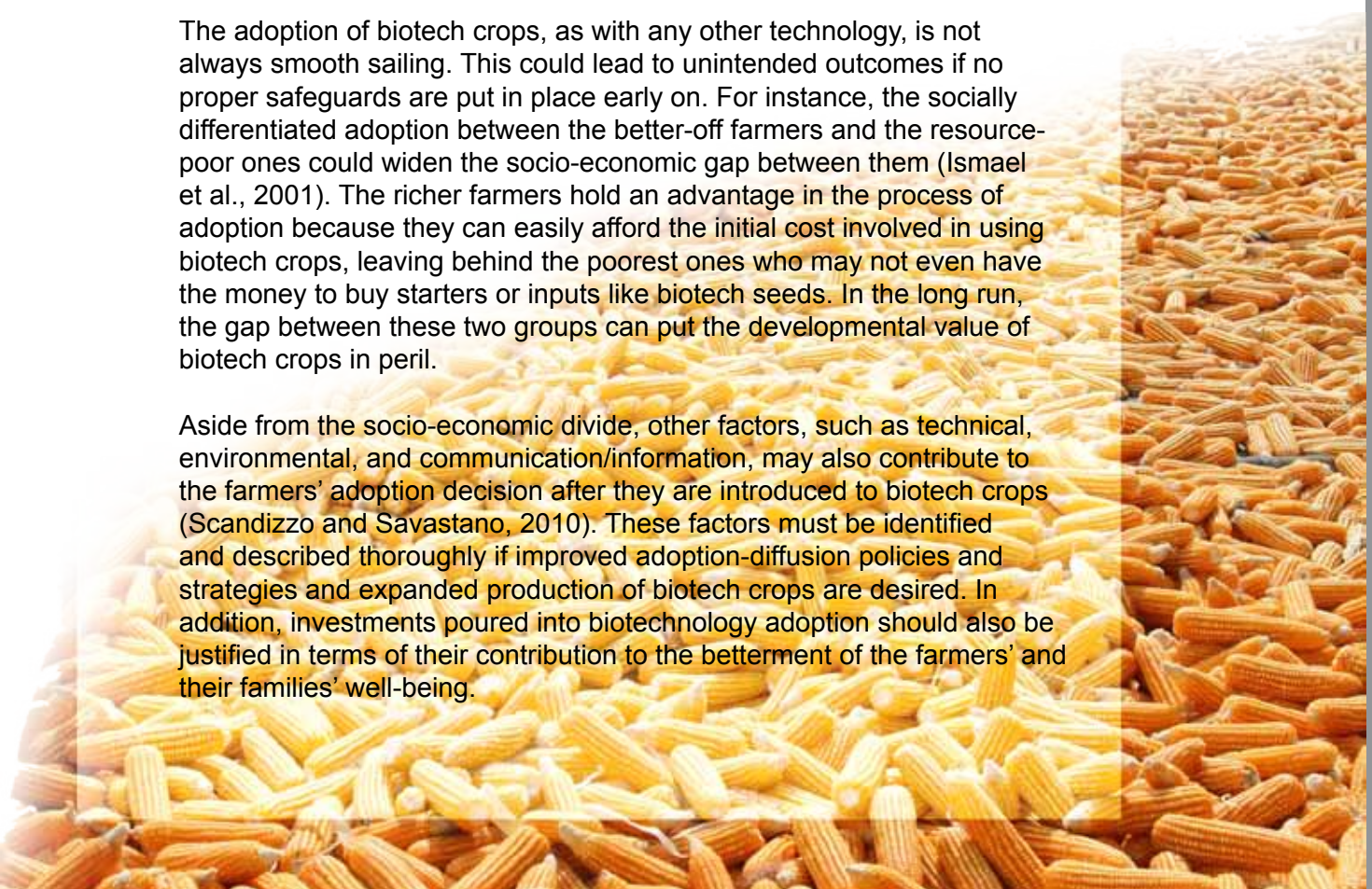
- Results in all study locations show a significant welfare effect of using Bt corn variety among corn farmers.
- Educational level and farm income are among the significant factors that influence the adoption of Bt corn.

The immense benefits above make biotech corn an easy pick for small-scale, resource-poor farmers whose consistent aspiration is to rise from subsistence to profitable farming. But recent adoption and communication studies conducted in the Philippines have, likewise, revealed that while there is high adoption of the crop, majority of the farmers have very low level of understanding of the nature of the technology and the recommended farming practices that go with it (Torres et al., 2012; Torres et al., 2006).

The above situation about fast and wide adoption, substantial benefits derived, but low understanding about the nature of technology triggers a number of questions that need to be answered to systematically and ethically promote the benefits of biotech crops especially among small-scale and resource-poor farmers. Who are the adoptors of biotech crops? How do they get to know the crops? How do they embrace such crops? Who influence them to adopt the crops? What are the dynamics of knowledge seeking and knowledge sharing among them? How do adoption and uptake of biotech crops take place? How are the resource poor-farmers benefited by the technology? Where is the place of biotech crops in the farmers' vision of their future? What changes have occurred in their lives as a result of biotech adoption? What is the prospect of other biotech crops being adopted as well by these farmers?

The adoption of biotech crops, as with any other technology, is not always smooth sailing. This could lead to unintended outcomes if no proper safeguards are put in place early on. For instance, the socially differentiated adoption between the better-off farmers and the resource-poor ones could widen the socio-economic gap between them (Ismael et al., 2001). The richer farmers hold an advantage in the process of adoption because they can easily afford the initial cost involved in using biotech crops, leaving behind the poorest ones who may not even have the money to buy starters or inputs like biotech seeds. In the long run, the gap between these two groups can put the developmental value of biotech crops in peril.

Aside from the socio-economic divide, other factors, such as technical, environmental, and communication/information, may also contribute to the farmers' adoption decision after they are introduced to biotech crops (Scandizzo and Savastano, 2010). These factors must be identified and described thoroughly if improved adoption-diffusion policies and strategies and expanded production of biotech crops are desired. In addition, investments poured into biotechnology adoption should also be justified in terms of their contribution to the betterment of the farmers' and their families' well-being.

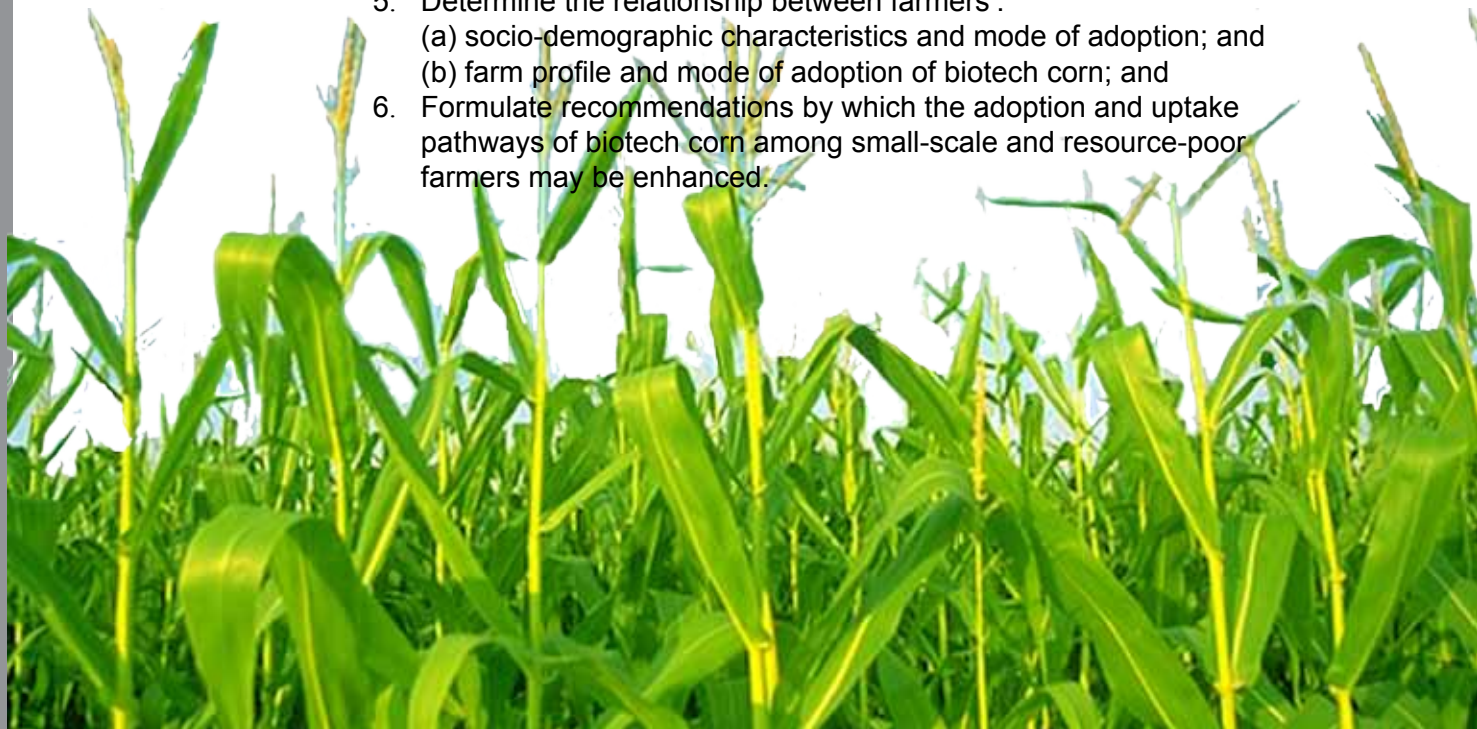


This study was conducted to analyze the dynamics of adoption and uptake pathways of biotech crops among small-scale, resource-poor farmers and the changes these have brought about in the farmers' lives. In terms of crops, it focused on biotech corn, which was the only approved biotech crop for commercialization in the country at the time of the study. Adoption here refers to how the famers acquire and eventually apply the knowledge and practices pertaining to the planting of biotech corn. Uptake pathway refers to the process that captures how the biotech corn is introduced, adopted, disseminated, and shared by the farmers with others.

Objectives

The specific objectives of the study are as follows:

1. Describe the farmer-adoptors of biotech corn in terms of their: (a) socio-demographic characteristics; and (b) farm profile;
2. Analyze the biotech corn adoption patterns in terms of:
   factors considered in adoption;
   - mode of adoption;
   - desire to continue planting biotech corn;
   - awareness of and willingness to plant other biotech crops; and
   - preferred characteristics of future biotech crops;
3. Assess their uptake pathways of biotech corn in terms of:
   - first information received on biotech corn;
   - sources of information;
   - attendance in trainings and workshops;
   - sharing of knowledge on biotech corn;
   - access to facilities and support services; and
   - results of Innovation Tree analysis;
4. Enumerate the benefits derived from and problems encountered in the adoption of biotech corn;
5. Determine the relationship between farmers':
   (a) socio-demographic characteristics and mode of adoption; and
   (b) farm profile and mode of adoption of biotech corn; and
6. Formulate recommendations by which the adoption and uptake pathways of biotech corn among small-scale and resource-poor farmers may be enhanced.



REVIEW OF LITERATURE

Biotechnology Crops in the Philippines

The Philippines is one of the 28 countries in the world, and one of the only four countries in Asia (together with China, India, and Myanmar), using biotechnology crops (James, 2011). Biotech corn is so far the only biotech crop in the country which has been approved for commercialization in early 2003. At present, biotech corn comes in three varieties: insect resistant (IR); herbicide tolerant (HT); and with stacked trait or a combination of being insect resistant and herbicide resistant (Bt/HT).

As early as 1990, the Philippines had already put in place a biotechnology regulatory system through the creation of the National Committee on Biosafety of the Philippines. Similarly, the National Biosafety Framework, considered a model by other countries, was established in 2006. This was followed by the Biosafety Clearing House in 2008. These are the institutional mechanisms put in place for the country's compliance with the provisions of the Cartagena Protocol on Biosafety. The latter is a global protocol for ensuring that the transfer and handling of living modified organisms would be safe to the environment.

As part of a rigorous protocol, biotech crops in the Philippines, such as corn, go through a series of tests before these are commercialized. From contained laboratory to multi-location field trials, the biotech crops are tested for their effects on the environment and health by experts from different government agencies (Panopio and Mercado, 2013). These tests are also reviewed by an independent body of assessors called the Scientific and Technical Review Panel. After all the biosafety and food safety tests that biotech corn has undergone, it has been approved for food, feed, and processing.

Hectarage Planted to Biotech Corn

The succeeding data in this section on biotech corn status in the Philippines were sourced from the Global Status of Commercialized Biotech/GM Crops: 2012 by Clive James, unless cited otherwise.

Adoption rate of biotech corn in the country has consistently been increasing through the years. In 2012, the area planted to biotech corn in the Philippines is projected to increase to 750,000 ha, which is 16 per cent higher than that of 644,000 ha in 2011. In the early years of commercialization, the Bt corn variety was most popular among the Filipino farmers. Through the years, however, farmers opted to shift to the stacked trait variety due to its combined resistance to corn borer and herbicides. In 2012, the stacked trait corn got a 90-per-cent share of the total 675,000 ha planted to biotech corn. On the other hand, the hectarage devoted to single trait Bt corn variety declined through the years with a sharp decrease of 76 per cent in 2012. Likewise, the herbicide tolerant variety (HT) covered only 9.6 per cent of total biotech corn hectarage. The shift from single trait to stacked trait variety has been observed since the introduction of the latter in 2006.

Biotech corn is now benefiting about 375,000 small resource-poor farmers in the country, with farm-level economic gains from biotech during the 2003-2011 period estimated at USD 264.5 million and for 2010 alone at USD 93.6 million.

Biotech Corn Varieties Approved for Commercialization

James' report (2012) enumerated eight events of biotech corn approved for commercial planting in the country. They are summarized in Table 1 below.

Table 1. Biotech corn events in the Philippines

Biotech Corn Event	Trait	Year Approved/ Renewed
MON810	IR	2002/2007
NK603	HT	2005/2010
Bt11	IR	2005/2010
MON810 x NK603	IR/HT	2005/2010
GA21	HT	2009
Bt11/GA21	IR/HT	2010
MON89034	IR/HT	2010
MON89034 x NK603	IR/HT	2011

This consistent yearly increase in adoption of biotech corn indicates that the technology must have been truly benefiting the farmers. This despite the controversy and allegations concerning safe consumption by humans and effect on the environment levelled agains Bt corn by the anti-biotech groups.

Seminal Study on Adoption and Uptake Pathways of Biotech Crops in the Philippines

In 2011 and a year prior to this current study, an earlier work was done to shed light on how adoption and uptake pathways of biotech crops took place among farmers in selected provinces of Luzon, Philippines. Adoption was defined as to how the farmers acquired and eventually applied the knowledge and practices pertaining to planting of biotech corn. Uptake pathway, as viewed from a communication lens, was operationalized as referring to the process that captured how the biotech corn was introduced, adopted, disseminated, and shared by the farmers with others (Torres, et al., 2011).

Results of the study showed that the farmers' adoption and uptake pathways were strongly facilitated by peer and kinship system and were well anchored on the shared lifeworld syndrome. People who significantly influenced them to adopt were their fellow farmers, relatives, and traders. Traders provided them the much needed capital and also served as contract buyers of their produce. Without the traders in the picture, the biotech corn production in the country would not have survived this long. Another group of actors who influenced adoption consisted of the so-called "ambassadors." Though few in number, they were local farmer leaders who diligently did the rounds of visiting farms and barangays to introduce biotech corn, attest to its benefits, and offer technical assistance.

The strongest motivating factor for adoption was the prospect of higher income. This was complemented by agronomic factors (pest resistance, good quality grains, no pesticide spraying) and social considerations (*pakikisama* or camaraderie). The ease of obtaining dependable loans from the traders and having the latter as their assured market outlets had further encouraged farmers to adopt biotech corn.

Other reasons for eventually adopting biotech corn are as follows:

- They have fool-proof assurance of high yield and better income.
- Fellow farmers and relatives are already adopting the technology and they would not want to be left behind.
- There are no longer other corn seed varieties available or are being sold by the seed companies except biotech corn.
- They would not want their farms to be infested by corn borers once all the other adjacent farms are planted to biotech corn that are already resistant to such pests.

The study indicated that uptake was scaled out when the following conditions were present:

- Many farmers were introduced to the technology at the same time.
- Fellow farmers, relatives, neighbors, and friends attested to the benefits of the technology.
- Suppliers of inputs were accessible.
- Loan providers were readily available.
- Market outlets for the produce were assured.

Narratives of Adoption and Uptake of Biotech Crops

A collection of 49 stories from stakeholders, who have adopted biotech crops from 14 countries in the world, has been published by ISAAA in 2009. The stories focused on how planned communication efforts have reached and touched the lives of these stakeholders, so that at the end of the day they became not only adoptors, but also advocates of the biotech crops. From these stories, the factors affecting adoption and its impact on farmers' lives can be gleaned. Two of the featured farmers were Filipinos: Rosalie Ellasus and Edwin Paraluman.

Ellasus' uptake of biotech corn was driven by her unpleasant experience with aflatoxin contamination, pests, and weeds that infested her corn farms in the early years. This paved the way for her attendance in a Farmers Field School (FFS) conducted by the Department of Agriculture in 2001 (Navarro and Tababa, 2009). She came to know of the biotech corn through the field demonstrations of FFS. She then decided to shift to biotech corn, which eventually became a very profitable venture for her. At that juncture, she was convinced that marginal farmers can improve their lot if they would try biotech corn. From 1.3 ha, Ellasus has expanded her corn farms to 6 ha, gaining an average yield of 7.8 tons, a dramatic soar from her previous 3.2 tons/ha harvest.

Paraluman was inspired to try out biotech corn by other farmers' testimonials he read in farming magazines (Navarro, 2009). He was among the first ones to inquire about it when field trials were conducted in South Cotabato. Since then, he has continuously been reaping the benefits of being a biotech corn adoptor. He narrates:

> *"Bt corn provides me with good quality grains; the cob is really clean. The profits are good. I get satisfied comments from feed processors and animal raisers, who buy my corn, which has consistently shown low levels of aflatoxin contamination. Biotechnology has changed many farmers' lives."*

Other documented testimonies include that of a model farmer, Joseph Benemerito, from Cagayan (Panopio and Mercado, 2013). Benemerito said that 22 ha of land could be easily managed with Bt corn, proof of which was a national award he won for his quality corn.

How Adoption Occurs

Diffusion of Innovation

Literature has often placed studies in adoption in the context of Diffusion of Innovation Model developed by Rogers (2003). The model depicts the process by which an innovation (like biotech corn) is communicated through certain channels over time among members of a social system. Rogers emphasized that diffusion is a special type of communication where messages are concerned with new ideas. An innovation is "anything new which is introduced into the social system." The "newness" of the message is what makes this diffusion of innovation unique.

Following this framework, a seminal study on diffusion of hybrid seed corn among Iowa farmers was conducted by two sociologists, Ryan and Gross (1943). The study focused on finding out how communication helped bring about change, such as adoption of hybrid corn. It also raised the question, "From whom in the system do you obtain information that leads you to adopt the innovation?" Their findings showed that mass media had limited effect in advancing diffusion and that it was face-to-face interaction that further shaped the process. The typical Iowa farmer first heard about the hybrid corn from a corn salesman but interpersonal communication with peers was the most frequent channel leading to persuasion.

Interpersonal communication with neighbors was essential in clinching adoption decisions. Those who perceived the hybrid corn as risky were more likely to seek the advice of their neighborhood opinion leaders about it.

Of significance was the finding that the process from awareness-interest-evaluation-trial and finally adoption took **nine years**, implying that a considerable time was required for adoption to occur. This was partly attributed to the technology being capital-intensive, a vital factor affecting the decision to adopt.

Social factors affecting subsequent adoption involved physical proximity among the actors. Farmers accessed freely the results or outcomes of their neighbors' experiments in the farms and information quality was not lost in the process of sharing. This means that communication tends to exhibit high fidelity of information when done among peers in close physical proximity.

The study also explained that the adoption of hybrid corn among Iowa farmers was triggered by the profitability of the technology. Farmers were viewed as profit-maximizers. It was noted that the first farmers to adopt (the innovators) were more cosmopolite and of higher socio-economic status than late adoptors.

Adoption Perspectives

Scholars in recent years took note that any approach to adoption is defined by the kind of perspective that the adoption drivers have about the technology users (Melkote and Steeves, 2001). These perspectives may be categorized into two: (a) blame-the farmer; and (b) blame the system. The first views non-adoptors as laggards and so, recalcitrant. This is attributed to some "in-the-head socio-psychological factors" that prevent the farmers from adopting perfectly good innovations. Examples of these psychological factors are fatalism, familism, religiosity, and lack of deferred gratification. This perspective implies that adoption can only occur once the farmers' traditional mindset is addressed.

The second perspective is a critique of the first and argues that there are non-psychologically-based factors hindering adoption. These are external to the farmers and would include: lack of financial and material inputs; lack of necessary infrastructure, such as roads, to facilitate marketing of produce; or lack of support services, such as irrigation, credit sources, and post-harvest facilities (Ascroft, 1973).

The findings on the internal and external constraints to adoption led further to the rise of a multidisciplinary broad-fronted approach called the Integrated Rural Development (IRD) approach, which was put forward by the World Bank (1973) through its then president, Robert McNamara. IRD aimed to address the piecemeal approach and remove all identifiable bottlenecks constraining adoption among farmers.

Learning from Friends

Winter-Nelson (2012) reported that learning from a friend could be a stronger motivator for adoption. He cited that things learned from a friend included using fertilizers in production of grains, trying new varieties, and installing irrigation system to grow high value vegetable crops. All these could not be merely observed in neighbors' fields and would require more details that farmers have to go to people they like to interact with socially. The researcher reasoned out that sometimes farmers would not talk to their neighbors because they did not like them.

Learning from Peers

Peer teaching was found to be the preferred learning process by farmers (Franz, 2010). As observed during the information gathering stage, a farmer: seeks evidence to support decisions; determines costs and benefits of the decisions; discovers pitfalls of the potential decision; and then decides to adopt or not to adopt. Usually, farmer-to-farmer relationship is more beneficial as farmers rely mostly on first-hand information from their peers. They find it rewarding to be of help to their fellow farmers.

Communication Factors

A very recent study looked into the communication factors in biotech corn innovation-decision process among corn farmers in Koronadal City in South Cotabato, Philippines (Villar, 2012). Unlike the previous studies on adoption, this one focused on non-adoption, specifically on the reason why farmers opted not to continue adopting biotech corn despite the benefits being communicated about it.

There were five reasons for farmers' non-adoption of biotech corn. Farmers: (1) completely shifted to other crops, such as rice and dwarfed coconuts, etc; (2) planted only white native corn variety; (3) alternately planted native yellow and white corn varieties; (4) planted native corn varieties with vegetables, root crops, and/or fruit trees; and (5) planted only conventional /native yellow variety. About 20 per cent (7 out of 35) of non-biotech corn adoptors were identified in the study site.

The main communication factor found to have affected the farmers' eventual non-adoption of biotech corn was the gap between information sharing among farmers on farmer-developed technologies and the failure to link farmers with the knowledgeable sources and experts on biotech crops. Specifically, the need for solutions to deal with *wayawaya*, stalk rot, black bug, and rats remained unresolved and unattended although corn farmers have been communicating these to the seed company agents, seed company technicians, and the city agriculture office for almost 10 years. Unlike rice where technical assistance abounds, there were no extension agents or experts on biotech corn the farmers could access or go to when they encountered problems in the field.

Aside from communication, another factor in non-adoption involves cost of inputs. The farmers who converted to planting rice, native white corn, and dwarfed coconut cited high prices of inputs and low price of produce as their main reasons for the cessation of biotech corn farming.

Factors that Correlate with Adoption

Educational level and farm income were among the significant factors that influenced the adoption of biotech corn (Yorobe and Quicoy, 2006).

Factors that influence adoption include: resource endowments (land, credit, and farm inputs); economic incentives; demographic characteristics; and agro-ecological characteristics (Monge et al., 2008). Specifically, the resource-poor farmers are not likely to adopt new technologies at once, such as biotech corn. It would take time before they fully adopt or venture into the new technology (Finan, 1998). Faced with uncertainty with regard to production risks, they would be unwilling to gamble their immediate, short-term subsistence security for the promise of higher yields.

In terms of demographic characteristics, women-farmers were found to be multi-taskers. They were more adaptable to change than men. Men liked the security of routine and they also liked to know what to expect (Franz et al., 2010).

Embeddedness in social networks also affects how resource-poor farmers interact, exchange information, and eventually adopt a technology (Monge et al., 2008). Those with higher position in the social networks would have better access to information and resources necessary to adopt the technology, such as credit, land, and farm inputs (seeds, fertilizers, etc).

Impacts of Adoption

Economic Impact

A study on the economic impact of biotech corn adoption in the Philippines was undertaken one year after its approved commercialization in the country. Among its salient findings are the following (Yorobe and Quicoy, 2006):

- Yield and income of biotech corn farmers were significantly higher than those of the non-biotech corn farmers. The economic benefit of planting biotech corn translates to around ₱10,132 (USD 180) increase in profit per hectare. Another study (Gonzales, 2007) reported that biotech corn could provide an overall income advantage of 5-14 per cent during wet season and 20-48 per cent during the dry season.
- Expenditure on insecticides was significantly lower among biotech corn farmers.
- Results in all locations of the study showed a significant welfare effect of using biotech corn variety among corn farmers.

Environmental Impact

The documented impacts of planting biotech crops, such as corn, likewise look encouraging. Pesticide use on biotech crops in the countries where they have been planted have fallen by at least 443 million kg from 1996 to 2010 (James, 2011). This contributes to reduction of environmental footprint of agriculture, thereby contributing to a safer environment and more sustainable agriculture systems (James, 2012). Because planting biotech crops can produce higher yield on limited land area, it may also be considered a land-saving technology in itself since it can help reduce deforestation. Eventually, it can contribute to biodiversity protection.

Adoption of Other Agricultural Technologies

A study commissioned by CGIAR looked into the factors affecting the adoption and impact of selected agricultural technologies in various parts of the world (Sechrest, et al.,1998). Sample technologies included those pertaining to groundnut, cassava, sorghum, dairy, and bananas, among others. While noting the voluminous studies that have already been conducted on factors that facilitate or hinder adoption, the paper approached systematically those critical requirements for a successful agricultural research system. It noted :

> *"To a great extent, promotion of adoption of agricultural technologies seems an afterthought or as a task of no great consequence or difficulty. The problems may not lie with recalcitrant farmers but with agricultural agencies that are not sufficiently attentive to what is known about promoting adoptions. Why, in hindsight, do agricultural agencies appear to put inadequate resources to promotion?"*

A synthesis of findings based on the cases studied was done and those that have important bearing on adoption of biotech corn are as follows:

- Bringing about successful adoption of innovations requires a strategy and specific allocation of responsibility.
- Adoption promotion strategies should include demonstrations of the effectiveness of innovations.
- Reliance on progressive farmers as models may be a useful part of the strategy.
- Strategies of adoption should take into account that both technology and the process of its adoption are dynamic.

Parallel to the above CGIAR study was a report produced by UNEP's International Environmental Technology Centre focusing on practical methodologies and tools for promoting adoption of sound technologies (IETC, 2003). This was in recognition of the fact that the uptake of technologies supporting sustainable development had been disappointing despite many initiatives taken on the matter. Their recommendations in the form of guiding principles are summarized below into seven Cs.

- Context – Performance of technology depends on the environment prevailing in a given locale. In any context, technology should be assessed in terms of environmental soundness, economic viability, and social acceptability.
-
- Challenges – From the supply side to the demand side, barriers are likely to occur and their severity depends on prevailing circumstances.
-

- Choice – Technology users should be able to make informed choices by being able to identify and procure those which they deem appropriate to their circumstances.

- Certainty – Lack of certainty or consequential high level of risk are major impediments to adoption. Access to sufficient and verified information could help increase certainty and thus negate the perception that a technology is just “emerging” and hence “unproven.”

- Communication - It is requisite for harmonizing the contributions of different players in the adoption process.

- Capacity – Stakeholders and those providing the support system and enabling environment to technology adoption should have the necessary knowledge and skills to perform their tasks.

- Commitment – Where technology transfer failed, there must be a commitment to overcome the challenges and build up the capacity to do so.

Theoretical Framework

Most of the studies on adoption are anchored on the diffusion of innovation theory by Everett Rogers (1962, 1983). Even the path for uptake of biotech corn has been mostly undertaken and studied with this theory as the guide and lens for analysis. Its accompanying diffusion model assumes that a proper mix of mass mediated and interpersonal communication strategies can move individuals from a process of awareness (A) of the new technology through interest (I), evaluation (E), trial (T), and finally adoption (A) (Figure 1).

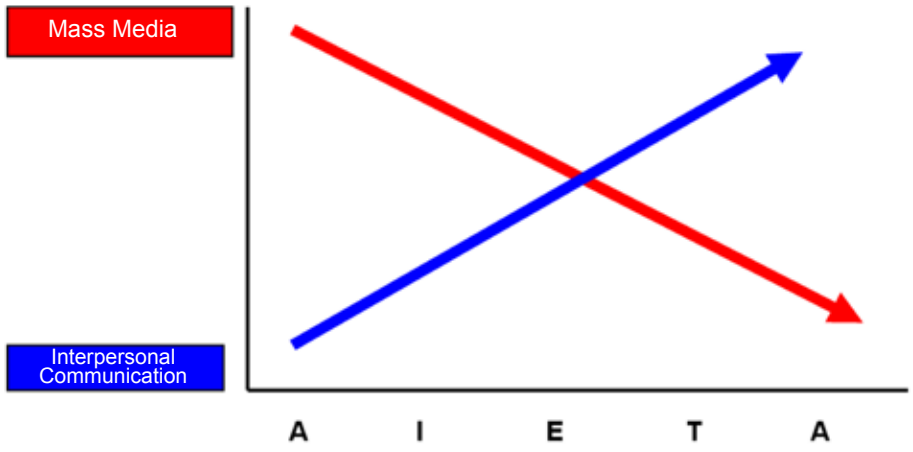


Figure 1. Diffusion of Innovation Model (Rogers,1962)

Moving this process along are the extension workers of the government, who act as “change agents” attempting to influence the adoption decisions in a direction deemed desirable. This approach assumes that the farmers are rationale enough to see the value of the innovation, such as technology. In recent years, the model has been criticized as “pro-innovation, pro-persuasion, and top-down” in nature.

As existing literature would indicate, earlier studies on biotech corn adoption were more closely hinged on the diffusion model than anything else. Hence, this study adopts the same model. But to address its reported weakness, the diffusion of innovation theory will be complemented by the social cognitive/influence theory (Bandura,1977) as additional perspective in analyzing the findings on adoption and uptake pathways.

Social cognitive theory states that people learn behaviors through observation, modeling, and motivation, such as positive reinforcement. Its four tenets are as follows:

1. People learn by observing others, a process known as vicarious learning, not only through their own direct experiences.
2. Although learning can modify behavior, people do not always apply what they have learned. Individual choice is based on perceived or actual consequences of behavior.
3. People are more likely to follow the behaviors modeled by someone with whom they can identify. The more the perceived commonalities and/or emotional attachments between the observer and the model, the more likely the observer will learn from the model.
4. The degree of self efficacy that a learner possesses directly affects his/her ability to learn. Self efficacy is a fundamental belief in one’s ability to achieve a goal. That is, if one believes that s/he can learn new behaviors, s/he will be much more successful in doing so.

The social influence theory likewise explains that people rely on the opinion of others, especially when the situation is highly ambiguous or uncertain and no objective evidence is readily available.

Conceptual Framework

This study assumes that certain factors serve as drivers of adoption. These include the respondents’ socio-demographic characteristics and farm-related profile (Figure 2). As independent variables, they influence the farmers’ mode of adoption categorized as *in toto* (adopted all biotech corn farming practices as recommended), partial (adopted only some of the recommended practices), and modified (adopted all but modified certain practices).

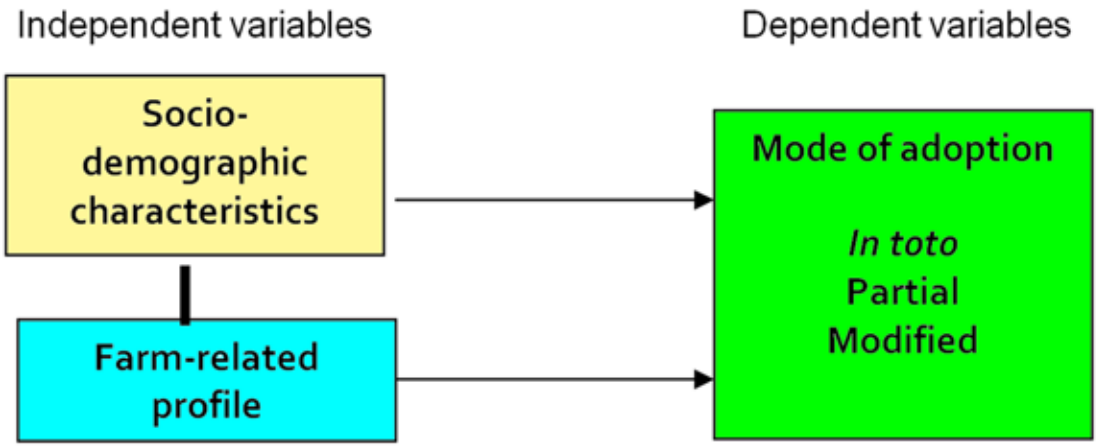


Figure 2. Conceptual framework of the study

METHODOLOGY

Research Design

The study made use of descriptive research design, combining survey and correlational study. As a descriptive study, it looked into the nature and prevailing patterns in the socio-demographic characteristics, farm profile, as well as the adoption and uptake pathways of biotech corn adoptors in the identified locale. As a correlational study, it determined whether relationship existed between the socio-demographic characteristics of farmers and their adoption mode; and between their farm profile and adoption mode of biotech crops.

Locale of the Study

The study covered three provinces in the Philippines, one in each of the major islands of Luzon, Visayas, and Mindanao. In colloboration with ISAAA, the provinces identified were Pampanga in Luzon, Iloilo in Visayas, and South Cotabato in Mindanao (Figure 3). These are known to be major corn-producing provinces.

Pampanga. The province lies in the Central Luzon region and has mostly lowland areas devoted to rice. Corn is its second crop during the dry season. Based on data from the Office of the Provincial Agricuturist (OPAG), there are about 4,722 ha, mostly lowland areas, planted by 2,905 farmers to biotech corn in the province. The top three corn-producing municipalities are Arayat, Magalang, and San Vicente. Irrigation is a main feature of their biotech corn farming. Price of corn grains ranges from Php11 to Php 14 per kilo. Farmers used to plant yellow corn but shifted to biotech corn once they heard and observed that many of their fellow farmers began to earn as much as Php 40,000-Php60,000 per

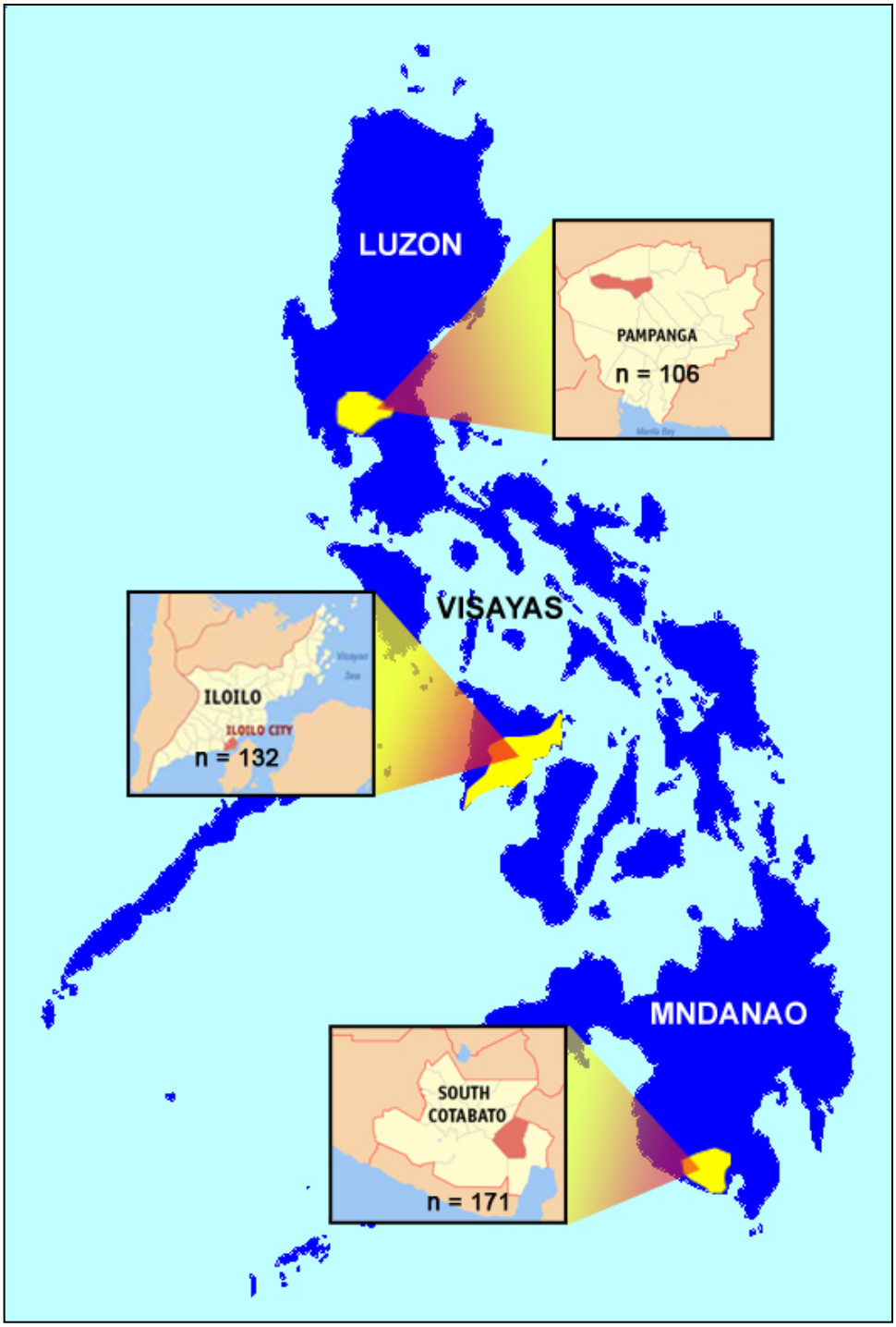


Figure 3. Location map of the three study sites

hectare. A famous pioneer and champion of biotech corn in the province, who goes by the name “Kong Carlos”, has become a very successful businessman and financier of other biotech corn farmers. An increase of 70-80 per cent in their income has been reported and this less-than-100-per-cent figure has been attributed to their big expense on irrigation.

Iloilo. The province is located at the southern and northeastern part of Panay Island in the Visayas. One of the six provinces of Region VI (Western Visayas), Iloilo is the top producer of yellow corn in the region. Most of the northern part and upland areas of Iloilo are corn-producing areas. Based on data provided by the focal corn coordinator at the DA Regional Field Unit (RFU), there are about 36,000 ha planted to corn in Region VI. Farms average 1 ha in size and are located mostly in upland areas, rendering the biotech corn farmers as indeed small-scale and resource-poor. There are two distinct planting calendars for corn: March-May and September-November. Despite the volume of corn produced, the region still has to meet the 570 MT demand for corn. This demand is due primarily to the high livestock and poultry industry in the area needing corn for feeds. In 2011, the area was able to produce only 242 MT of this demand. Of interest was the information provided by the coordinator that most of the "financiers" of biotech corn in Iloilo are rich locals and overseas workers (such as seamen).

South Cotabato. This is located in the southwestern part of Mindanao Island. As confirmed by the municipal agriculturists, the top four biotech corn-producing municipalities in the province are Lake Sebu, T'boli, Banga, and Polomolok. Lake Sebu leads all these municipalities in terms of volume of production (i.e., 33,956 ha of corn area harvested). The municipality with the largest land area in South Cotabato is also Lake Sebu. The volume of biotech corn produced in one of the municipality's barangays, Ned, is larger than that of any of the other municipalities of South Cotabato. The barangay, however, is too remote. It would take almost a day to reach the area since it is accessible only by single motorcycle or by foot. The barangay is also allegedly home to many members of the rebel group Moro Islamic Liberation Front (MILF). A former priest and currently a Board Member of the province reported that there was very strong opposition to GM crops in South Cotabato coming from the Roman Catholic church, as well as several non-government organizations (NGOs) and people's organizations (POs). Hence, the provincial government has never openly promoted biotech corn to farmers. The local politicians just let the farmers decide for themselves on whether or not they would adopt biotech corn.

Sampling Method and Selection of Respondents

Since the research focused primarily on adoption and uptake pathways, the sample respondents included only those farmers already adopting biotech corn. Adoptors would be the only ones in a position to answer the questions of the study. While it was not the principal intent of this study to delve into the behavior of non-adoptors, given the practical difficulty of finding them in the sites which already had high level of biotech corn adoption, the research nonetheless exerted effort to identify and include those found in the areas.

Multi-stage sampling was done. After the focal provinces have been identified, the top three to four municipalities per province with the most number of biotech corn farmers were then selected. They were also the same municipalities with the highest produce of biotech corn at the provincial level. Then, from each municipality, the top three barangays with the most number of bioetch corn adoptors were identified. The final list of farmers was obtained from the following: the extension worker of the Pampanga Agricultural College in Pampanga; MODEL Farmers Association in Iloilo; and Office of the Municipal/City Agriculturist (OMAG) in South Cotabato. The list of biotech corn farmers was not consistently available from OMAG in all the municipalities. Usually, these corn farmers were better known to seed suppliers, traders, and cooperatives.

Based on the number of farmers provided by the sources above, the number of samples per province was computed using Slovin's formula as follows:

n=N/ (1+Ne 2) where: n=number of samples
N= total population of biotech crop farmer
e=error tolerance or desired margin of error (.05%)

Based on the above computation, the number of sample respondents identified for each province and municipality are summarized in Table 1.

Table 2. Distribution of sample respondents by province and municipality

Province/Town	Frequency	Percentage (%)
Pampanga:		
Arayat	27	6.6
Magalang	26	6.4
Mexico	53	13.0
Sub-total	106	26.0
Iloilo:		
Batad	9	2.2
Lemery	43	10.4
Sara	80	19.5
Sub-total	132	32.1
South Cotobato:		
Banga	29	7.1
Lake Sebu	51	12.5
Polomolok	30	7.3
T'boli	61	14.9
Sub-total	171	41.8
Grand Total	409	100.0

Data Gathering Methods and Instruments

The data gathering methods employed were survey, focus group discussion (FGD), and key informant interviews (KIIs). The survey made use of a structured interview schedule designed to gather the respondents' socio-demograpic characteristics, farm-related profile, and the "what, who, why, and how" of their adoption. FGD employed the Innovation Tree technique to probe on the details of the farmers' uptake pathways of biotech corn.

The Innovation Tree method is a participatory rural appraisal tool designed to enable respondents to visualize and analyze the way in which an innovation is spread over time among community members (Van Mele and Zakaria, 2002). The method is qualitative in nature and provides an opportunity for the farmers to discuss with fellow farmers the dynamics of adoption of biotech crops in their community. The method also probed the socio-economic benefits and changes the farmers valued the most in adopting a biotech crop.

A number of KIIs were done with the provincial and municipal agriculturists, as well as extension workers who went with the research team to the field. Background data on information about corn production and farmers' socio-economic conditions, adoption behavior, and local networks were also explored with them. Likewise, a number of financiers and/or traders were interviewed to find out more about the financing schemes and marketing systems prevailing in the area as these relate to the farmers' adoption behavior and uptake pathways. In a few cases, additional interviews were done with non-adoptors of biotech corn whenever they could be found in the area.

Data Analysis

Quantitative data derived from survey were analyzed using descriptive statistics (i.e., means, frequencies, percentages) and simple inferential statistics (i.e., correlation tests). The data generated from FGDs, particularly from the Innovation Tree exercises, were summarized using flowcharts to depict the overall shape and direction of the uptake pathways between different farmer groups. Data from KIIs and FGDs were documented as narratives to support the analysis of quantitative data. Whenever appropriate, FGD and KII results were also used to explain some patterns and trends observed in the study.

To determine the relationships between selected variables, the following null hypotheses were formulated and subjected to appropriate statistical tests:

- There is no relationship between farmers' socio-demographic characteristics and their mode of adoption of biotech corn.

- There is no relationship between farmers' farm-related profile and their mode of adoption of biotech corn.

The statistical tests used were Spearman's Correlation Coefficient for variables on ordinal scale and the Chi-Square Test of Independence and Cramer's V test for variables on nominal scale.

RESULTS AND DISCUSSION

Socio-demographic Characteristics

Table 3 presents the consolidated data on the socio-demographic characteristics of biotech corn adoptors. These include age, gender, civil status, number of children, educational attainment, additional sources of income, and organizational affiliation.

Age

Majority of the biotech corn farmers were nearing their senior years, with 52.8 per cent belonging to the 41-60 age bracket. Only about one-third (28.9%) were 40 years old and below. Average age was 48. According to the farmers themselves, the 41-60 age range covers their productive years. Having gained experience already in the earlier years prior to their 40s, they are at the stage where they can easily discern "what works and what does not" in their farms. Also, as they age and their ability to do manual work diminishes, they resort to hiring farm labor to do the strenuous farm tasks for them.

Gender

The biotech corn farming sector was dominated by man-farmers (74.1%), but with women (25.9%) increasingly getting engaged in the enterprise. This trend was evident in all the provinces. During the field data gathering, the women farmers met were generally younger than the males. These women remarked that they performed mostly managerial tasks (e.g., funding farm activities and deciding on the inputs, among others) and they usually hired laborers to do the laborious farm activities for them. Other respondents have noted the increasing trend for females to engage in biotech corn farming, not as mere farm help, but more as farm entrepreneurs, managers, and decision makers themselves.

Education

Majority of the biotech corn adoptors have gone beyond elementary schooling, with 43.3 per cent having reached and/or completed high school and 16.4 per cent having gone to and/or completed college. Apparently, the picture of corn farmers in terms of education is changing. This also points to the emerging trend that biotech corn adoptors are more highly educated than the typical corn farmers (Yorobe and Quicoy, 2006).

Civil Status

The biotech corn farmers in the study were mostly married (85.1%). This is consistent with the farmers' characteristics in the country. Being a household enterprise, farms are usually being managed by married males as source of income for their families.

Family Size

Though not a majority, a bigger percentage of respondents (40.6%) had only 1-3 children. Those with bigger family size of 4-6 children accounted for lower percentage (35%). There were very few (14.7%) who had the proverbial big farm family size of 7 and more children. These data indicate that farm families engaged in biotech corn are decreasing in size. Having relatively higher education, they could have been enlightened on the value of having fewer children.

Organizational Affiliation

A greater proportion of biotech corn adoptors (66.5%) were members of organizations, most of which were related to farming. About one-third (32.5%) were unaffiliated. It should be explained that the respondents were also rice farmers, engaged in biotech corn planting during the dry season. Hence, their engagement in rice farming was primarily the one that brought them to being members of farming organizations. Nonetheless, these organizations also attend to their needs pertaining to other crops, like biotech corn.

Table 3. Socio-demographic characteristics

Socio-demographic Profile	Frequency (n=409)	Percentage
Age		
20 and below	4	1.0
21-40	114	27.9
41-60	216	52.8
61 and above	75	18.3
TOTAL	409	100
Gender		
Male	303	74.1
Female	106	25.9
TOTAL	409	100
Education		
No education	1	0.2
Elementary	146	35.7
High school	177	43.3
College	67	16.4
Vocational	16	3.9
No answer	2	0.5
TOTAL	409	100
Civil status		
Single	38	9.3
Married	348	85.1
Widow/widower	19	4.6
Separated	4	1.0
TOTAL	409	100
Family size		
None	40	9.7
1 to 3	166	40.6
4 to 6	143	35.0
7 and above	60	14.7
TOTAL	409	100
Organizational affiliation		
Member	272	66.5
Not a member	133	32.5
No answer	4	1.0
TOTAL	409	100

Farm-related Profile

Table 4 summarizes the farm-related profile of the biotech corn farmers who served as respondents in this study.

Number of Years Farming

The farmers were almost equally distributed to those who were farming for 15 years and below (39.8%) and those farming for 16-30 years (37.6%), regardless of crops planted. Average number of years farming was 23. Hence, it can be said that the respondents are already seasoned farmers based on experience.

Number of Years Planting Biotech Corn

Biotech corn was approved for commercial production in the country in 2003. Thus, at the time the study was conducted, the crop has been commercialized in the farms for almost 10 years. There were more farmers (46.5%) planting biotech corn for a longer time (i.e., 6-10 years) than those planting for only 1-5 years (37.9%). Average number of years planting biotech corn was 6.85 years. So, in terms of technology adoption, biotech corn farmers can be categorized as relatively late adoptors, having taken almost three years after the crop was commercialized before engaging in its production. The number of adoptors actually started with a fewer ones in the initial years and then multiplied through the years as they themselves saw and experienced increased yield and income from planting biotech corn. Details on how farmers went through their uptake pathway are discussed in the Innovation Tree analysis portion of this report.

The relatively late adoption of biotech corn was due to two reasons: they lacked the capital to start the new venture and they were not so sure of how the new crop would perform. The farmers' eventual adoption was facilitated by the putting up of demonstration farms in the different areas by private seed companies. These, according to the farmers, enabled them to see and observe the actual performance of the crop. More than their acceptance of the crop's performance, they were also offered assistance by the seed companies in terms of loans in kind (seeds, weedicides, fertilizers) and cash for the other required inputs (labor, rentals). The expansion of farms planted to biotech corn gave rise to the emergence of "financiers" who readily provided easy-to-access production loans on the condition that they be the sole buyers of the farmers' corn produce. This scheme was not actually new, having been brought over from their rice farming production arrangement with traders. So aside from the promise of better income, sure capital and sure buyers for their crops made the biotech corn adoption an attractive venture in the various communities.

Varieties of Biotech Corn Planted

Data gathering on this aspect was marred by some difficulty and confusion as many farmers were not familiar with the varieties of biotech corn they were using. Biotech experts categorized the biotech corn varieties into three: (a) variety which exhibits a trait of being resistant to corn borer (IR); (b) variety which exhibits tolerance to herbicides (HT); and (c) variety with stacked trait or which exhibits resistance to both the corn borer and herbicides (IR/HT). But in the field, there was a prevailing misconception among almost all the farmers that Bt corn, an IR variety, was the only one existing and available.

To determine the specific varieties used, farmers were asked the labels or number codes of the seeds they bought. They would remember the DKs and MON810 but rarely the complete names. So other options for identification were undertaken by the researchers and these included the following: inspection of the seed bags they have kept; asking their fellow farmers who planted the same seeds; asking the municipal agriculturist or extension worker who usually visits them and is familiar with their farms; and asking their fellow farmers who double as corn buyers. One important guide observed was that farmers in an area or cluster would usually adopt the same variety as they have almost always the same seed supplier.

Results indicated that farmers did not stick to only one corn variety in all planting seasons. They would change their corn variety per planting season depending on what was readily available from the seed suppliers. Majority (68.7%) planted the one with stacked trait (IR/HT) as it is resistant to both the borer attack and the weedicides being sprayed on corn plants as they grow. HT ranked second (53.3%); and unexpectedly, Bt corn was planted by only 24.9 per cent (Table 7). This somehow clarifies the picture and the misconception that Bt corn is the one most popular among biotech corn farmers. The fact borne out by the data is that Bt corn is the least planted.

Some farmers observed that biotech corn varieties, which yield smaller grains, give them higher weight and better income so they look for this feature come planting time. The problem, however, was that quality of seeds was sometimes not assured. There were reported instances when the seeds did not germinate and the farmers did not even know that seeds could expire. This case happened to many farmers in Iloilo and South Cotabato:

> *"There was a case when the seeds supplied to us did not germinate. We all thought about it as weird. But then nobody explained to us that seeds could actually expire. The supplier informed us about it later. Good that he replaced all the faulty seeds."*

The case above further reflects the inadequacy of information given the farmers about biotech corn. Even documented reports and literature make no mention about such possible anomaly. Hence, this is an area in adoption which should be clarified early on to the adoptors, lest they lose their trust on the crop.

Farm Size

The respondents typified the smallholder-farmers, with 41.8 per cent owning 1-2.99 ha. The average farm size was 2.7 ha. This figure does not depart much from the results of earlier studies citing 2.64 ha (Yorobe and Quicoy, 2006) and 2.17 ha (Torres et al., 2012) as the average farm size of biotech corn farmers.

Topography of Farms

There were more mountainous or upland areas (52.3%) devoted to biotech corn planting than those in the lowlands or plain areas (38.1%) in this study. A few farmers (6.85%) ventured farming in areas having both topographies. The location of farm lands has implications on the farming practices and economic aspect of production, as shown in the succeeding paragraphs and in the discussion of income from biotech corn farming.

Those planting in the lowlands practiced land preparation and tillage while those in the uplands practiced "no tillage." Land preparation, like plowing and harrowing, involved rentals for tractors, hired labor, and other expenses for irrigation. A sample cost for land preparation alone was reported to amount to Php 3,000/hectare. Irrigation cost (to cover diesel cost for the pump) was as high as Php 18,000/ha. Hence, lowland farms incurred higher production cost than the upland farms.

As observed in the field, there were no visible signs that the farmers were using some kind of soil conservation measures. Corn was simply planted on rows without necessarily following the contours. This is an area that should be probed further so that appropriate soil conservation measures may be put in place.

Ownership of Farms

There was high percentage (60.9%) of biotech corn farmers who owned their farms. Nearly one-third (27.6%) were renting farms, a common practice among farmers with limited farm size but have the capacity to finance more areas for planting. There were also instances when other farmers would not like to invest on the needed capital, so they skipped planting and had their farms rented out instead. In another extreme, there were also farmers who were not able to repay their loans to financiers. They would be blacklisted and would not have any capital to plant again. To maintain their source of income, they rented out their farms to others. Under the arrangement, those farmers renting out their farms still get a percentage share of the harvest.

> *"Planting biotech corn is expensive. We could not re-use or raise our own seeds. It is not always that we have the needed capital. Especially if our farms are small, we would rather rent them out than bear the burden of paying later. We could actually lose if we still have to pay for irrigation."*

Table 4. Farm-related profile

Farming Profile	Frequency (n=409)	Percentage
Number of years farming		
15 and below	163	39.8
16-30	154	37.7
31-45	56	13.7
46 and above	32	7.82
No answer	4	0.98
TOTAL	409	100
Number of years planting biotech corn		
Less than 1	26	6.3
1-5	155	37.9
6-10	190	46.5
Incorrect answer (11 and longer)*	26	6.4
No answer	12	2.9
TOTAL	409	100
Varieties of biotech corn planted **		
Stacked trait (IR/HT)	281	68.7
Herbicide tolerant (HT)	218	53.3
Bt corn (IR)	102	24.9
Yellow corn	41	10.0
No answer	2	0.5
Farm size		
2.99 ha and less	301	73.6
3.00 – 5.99 ha	74	18.1
6.00 – 9.99	8	2.0
10.00 ha and above	9	2.2
No answer/ Irrelevant answer	17	4.1
TOTAL	409	100
Topography of farms		
Plain	156	38.1
Mountainous, slope	214	52.3
Mixed	28	6.9
No answer	11	2.7
TOTAL	409	100
Ownership of farms		
Owned	249	60.9
Rented	113	27.6
Combination of owned and rented	47	11.5
TOTAL	409	100

* Biotech corn was commercialized only in 2003.

Table 4. continued...

Farming Profile	Frequency (n=409)	Percentage
Sources of capital**	s	
Individual money lender	221	54.0
Trader	100	24.5
Relative/friend	72	17.6
Own money/savings	57	13.9
Lending institution/bank	36	8.8
No answer	7	1.7
TOTAL		
Market outlets**		
Trader	354	86.5
Seed company	36	8.8
Town market	15	3.7
Miller	5	1.2
Cooperative	6	1.5
Not applicable	17	4.2
Gross income from farming		
Php 50,000 and less	92	22.5
Php 50,001-100,000	134	32.8
Php 100,001and above	183	44.7
TOTAL	409	100

** Multiple response

Sources of Capital

Due to the high cost of inputs, the prevailing norm among biotech corn farmers was to obtain loans from various sources. Majority (54%; Table 8) obtained their loans from individuals they called “financiers.” Financiers differed from the usual money lenders in that they only loaned out to biotech corn farmers who agreed to sell their harvest to them. So in a way, they were merely “financing” the production of farmers whose harvest they were privileged to buy. There were exceptional instances though when financiers merely provided the loan and got back the farmers’ repayment in cash.

Sources of loans also included traders and/or seed suppliers (24.4%). These actors offered the same arrangement as that of the financiers but oftentimes they were the ones providing the seeds that the farmers will plant.

Very few (16.4%) were using their own money or savings to finance their farming venture although they were earning from biotech corn. When this phenomenon was explored with some farmers, they explained that their

indebtedness to financiers/traders/seed suppliers was more preferable because this assured them of ready buyers after harvest. Whereas if they finance their own production, then they have to haggle eventually with buyers whose priority of course would be those with outstanding loans from these buyer-financiers.

The farmers also noted that sourcing of capital from the financiers, though with accompanying interest, was quite manageable given the high income they derived from biotech corn. This also boils down to the customary attitude of farmers to invest their money on other bulky expenses (such as house repairs, purchase of motorcycle and home appliances, and children's education) since they are assured of an alternative source of capital anyway.

> *"Why invest your money on farm capital? There are financiers who do that for us. It is better that we use our income for house expenses, which are endless, anyway. And because we are sending our children to school, the money is badly needed there. The current patronage arrangement between us and financiers is working well. It could be burdensome at some point, but since we find no alternative, we would rather stick to it."*

Only an exceptional few sourced their capital from banks/lending institutions and individual sources, like friends and relatives. As explained before, they would rather borrow from the established financiers in their respective areas because their friends and relatives were mostly in biotech corn farming as well and would have the same need for capital as they did.

One farmer's farm expenses for biotech corn farming amounted to about Php 62,850/ ha, covering costs of labor, seeds, fertilizers, and rentals of needed machineries. With this huge required capital, it was not surprising for the farmers, smallholders as they were, to resort to loan providers even if they have to pay interest.

Market Outlets

Data on market outlets indicated a very glaring result: traders/financiers got the bulk of the corn produce (86.5%). The other outlets such as seed companies, town markets, miller, and cooperatives got a measly share. As mentioned earlier, a number of traders were also financiers providing loans in kind and in cash for the needed inputs. As part of the informal loan arrangement, these traders usually get the right to buy the corn produce from the farmers come harvest time. And to avoid added burden to the farmers, the traders would pick up and collect the corn produce straight from the farms, as fresh harvest cobs or as dried kernel, depending on the prevailing selling norm and arrangement in the area.

> *"We do not have any problem about buyers or transporting our harvest to the market. The traders pick up our produce from the farms. This is part of our loan arrangement. Of course, we lose the opportunity to sell our harvest at higher prices. But the losses from that opportunity are somehow compensated by having a sense of security and peace of mind that our produce would be sold by all means."*

It could be said that the certainty of market for the biotech corn was one of the motivators for adoption. Farmers immediately got their payment in cash and were likewise spared from worrying about where to sell their big harvest. On top of all these, and perhaps without the farmers and traders knowing it, this marketing scheme prevents the glut or oversupply, which could eventually damage the corn production system or supply chain in the area. This is a hidden effect which benefits the entire biotech corn production in a way.

Income

Income was analyzed using gross and net income data. The former could easily be recalled by the farmers as the total payment they got from the traders or buyers of their produce. But the conception of a net income was a hurdle in the study. This was because biotech corn farmers did not keep records of their farm expenses, which have to be eventually deducted from the gross income to derive their net income. The farmers loosely reckoned whatever cash was left to them during harvest time as their "net income."

To address this concern, the gross income was analyzed using the data from the survey, while the net income was computed using the details gathered from a probing interview with five farmers, one seed supplier, and the Municipal Agriculture Officer (MAO). Based on these data, a model computation was constructed to generate the estimated net income.

a. Gross income

Majority had gross income of Php 50,000 and above per hectare per cropping season of biotech corn (Table 3). Nearly half of the respondents had a gross income of Php 100,001 and above (44.7%), followed by those who earned Php 50,001 to Php 100,,000 (32.8%). These data show that farmers were having relatively high gross income from the biotech crop.

b. Net Income

To depict the picture on net income, key data are shown in the box below.

Configuration of Net Income for Lowland Farms
(At 1 USD = Php40)

Assumptions:

Harvest:	6 tons/ha = 6,000 kg/ha
Selling price :	Php 12.50/kg (USD 0.31/kg)
Total Sale:	**Php 75,000/ha (USD 1,875)**

Expenses:

Farm labor:	Php 9,850/ha (USD 246.25)
Farm inputs:	Php 32,400/ha (USD 810)
Others (rental, food, etc.)	Php 12,200/ha (USD 610)
Total Expenses:	**Php 54,450/ha (USD 1,361.25)**

Net income: **Php 20,550/ha** (USD 513.75/ha)
Average farm size: 2.7 ha
Total Income: Php 20,550 x 2.7 ha. = Php 55,485 (USD 1,387.12)

Of the gross income, Php 54,450 (73%) went to farm expenses consisting of farm labor, farm inputs, irrigation (for lowland farms), rentals, and food expenses, leaving about 27 per cent as net income for the farmers. Of the farm expenses, farm inputs like seeds, fertilizers, and weedicides, accounted for a high 60 per cent. These were the main items financiers provided them on loan basis.

The above computations show that a biotech corn farmer could earn a net income of Php 20,550 per hectare or a total of Php 55,485,for 2.7 ha average farm size. This is nearly double the amount of Php 10,000 per hectare which farmers used to earn from conventional corn varieties. A more detailed picture of the farm expenses are summarized in Table 5.

Table 5. A sample detailed farm expenses in biotech corn farming (lowland farms)

Expense Item	Amount (Php)
1. Labor	**Php 9,850 (18%)**
Stable (Php 2,000/ha)	2,000
Plowing (Php 400 x 2 times)	800
Harrowing (Php 400 x 2 times)	800
Planting (150 x 5 people)	750
Fertilizer application (Php 150 x 5 people x 2 times)	1,500
Harvesting (Php 4,000 lumpsum or "pakyaw")	4,000
2. Irrigation (diesel) Php 2,000/ha x 3 times	**6,000 (11%)**
3. Rentals	**3,200 (5.5%)**
Thresher (Php 22/cav x 100 cav/ha)	2,200
Hauling (Php 10/cav x100 cav/ha)	1,000
5. Farm inputs	**32,400 (60%)**
Seeds (Php 4,200 x 3 bags/ha)	12,600
Fertilizers (Php 1,2000 x 16 bags/ha	19,200
Weedicides (Php 600/bottle)	600
6. Food for laborers	**3,000 (5.5%)**
TOTAL	**Php 54, 450 (100%)**

For upland areas, where farmers practiced no tillage and used no irrigation, the reported earning was as much as three times their previous earnings from non-biotech corn varieties. A sample income configuration for upland farms planted to biotech corn is shown in the box below.

Configuration of Net Income for Upland Farms
(At 1 USD = Php40)

Assumptions:

Harvest:	100 cavans/ha = 7,000 kg/ha
Selling price :	Php 11.00/kg (USD 0.30/kg)
Total Sale:	**Php 77,000/ha (USD 1,925.00)**

Expenses:

Farm labor:	Php 19,770/ha (USD 494.25)
Farm inputs:	Php 23,600/ha (USD 590.00)
Total Expenses:	**Php 43,370/ha (USD 1,084.25)**

Net income: **Php 33,630/ha** (USD 834/ha)
Average farm size: 2.7 ha
Total Income: Php 33,630 x 2.7 ha. = Php 90,801
(US$D 2,270)

Of the Php 77,000 gross income per hectare, Php 43,370 (56%) went to farm expenses consisting of farm labor and farm inputs, leaving them with Php 33,360 (44%) as net income. For an average farm size then of 2.7 ha, total net income would be Php 90,801. Similar to lowland farms, farm inputs like seeds, fertilizers, and weedicides accounted for a high 54 per cent of their farm expenses. These are usually the ones loaned out to them by the financiers. The detailed expenses for an upland farm are shown in Table 6.

On the whole, income derived from upland farms was 27 per cent higher than the income derived from lowland farms. This was attributed to lesser expenses in upland farms as there were no irrigation and only minimal tillage involved in these areas.

Table 6. A sample detailed farm expenses in biotech corn farming (upland farms)

Expense Item	Amount (Php)
1. Labor	**Php 19,770 (46%)**
Land preparation (Php 300 x 5 people x 2 times)	3,000
Weeding (Php 150 x 3 people x 2 times)	2,700
Planting (Php 150 x 5 people)	750
Fertilizer application (Php 150 x 10 people)	1,500
Harvesting (Php 15/cavan x 100 cavans)	1,500
Drying	6,720
Marketing	3,600
2. Farm inputs	**23,600 (54%)**
Seeds (Php 4,000 x 2 bags/ha)	8,000
Fertilizers (Php 1,200 x 11 bags/ha)	13,200
Weedicides (Php 1,200 x 2 gallons)	2,400
TOTAL	**Php 43,370 (100%)**

Farmers had some interesting stories to tell about how their informal loan arrangement with financiers and traders worked.

> *"The usual practice is for traders to sell their inputs on credit at higher cost. For example, if a bag of fertilizer costs Php 1,200/bag, it would be computed at Php 1,400/bag when loaned. But here is the catch: come payment time during harvest, the total amount loaned would be charged another 10-20 per cent (depending on the trader) as interest."*

"We know that somehow there is a tendency for traders and financiers to overcharge. But because this is the only convenient arrangement we could turn to at the moment, we have no choice but patronize the system. We have gotten used to it, anyway."

Farming Activities Done by Family Members

The pattern shown in Table 7 depicts the major role of the male family head or the father in various farming activities pertaining to biotech corn. Land preparation (74.1%) and marketing (71.6%) stood out as his topmost responsibilities. The mother, on the other hand, had a major role only in food preparation (69.7%) and budgeting (60.4%). Except for food preparation and budgeting, the father had the major responsibility in all farm activities. The children, either son or daughter, had no major role and had very low involvement in the farm activities. Hence, it appears that biotech corn farming is not the proverbial family enterprise where children's labor is heavily factored in.

Table 7. Farming activities performed by family members

Activity	Father	Mother	Son	Daughter
	%*	%*	%*	%*
Land preparation	74.1	17.1	24.9	7.3
Weeding	54.8	11.5	17.1	4.2
Irrigation	28.6	1.7	9.0	0.7
Planting	54.3	23.7	23.7	13.7
Fertilizer application	55.0	20.5	21.5	10.8
Spraying	53.5	3.2	13.7	1.2
Harvesting	48.4	20.3	19.1	11.0
Marketing	71.6	30.1	9.3	1.0
Food Preparation	31.8	69.7	5.5	8.3
Budgeting	45.5	60.4	5.4	1.7
Borrowing	63.3	31.8	4.9	1.0

* Multiple response

Biotech Corn Adoption Patterns

Factors Considered in Adoption

Factors that farmers considered in their adoption of biotech corn were categorized into agronomic, economic, socio-cultural, and psychological. These groupings were based on the results of the seminal study conducted a year earlier on biotech corn adoption and uptake pathways (Torres et al., 2012) in selected provinces of Luzon, Philippines.

Economic was the main driving force for adopting biotech corn (Table 8). Since farming is an enterprise, it is not surprising that an overwhelming number (83.4%) considered better yield and income as the prime considerations for adopting the biotech corn varieties. The other reasons were agronomic in nature: pest resistance (48.9%); good product quality (48.4%); and resistance to drought (24.2%). These factors were actually associated with higher income.

Aside from income, a notable factor that favored adoption of biotech corn was the availability of financial assistance (46.9%) from financiers, traders, and even the seed suppliers. Farmers had easy access to financial assistance -- in kind or in cash or both – from these financial providers in their respective areas. This was because these financiers also served as buyers of or markets for their corn produce. The informal loan arrangement oftentimes include the deal that farmers can only sell their harvest to these loan providers. There were, however, some instances when farmer-borrowers were allowed to sell their produce to other buyers or traders, but this was more of an exception to the prevailing norm.

"Source of capital for farm inputs has been our perennial problem in the past. And this was compounded by uncertainty in our harvest due to borer attacks. Oftentimes, we end up losing in our venture and so we get deeply buried in debt. Our investment in biotech corn finally enabled us to rise from indebtedness. Though, we are still in the cycle of "borrowing-and-repaying-and borrowing again," at least we can now pay back our loan and invest on other things, like motorcycle."

The presence of the capital providers serving also as buyers is actually an important scheme in the supply chain. It addresses the main problems of capital availability and market access, two factors that are sure to spell disaster if not addressed in any farming enterprise as shown by experiences in the past.

Table 8. Factors considered in the adoption of biotech corn

Reason	Frequency (n=409)*	Percentage
a. Economic		
Better yield and income	341	83.4
Availability of financial assistance	192	46.9
Lesser expenses	154	37.7
Availability of seeds	132	32.3
b. Agronomic		
Crop resistance to pest	200	48.9
Good product quality	198	48.4
Crop resistance to drought	99	24.2
c. Socio-cultural		
Inspired by success of other farmers	116	28.4
Camaraderie	39	9.5
d. Psychological		
Peace of mind	102	24.9
No answer	19	4.6

* Multiple response

Lesser expense (37.7%) was also a factor for adoption. Since the biotech corn varieties ensure no borer pest attack, the use of costly pesticides has practically been eliminated. Similarly, availability of biotech corn seeds (32.2%) was certainly an important factor that motivated farmers to adopt since farming starts with seeds.

Aside from economic reasons, there were also other important factors cited that were socially significant and should be paid due attention. "Inspired by success of other farmers" (28.4%) implies the value that farmers hold towards their peers, as well as their strong belief about themselves. Success stories give them the notion that "if others can do it, then certainly I can do it, too."

A psychological benefit gained, to which perhaps no price tag could be attached, was having "peace of mind." Farmers explained that this was a very liberating experience. Whereas before biotech corn, they had to endure worrying day and night about how much would be left for them to harvest after persistent borer attacks, with biotech corn they could sleep soundly and be assured of their hefty harvest. This "peace of mind" was something they have been deprived of for many years.

> *"With biotech corn, we are certain of our harvest. It used to be that we had sleepless nights everytime we planted. Despite the amount we spent for pesticides, the precautions we took, and the prayers we offered, our corn would still be attacked by borers. Those were times full of anxiety because we could never be sure of our harvest. Now we could sleep soundly and that alone is a nice reward."*

On hindsight, there were other factors mentioned by a few during the FGDs and interviews which somehow gave them no choice but adopt biotech corn. A group of farmers in one of the sites mentioned that no other seeds, except the biotech ones, were being sold by suppliers in their area; hence, they had no choice. Others also stated the fact that corn buyers plying their areas were only buying the biotech varieties and not anymore the non biotech ones; hence, they had to shift variety. Then in a rare instance and with element of satire, a farmer noted that he had to adopt biotech corn because he was afraid all the borers that were driven away by his neighboring farms planted to biotech corn would now swarm his non-biotech farm.

"Everybody in the barangay is now into biotech corn. If I do not adopt that same variety, I fear that all the corn borers driven away by biotech corn in my neighboring farms will all come to attack my crops. Isn't it a wise decision?"

"Traders only extend financial assistance to those planting biotech corn. And they choose to buy only the biotech varieties. I would not like to be left out so I shifted variety."

Mode of Adoption

In past studies, it was shown that adoption of any technology among farmers tended to differ: some adopted the technology ***in toto*** or as a whole, as recommended; others adopted only certain features; and still others modified those aspects which did not suit their conditions.

In the case of biotech corn farmers, a very low 3.9 per cent reported full adoption; and a high 63.6 per cent claimed to have not followed at all the accompanying practices for the technology (Table 9). This result, however, could be explained by the fact that the majority did not have the opportunity to be informed about such recommended practices in the first place. As findings indicated, most of the farmers' dealings were with the seed suppliers and traders, who unfortunately did not have the full knowledge also of the recommended practices. The rare instances when farmers encountered the agricultural technicians from local government units were the only occasions when they were able to receive information about the recommended practices on biotech corn.

> *"Nobody told us about the specific practices required for biotech corn. We merely follow what we have been doing for non-biotech corn, except that we reduce the planting distance between plants. The results are good, so there must be no problem with our current practices."*

The research team tried to seek the recommended practices from corn experts in the College of Agriculture, University of the Philippines Los Banos. The experts explained that the only difference in the practices for biotech and non-biotech is that no more pesticides are applied to the former.

Table 9. Mode of adoption of biotech corn

Type of Adoption	Frequency (n=409)	Percentage
Did not follow the technology	260	63.6
Partial adoption of technology	133	32.5
In toto/full adoption	16	3.9
TOTAL	409	100

The above findings could be quite disturbing because even if farmers were not aware of the proper cultural practices, they ventured into biotech corn farming nonetheless. This is tantamount to "taking chances" or perhaps "making uninformed decision," which should be attended to in as much as farmers themselves were interested to know what these practices were. At the fundamental level, they have yet to fully understand the nature of biotech crop and what makes them resistant to borer and/or weedicides.

Desire to Continue/Not Continue Planting Biotech Corn

There is no question that the biotech corn farmers covered in the study would continue planting the crop. A very high 93.2 per cent had indicated so (Table 10). Only a handful (9 out of 409) decided not to continue for the following reasons: farms located in marginal areas were not suitable for biotech corn; income from white corn was comparable with that from biotech corn with even less inputs for the former; seeds from biotech corn could not be reproduced making the farmers dependent on outside seed sources; shift to being a contract grower for cassava (as alternative to corn for feeds) provided higher income with less inputs and labor; and acidic soil was not suitable for biotech corn.

Table 10. Desire to continue planting biotech corn

Desire to Continue	Frequency (n=409)	Percentage
Will continue	381	93.2
Will not continue	9	2.2
It depends	16	3.9
No answer	3	0.7
TOTAL	409	100

Awareness and Willingness to Plant Other Biotech Crops

Since the farmers had already experienced planting biotech corn and had derived a much higher income from it, the study explored the farmers' predisposition towards other biotech crops that were being eyed also for commercialization in the country. Farmers were asked about their awareness of the forthcoming biotech crops and whether or not they would adopt the same. Specific biotech crops pertained to Bt cotton, Bt eggplant, and Golden Rice.

An overwhelming majority were not aware of the three biotech crops (Table 11). The highest frequency on lack of awareness was on Bt cotton (83.1%) as this has not been tested and approved for commercialization in the country. At the time of the study, Bt cotton was a widely adopted biotech crop in India and China. This may indicate the very low level of public information among farmers being done on biotech crops in the country.

Table 11. Awareness of and willingness to plant other biotech crops

Item	Bt Cotton		Bt Eggplant		Golden Rice	
	Freq	%	Freq	%	Freq	%
Awareness						
Aware	40	9.8	51	12.5	54	13.2
Not aware	340	83.1	323	79.0	317	77.5
No answer	29	7.1	35	8.5	38	9.3
Total	409	100	409	100	409	100
Willingness to plant						
Willing to plant	170	41.6	239	58.4	237	57.9
Not willing to plant	80	19.6	80	19.6	77	18.8
Maybe	86	21	55	13.4	62	15.2
No answer	73	17.8	35	8.6	33	8.1
Total	409	100	409	100	409	100

Despite the low awareness of other biotech crops, there was relatively high inclination among the farmers to eventually adopt these crops when they become commercialized in the future. Preference was highest for Bt eggplant, because many of the biotech farmers interviewed were also engaged in vegetable farming for home consumption and for cash. This favorable attitude towards Bt eggplant must have been influenced by the favorable experience they had with biotech corn.

> *"When will the Bt eggplant be released? We are surely interested in it. The eggplants we raise are always infected by borers, hence, we do not have good harvest. If these eggplants are like the biotech corn, then at lower production cost, we foresee better income."*

Preferred Characteristics of Biotech Crops

If ever there would be other biotech crops to be developed by scientists in the future, the farmers suggested a number of characteristics they would wish to see in the crop (Table 12). The top three characteristics were: being pest resistant (71.4%); being drought resistant (58.4%); and having bigger stems. Because of their unpleasant experience with other pests still attacking biotech corn, which they thought was a "super crop," they would like scientists to address these other features as well.

Though many farmers were not vocal about it, there were a few (0.7%) who noted that there was a tendency for farmers to prefer the latest or new variety of biotech corn over the old ones. Farmers believe that the latest varieties must be better than the older ones.

Table 12. Preferred characteristics of biotech crops

Crop Characteristic	Frequency (n=409)	Percentage
Pest resistant	292	71.4
Drought resistant	239	58.4
With bigger stem	205	50.1
Less expensive inputs but good quality produce	97	23.7
Seedless	65	15.9
Weather resistant	24	5.9
New variety	3	0.7

Uptake Pathways of Biotech Corn

First Information on Biotech Corn

The first information that most farmers came to know about biotech corn consisted mostly of the benefits derived from the crop (71.6%; Table 13). Certainly, this was good news for them and a prime motivator for adoption at that.

> *"We saw with our own eyes how our fellow farmers who planted biotech corn were able to make it big in terms of income. We observed their corn fields. The evidence was so convincing. We heard their stories over and over. If our colleagues were able to do so, then we thought we could try the new crop also. And our decision was right."*

A few (14.9%) came to know about it as a new pest resistant variety. A very low 13.2 per cent, however, had acquired the knowledge on how to plant the new variety. This means that while farmers were keen on adopting the crop because of its promise of high income, they were never provided information on the appropriate farming practices they should follow. Hence, farmers maintained the usual farming practices they were using for conventional or non-biotech corn varieties.

Sources of Information

Farmers sought information on biotech corn from varied sources. Among these, interpersonal sources dominated over the media sources (Table 14). The most sought person sources were the seed suppliers/traders (56.2%). These were actually their financiers, thus, farmers had the most frequent contact with these people. Agricultural technicians (34%) and co-farmers (30.3%) followed in rank.

Table 13. First information on biotech corn

Information	Frequency (n=409)*	Percentage
Benefits	293	71.6
Pest resistant	61	14.9
How to plant	54	13.2
New variety	5	1.2
No answer; could not recall	28	6.8

* Multiple response

Table 14. Sources of information on biotech crops

Source of Information	Frequency (n=409)*	Percentage
Interpersonal source		
Seed suppliers/traders	235	58.4
Agricultural technicians	139	34.0
Co-farmers	124	30.3
Agricultural suppliers	47	11.5
Barangay officials	12	2.9
Media sources		
TV program	28	6.8
Radio program	21	5.1
Newspaper	7	1.7
Internet	5	1.2
Cellphone	1	0.2

* Multiple response

Between the two sources (co-farmers and media), their co-farmers served as the most significant factor who influenced the farmers to adopt biotech corn (91.9%; Table 15). This is attributed to the strong peer system and shared lifeworld outlook among farmers. Unlike the professional occupations where competition is high, farmers usually have the strong tendency not to alienate their fellow farmers; instead they try to "bring them in" in the same circle from which they derive some benefits for reason of "equality" *(pare-parehong makinabang).* They felt that benefits from biotech corn should be shared with all, and not kept only among themselves.

Table 15. Information sources that convinced the farmers to adopt biotech corn

Source	Frequency (n=409)*	Percentage
Co-farmer	376	91.9
Media	27	6.6
No answer	13	3.2

* Multiple response

Attendance in Trainings/Workshops

About two-thirds (66.5%) had attended trainings/workshops on biotech crops (Table 16). This indicates the high exposure of farmers to information and knowledge about biotech crops. Likewise, it suggests the openness and willingness of farmers to learn and know more about the new crop variety which they had been hearing about as promising in terms of higher income.

Table 16. Attendance in trainings/workshops

Attendance	Frequency (n=409)	Percentage
Has attended	272	66.5
Has not attended	125	30.6
No answer	12	2.9
TOTAL	409	100

Trainings and workshops on biotech corn for farmers were mostly undertaken by the private companies (73.2%; Table 17). These included the multinational companies producing and supplying the biotech corn seeds, like Monsanto, Pioneer, and Syngenta. Having a big stake on the technology, they organized trainings in major corn producing areas. Their work was also supplemented by the seed suppliers/traders (23.9%) carrying their brands. The government agricultural technicians also conducted some of these trainings but to a much lower extent (25%). This trend can be attributed to the fact that biotech corn is a private-driven technology.

Table 17. Organizations that conducted the trainings/workshops

Organization	Frequency (n=272)*	Percentage
Private companies	199	73.2
Government technicians	68	25.0
Seed suppliers/traders	65	23.9
Cooperatives	21	7.7
Relatives	3	1.1
No answer	41	15.1

* Multiple response

When asked about their interest to attend other trainings on biotech corn, nearly half (48.2%) gave a positive response (Table 18). This is an indication of a favorable attitude towards the crop. Since there is a relatively high motivation and an expressed need, additional trainings on biotech corn may have to be organized for the biotech corn farmers in the near future. This time, these trainings should explain the basics, such as the nature and the recommended practices, if any, for these crops.

Table 18. Interest in trainings on biotech corn production

Organization	Frequency (n=272)*	Percentage
Private companies	199	73.2
Government technicians	68	25.0
Seed suppliers/traders	65	23.9
Cooperatives	21	7.7
Relatives	3	1.1
No answer	41	15.1

Sharing of Knowledge on Biotech Corn

There was very strong tendency among farmers to share their knowledge about biotech corn mostly with their co-farmers (67.7%), with a few (20%) sharing it with their relatives who were also into farming (Table 19). This depicts a very strong sense of peer system and shared lifeworld among them, which is typical of farming communities in the Philippines. Under the peer system, farmers consider their fellow farmers as co-beneficiaries, not as competitors, in the benefits derived from the technology. Farming as their "world" is more of a community or collective effort, hence, they expect everyone to be sharing material and non-material resources, like information, to help others. In a way, information and knowledge have been regarded as social commodities which they share with their peers.

> *"Ours is a small community of farmers. And because we rely on the same source of livelihood, sharing of information and knowledge on how we can improve it is a very normal and spontaneous activity among us. We share stories every time we meet, and these would always include what's happening in our farms. Good news or bad news, information is shared as a commodity for our common good."*

Table 19. People with whom the farmers shared their knowledge on biotech crop

Group/ Individual	Frequency (n=409)*	Percentage
Co-farmers	277	67.7
Relatives	82	20.0
DA Technician	2	0.5
None	17	4.2
Fund Source	1	0.2
No answer	58	14.2

* Multiple response

Access to Facilities and Support Services

Majority of the biotech corn farmers had access to facilities needed for production, like tractors, dryers, water pumps (for irrigated farms), and storage facilities. Big tractors, hand tractors, and dryers were mostly rented while water pumps used for irrigation were owned (Table 20). About a quarter had storage facilities with equal percentage each (22.5%) owning and renting these facilities. In most cases, farmers were selling their crops immediately after harvest so they did not need post harvest facilities such as dryers. Those who preferred to dry the corn grains before selling did this to get a higher price.

Table 20. Access to facilities in biotech corn production

Facilities	Owned		Rented	
	Frequency (n=409)*	%	Freq (n=409)*	%
Big tractor	94	23.0	206	50.4
Dryer	85	20.8	155	37.9
Hand tractor	134	32.8	145	35.5
Water pump	149	36.4	120	29.3
Farm implements and work animals (plow, sprayers, cow, carabao, etc.)	110	26.9	66	16.1
Storage facility	92	22.5	92	22.5

* Multiple response

"Big tractors are among the things which the government should at least make available to us. We observe the same planting season and during the plowing stage, there are very few big tractors available for rent. During peak season, there are farmers who could not plant on time because the plowing of their fields has been delayed. Tractors are quite expensive for us to purchase, but we are willing to rent. For irrigation pumps, we usually buy our own."

Of the 409 respondents, 174 accessed support services for their corn production particularly from the government. Among these services, financial capital was the most accessed service (68.3%) but not from the government but from private financiers and traders, followed, though far behind, by farm inputs (31.0%) and source of new technologies (30.4%) (Table 21). Hence, there may be a need to look into the loans currently being provided to them by the financiers and traders to determine other options by which farmers can have their needed capital support for production.

Table 21. Support services availed of in biotech corn production

Service/Support	Frequency (n=174)*	Percentage
Financial	119	68.3
Farm inputs	54	31.0
Source of new farming methodologies	53	30.4
Infrastructure	7	4.0
Farm equipment	5	2.8

* Multiple response

Innovation Tree Analysis

For the qualitative part of the study, a participatory rural appraisal method (PRA) called Innovation Tree analysis was used to determine how the adoption of biotech corn started and spread out in the selected Philippine communities. Developed by Van Mele and Zakaria (2002), it helps researchers and development facilitators distinguish various types of adoptors and identify some social, economic, political, and/or cultural factors that influence the adoption, contextualization, and/or spread of an innovation, such as biotech corn in a community.

The Innovation Tree was used in the study to complement and enrich the data gathered from the survey of farmers through structured interview schedule. By its qualitative nature, it served as a venue for the farmers to discuss among themselves the dynamics of adoption of biotech corn in their community. It also gave the researchers an opportunity to dialogue with the farmers and gain a deeper understanding of the process and issues of the adoption and uptake pathway of biotech corn in a particular community.

The following steps summarized how the Innovation Tree method was facilitated in several communities selected for the study:

- Around 10-20 farmer respondents were gathered together in a venue within the community (e.g., barangay halls, space under a tree or in front of a farmer's house, milling center).
- A facilitator introduced the research project and the objectives of the Innovation Tree activity to the farmers.

- The farmers were each given a piece of paper and a marker. They were asked to write on the paper their name, and the month and year they started planting biotech corn.
- Each farmer was asked to share the month and year he/she adopted biotech corn, the individuals from whom he/she learned about the technology, the person who convinced him/her to adopt, those he/she convinced to adopt the technology (if any), and other related things he/she wanted to relate to the group. The order of sharing was based on the chronology of adoption – from the earliest to the recent adoptors who were present during the gathering.
- When necessary, the facilitator asked for clarifications, related questions, and/or solicited comments from other farmers.

Whenever time permitted, several Innovation Tree exercises were undertaken in the study areas. This was meant to capture the pattern and/or uniqueness of adoption and uptake pathway in each particular community. At the last part of this section, an overall pattern is discussed to give the general picture of the uptake pathway at the country level.

a. Pampanga, Philippines

Pampanga is located at the southern part of Central Luzon, Philippines. The province was severely affected by the eruptions of Mt. Pinatubo in the 1990s. Many of its areas were submerged under volcanic ashes and farms had been barren for so many years. Through biotech corn, farms in Pampanga have become productive again. The uptake pathways for the top three community producers of biotech corn in Pampanga are discussed.

a.1 Brgy. Escaler, Magalang, Pampanga

Figure 4 summarizes the farmers' uptake of biotech corn in Escaler, Magalang, Pampanga. Farmers in this community claimed they had been into biotech corn as early as year 2000. They must have been referring to the period when biotech corn was still being field-tested because commercialization of the crop occurred only in 2003. For the purpose of tracing the uptake pathway, the years they gave, though dubious, were used for discussion. More emphasis was given to the intervals as these indicate the pace of adoption.

Among the 11 participants of the Innovation Tree exercise, the very first farmer who planted biotech corn in the community was Ferdinand. He came to know about the technology in 2000 from a farmer in another town. He planted the new variety in 2000 and experienced good harvest during his very first try. So he was encouraged to continue planting it. In 2001, Cresencia also planted the crop after knowing about it from a relative. Like Ferdinand, she also did not share it with other farmers, thinking that her fellow farmers already knew about it anyway.

A seminar conducted by a seed company in 2001 started to create the wave of adoption. Without second thought, Emiliano immediately planted biotech corn in that same year. And, he shared his good experience immediately with five other farmers (Elmer, Ryan, Valentino, Nenita, and Lucena) who planted the same in 2002. These five farmers then spread out the good news to farmers in neighboring towns. However, not all of those who participated in the seminar immediately planted biotech corn. One of them, Bienvenido, tried it one year after, while Emmanuel tried it two years after (2003) due to lack of capital.

Based on yearly intervals, adoption was rather immediate and fast as it took only 1-3 years for the technology to be adopted by many. Farmers in this group can be labeled as early adoptors. Early adoption of the technology was due to the proven quality of biotech corn and the high price it commanded in the market. They also noted the less expense involved for farm labor. All these subsequently resulted in higher income for the farmers.

Because of their adoption of biotech corn, some farmers said they were able to send their children to school, repay their loans, put up a business (such as a variety or *sari-sari* store), and afford a church wedding. The last item referred to a few famers who had to forego their church wedding, or had a civil wedding instead, or just lived-in with their partners due to financial constraints. Some were able to buy motorcycles and even home appliances, like television, refrigerator, and karaoke set.

The FGD participants expressed some needs to improve their corn business. These included farm-to-market roads, irrigation, and tractor. They also wanted the concerned officials to look into regulating the prices

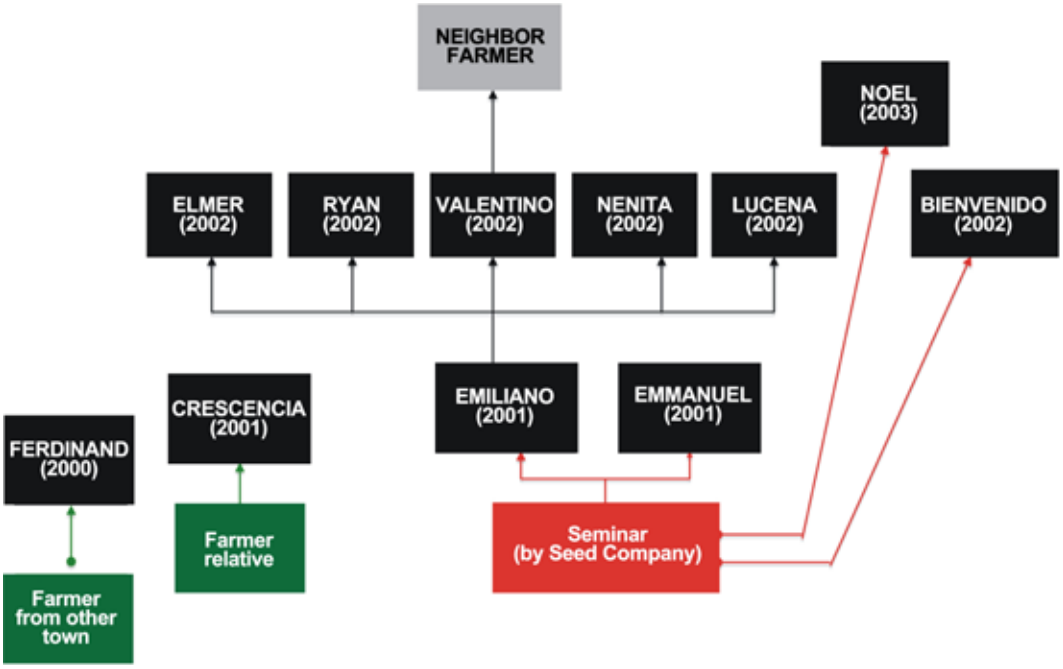


Figure 4. Uptake pathway of biotech corn among farmers in Brgy. Escaler, Magalang, Pampanga

of farm inputs, such as seeds and fertilizers. They said the government should refrain from importing corn so that the price of corn in the market would increase and favor farmers like them.

a.2 Brgy. San Ildefonso, Magalang, Pampanga

The uptake pathway of biotech corn in San Ildefonso, Magalang, Pampanga was initiated by the Department of Agriculture (DA), seed companies, and fellow farmers (Figure 5). The farmers came to know of the biotech corn's performance through the demonstration farms jointly established by the DA and seed companies. As early as 2000 when these demo farms were proliferating, farmers like Ernesto, Rustico, Jesus, and Indolencio tried out the crop in their own farms. They also shared information about the crop with their other fellow farmers. Since then, everybody else in their community had been into biotech corn planting.

Other farmers, like Conrado and Honorio, took two years (2002) before engaging in the new variety. Suceeding adoptors came into the picture at a much later date: Lepoldo in 2006 and Carmen in 2008. The lull in the spread of the technology was due to the farmers' non-ownership of land/ farm at the time they first heard about the technology.

The participants of the Innovation Tree exercise agreed that immunity to borers, easy crop management, and higher income were some of the advantages of the biotech corn. Some of them were able to build their own house, own a tractor, and repay their loans due to increased income

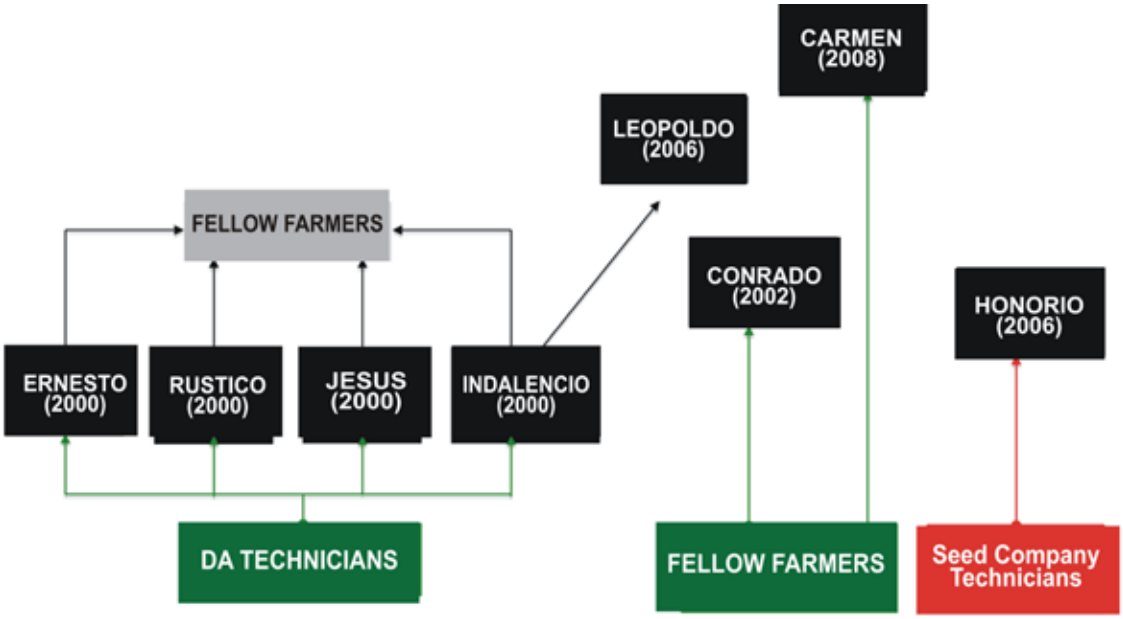


Figure 5. Uptake pathway of biotech corn among farmers in Brgy. San Ildefonso,Magalang, Pampanga

from biotech corn. Among the expressed needs of the farmers were farm-to-market roads, drying facility, and subsidy for farm inputs. They also expected the government to act on lowering the price of corn seeds and fertilizers and putting an end to the importation of corn.

a.3 Brgy. Anao, New Mexico, Pampanga

The uptake pathway of biotech corn in Anao, New Mexico, Pampanga may be considered a unique case. All Innovation Tree participants attributed their decision to go into corn production to one person - a former municipal councilor fondly called “Kong Carlos” [or *Kuya* (Big Brother) Carlos Guevarra] by his fellow farmers. According to the farmers’ stories, their Kong Carlos started to engage in corn production in 1990. He was once hailed as Farmer of the Year at the national level. In 2000, two seed companies gave the farmers of Anao, New Mexico, Pampanga separate seminars about biotech corn. Kong Carlos tried planting the crop and harvested/earned double of how much he used to harvest using the old variety. Soon the DA even made Kong Carlos’ farm the show window of biotech corn in the area. Aside from his commendable experience, he was also considered as the pioneer in corn production in their locality. This has encouraged other farmers in the barangay to also try planting biotech corn. In a way, it was Kong Carlos whom the farmers looked up to as the champion of biotech corn in their community.

Figure 6 traces the uptake pathway and adoption of biotech corn in this barangay. Among the 11 participants in the Innovation Tree activity, two started planting biotech corn in 2001, six in 2002, two in 2004, and only one in 2010. The fastest pace occurred in 2002 when the crop was to

be eventually approved for commercialization in the country. Since then, all the farmer-participants claimed that biotech corn had doubled their income. Cornelio and Dong, the early adoptors, cited high income as the prime motivator for adoption. Rogelio, the late adoptor, on the other hand, explained that his farm was not suitable for corn production at the time he came to know about biotech corn. The rest did not readily adopt the technology because they preferred to plant white corn before. Others were constrained by expensive inputs involved in biotech corn planting.

Asked about the advantages of biotech corn production, the farmers said that: it was more profitable; it needed less input since application of pesticide was not necessary; and they were more assured of a good harvest. Similar to other biotech corn adoptors, the farmers of Anao, New Mexico, Pampanga were also able to send their children to school, build their own houses, own a tractor, and buy some personal gadgets, such as cellular phones.

The farmers wished for low prices of farm inputs, better markets where they could sell their produce at a higher price, and availability of machineries, specifically tractor for plowing, as well as irrigation facility. They also expressed their need for seminars on proper use and planting of biotech corn as this has not been taken up with them in the seminars they attended.

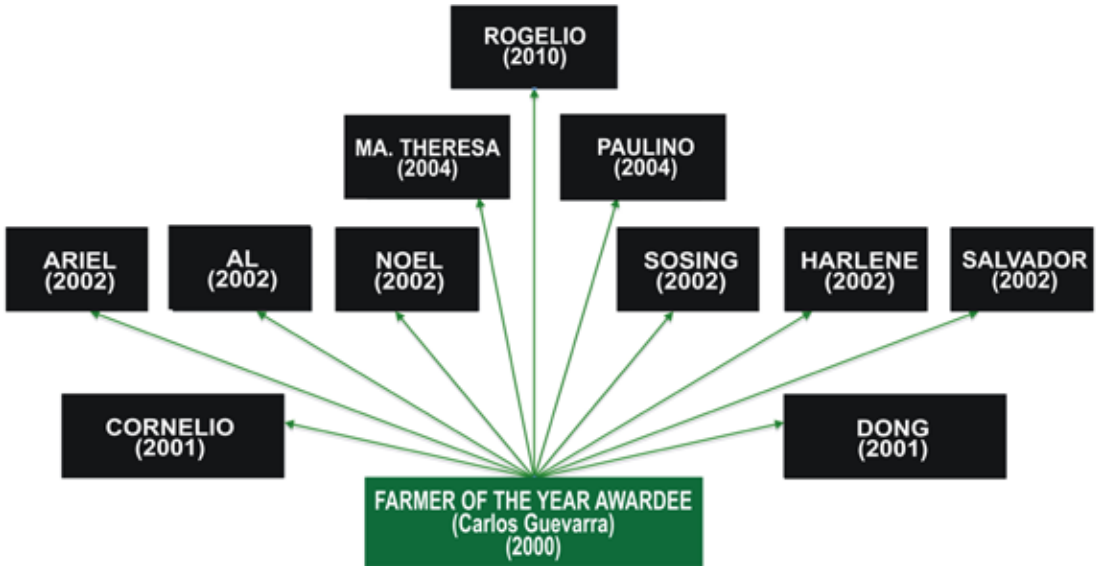


Figure 6. Uptake pathway of biotech corn among farmers in Brgy. Anao, New Mexico, Pampanga

a.3 Brgy. Palinlang, Arayat, Pampanga

As shown in Figure 7, the earliest adoptors, Abelino and Reynaldo, were introduced to the crop in 2001 through the Farmers Field School (FFS). That was even before the crop was approved for commercialization in 2003. Romeo was also a product of FFS but at a later year (2006). This was followed in 2002 by a seed company's seminar in the barangay, through which Vitaliano, Remigio, Jose, and Nelson were influenced to shift to the new biotech corn variety in the same year. But it took two more years (2004) for Robert and Carlito to get into biotech corn planting. Still, the latest adoptors, Tolentino and Eugenia, shifted to the crop only in 2006. Source of capital and fear of the "usurious" rates imposed by the financiers were the factors that prevented the farmers from readily adopting the crop. Antonina came to know about biotech corn from an agricultural supplies store in 2002. There was an almost two-year gap in between generations of adoptors. The FFS and the seed companies eventually produced many biotech corn converts.

Farmers planted biotech corn due to lesser expenses for farm inputs, higher income/profit, lesser need for irrigation, and more guaranteed harvest. As a result of adopting the technology, they have repaid their loans and bought some home appliances. The farmers in the area believed that their corn production could be improved if they would be provided with a drying facility and necessary farm machineries, especially for plowing. They were interested in seminars on corn technologies. They were also hopeful that the government could subsidize some of their farm inputs and could provide some financial assistance for the establishment of a cooperative that would help them refrain from borrowing capital from usurers.

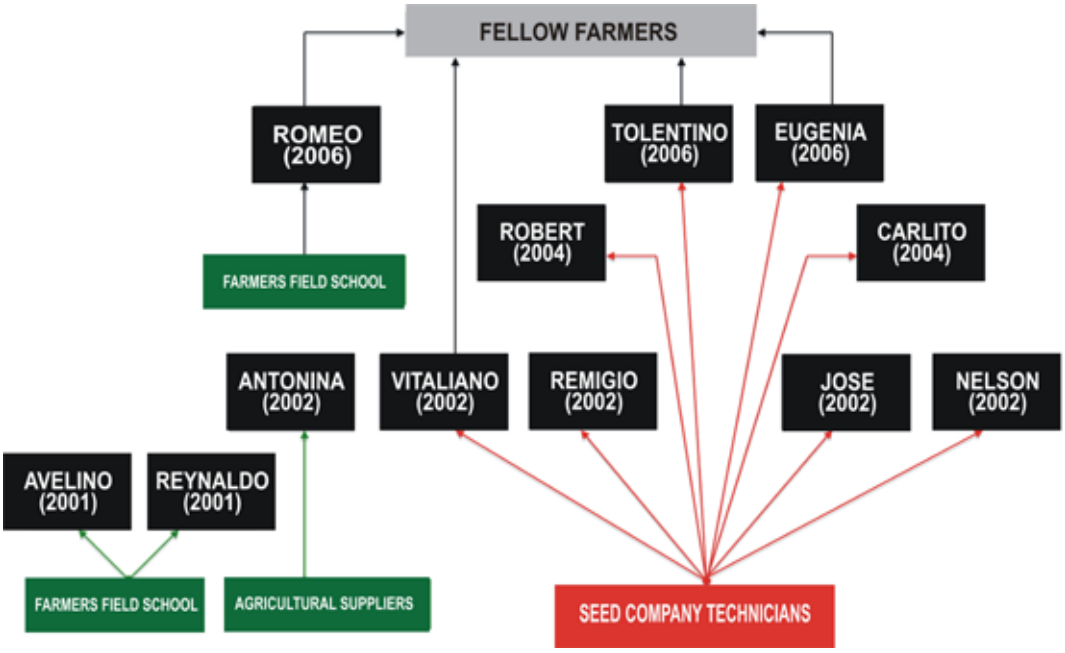


Figure 7. Uptake pathway of biotech corn among farmers in Brgy. Palinlang, Arayat, Pampanga

b. Iloilo, Philippines

Iloilo is located in the northeastern part of Panay Island. One of the six provinces of the Western Visayas Region, Iloilo is the top producer of yellow corn in the region. Most of the northern parts of Iloilo are corn producing areas.

Only one Innovation Tree exercise was done in Iloilo. This was because farmers came from upland areas, which were difficult to access. Hence, farmers were gathered all at one time in the conference hall of a farmers' cooperative called the MODEL Farmers Association. Due to limited time, the group of famers agreed to have representatives participate in the activity while the rest were simultaneously being interviewed by enumerators.

Figure 8 shows the flow of the biotech corn uptake based on the stories of the 11 farmers who participated in the Innovation Tree activity. It should be noted that in addition to the seed companies, another major player in the uptake pathway was the MODEL farmers' cooperative, where all the respondents interviewed in this study belonged.

Biotech corn farming came much later in this Visayas area compared to that of Pampanga in Luzon. While the crop was commercialized in 2002, Gloria and Silverio first learned about biotech crop from a technician of a seed company only in 2004. Gloria started planting right away. Silverio, on the other hand, adopted the technology in 2007, three years after Gloria did. Being risk-averse, he had second thoughts about it and he wanted to make sure that biotech corn would indeed give him more profit. Once they had proven the performance of the crop, they brought the good news to their other co-farmers, relatives, and friends in the adjacent farms and in neighboring barangays and towns.

Taking another track, Delia and Jose were convinced to try biotech corn in 2006 by the MODEL Farmers Association through its head, Delson Sonza. Also a corn farmer himself, Sonza started growing biotech corn in 2005. He organized the farmers' association to benefit the corn farmers better.

Lee, Mary Jane, and Jose Rex were convinced by team leaders and technicians of the MODEL Farm Association. According to these farmers, the team leaders assigned to the different barangays and towns regularly visited and monitored the farmer-members. The participants added that Sonza, trader and leader of the association-cum-multipurpose

cooperative, who has been successful in planting the Bt corn variety, convinced them in adopting the technology. So it took an experienced farmer and a trusted leader like Sonza to bring many farmers to biotech corn adoption.

The late adoptors only started planting Bt corn in 2007-2010 period. They were convinced by other fellow farmers to adopt the technology. The late adoptors had known about the biotech corn since 2006 but they did not immediately adopt it because of lack of capital and lack of land where to plant the crop. They also wanted to make sure that biotech corn would indeed increase their income. The favorable experiences of the early adoptors eventually convinced the late adoptors to shift to biotech corn.

Most of the participants attested to the fact that income derived from biotech corn was much bigger, by leaps and bounds, than their native corn. They added that corn farming has become less laborious, thus, giving them more time for their respective families and other productive activities. From their income, they were able to buy motorcycle (a treasured family possession), send their children to school, and renovate their houses. A motorcycle was an important investment among the biotech corn farmers because it served as their all-purpose mobility vehicle. Being in the uplands, they found the motorcycle a very dependable form of transport for their farm inputs, crops, family members, farm implements, and even construction materials.

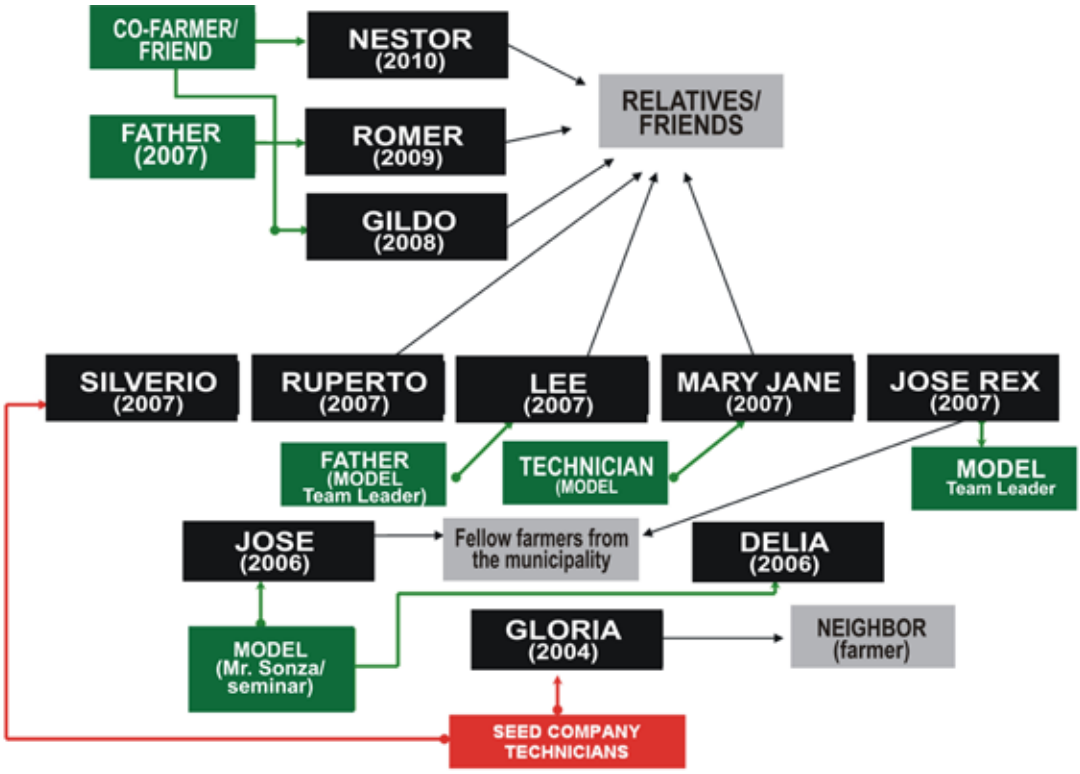


Figure 8. Uptake pathway of biotech corn among farmers in Sara, Iloilo

c. South Cotabato

South Cotabato is located in the southernmost island of Mindanao, Philippines. It was one of the sites for field testing of Bt corn way back in 2001. The province boasts of a strong corn production performance due to wide areas suitable for corn production, availability of high quality biotech corn seeds, and access to technology. Many of the seed producing companies, like Pioneer and Syngenta, have their offices based in the province. At least 144,200 ha in the province were planted to corn, producing 435,981 metric tons in 2012.

c.1 Brgy. Rang-ay, Banga

Banga is one of the biggest corn-producing municipalities in South Cotabato. One of its most productive barangays in corn production is Rang-ay.

Most of the farmer-participants in Brgy. Rang-ay first learned about biotech corn in 2003 from seed technicians of a multinational agricultural biotechnology corporation operating in the Philippines. One of the farmers, Alfonso, was contracted by the seed company to establish a demonstration farm on biotech corn variety in their barangay in December 2003. He served as an ambassador of the company during and after the demonstration.

Several farmers who were members of a local cooperative and neighbors of Alfonso also participated in the farm demonstration as observers. They regularly visited the farm and listened to the company technicians who explained the steps in and the benefits of cultivating the crop. Since synchronized farming was practiced in Rang-ay, majority of the corn farmers started planting biotech corn in 2004 upon observing that the corn variety resisted corn borer attack and yielded more harvest than the white corn variety. This triggered the high rate of adoption of biotech in 2004 as reflected in Figure 9. Aside from Alfonso, six other farmers adopted biotech corn that year. They had been cultivating local varieties of white corn and non-transgenic yellow corn before Bt corn was introduced to them in 2003.

According to the participants, many farmers in the barangay were easily influenced by their fellow farmers in adjacent farms. Word about benefits of biotech corn easily spread in the neighborhood. In addition, farmers learned about the crop and its benefits during their meetings in a local cooperative.

Henry and Jaime adopted Bt corn two years later. They explained that delayed adoption by some farmers was often due to the latter having second thoughts about the efficacy of the crop. They observed farms planted with biotech corn first to see if these would not really be infested by corn borer and would indeed give good harvest. Several farmers even thought at first that it was not good for human and animal health, an issue raised by the Catholic Church and other social activist groups in their area. In South Cotabato, the Church was actively campaigning against transgenic crops in the late 1990s and early 2000s. It was even mentioned by one farmer that some individuals told them that biotech corn was poisonous. The other reason for delayed adoption was that some farmers prioritized cassava over biotech corn for several years before they decided to try the latter. Farmers explained that cassava as alternative feed source is easier to cultivate, yet gives them higher income.

Most of the farmers claimed that the income from biotech corn was bigger than that from the white corn and non-biotech yellow corn varieties. The difference, some of them said, was about Php 3,000- 4,000/ha. One argued that there was not much difference in income, but it was easier to cultivate biotech corn, especially when the herbicide tolerant (i.e., resistant to weedicides being sprayed on corn plants during growing stage) was introduced to them. They claimed that corn farming became less laborious, and they could spend time in other farm ventures, like cultivating vegetables, guavas, and bananas, which were often intercropped with corn. More importantly, they gained more time to spend with their respective families.

> *"Before, we were spraying pesticides relentlessly on the crops to get rid of the borers which stubbornly attacked them. We spent much on pesticides and farm labor, yet a big proportion of the crops would still be infested. We have been investing much time on the farm just taking care of the corn plants. But things have changed when we shifted to biotech corn. We do not anymore buy and spray pesticides. Although there are still diseases, like stalk rot, the damage is not that much and we can still harvest a substantial amount."*

Those with larger farms (i.e., 3 ha and above) often earn at least three times more than those farming 1 ha and below. For instance, Alfonso had more than 10 ha of owned and rented land cultivated with biotech corn. Hence, he is considered the most successful biotech corn farmer in Rang-ay.

As mentioned by the farmers, some of the factors that facilitated adoption were the following: (a) demonstration farm on biotech corn; (b) information sharing about the benefits of biotech corn; (c) presence of private traders who provided farm capital; (d) information on how biotech corn was cultivated; and (e) synchronized farming in some areas. Meanwhile, delayed adoption was often due to the following: (a) lack of farming capital; (b) lack of information on how to cultivate biotech corn; (c) negative information about the transgenic crop; and (d) unfavorable weather conditions.

The farmers thought that the following would help them improve and scale up biotech corn production in the barangay: (a) a strong federation of corn farmers that could negotiate with big traders regarding selling prices; (b) postharvest facilities to store their harvest for a longer time, that is, until market selling price of corn increases; and (c) regulation of the prices of farm inputs, especially seeds and fertilizers.

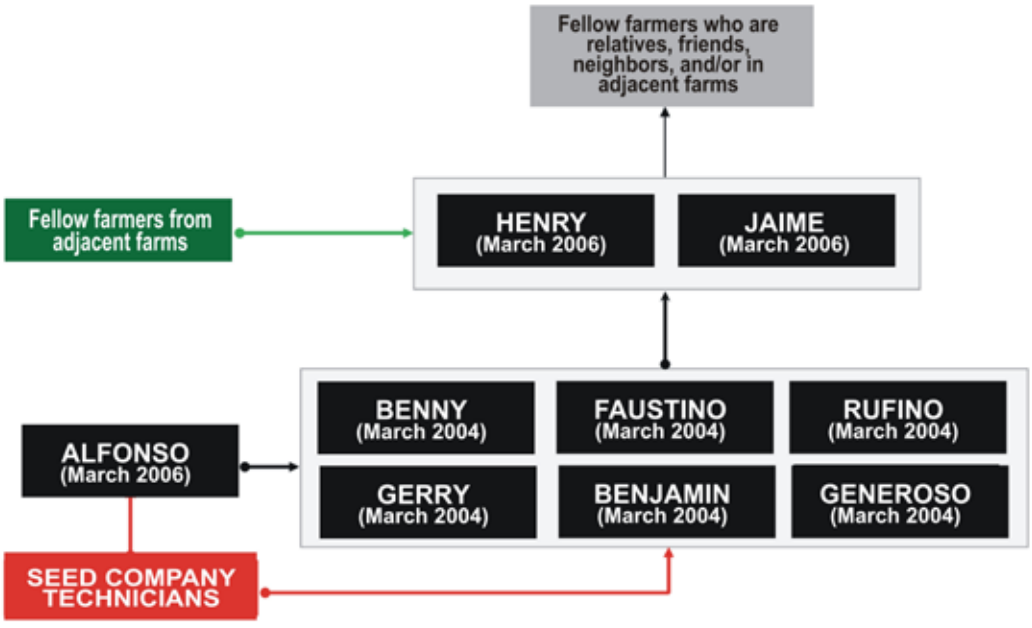


Figure 9. Uptake pathway of biotech corn among farmers in Brgy. Rang-ay, Banga, South Cotabato

c.2 Brgy. Klinan-6, Polomolok

Many corn farmers in Polomolok, South Cotabato were among the first adoptors of biotech corn after it was commercialized in the Philippines in December 2003. In Brgy. Klinan-6, the early adoptors learned about biotech corn in 2003 from various sources: Alfredo, Florencio, Buenaventura, Ulysses and Josefina; technicians of a seed company; Mila, from a local private trader selling seeds and other farm inputs; and Feliciano, from a local cooperative called UKL, which was in contact with another seed company (Figure 10). Several of them also heard about Bt corn from radio because it was a highly contentious issue in the province between organizations promoting its adoption and those opposing its commercialization (i.e., Roman Catholic Church, environmental groups).

Despite the strong opposition movement against biotech corn in South Cotabato, many farmers still started planting the transgenic crop after it was approved for commercialization in December 2003. Most of the farmers agreed that the promise of good harvest and higher income was their primary reason for trying biotech corn. The realization of this promise convinced other farmers to plant the crop as well. They explained that adoption was facilitated by the fact that farmers often talked with one another regarding their farm activities almost every day.

The Innovation Tree participants shared that some of their fellow farmers adopted one or more years later because they had second thoughts about biotech corn. They opted to observe first the farms of their neighbors and friends to see if the biotech crop would really perform exceptionally better than the white corn variety, which was popular in the area then. Lucrecia and Evelyn admitted that the Catholic Church also influenced their decision not to plant biotech corn for several years after it was introduced in the community. They explained that the Church opposed biotech corn and discouraged them from planting it. They changed their minds, however, after observing from fellow farmers that biotech corn had agronomic and economic benefits that conventional varieties could not give them. Lucrecia, for instance, noticed that her farm was always attacked by the notorious Asian Corn Borer (ACB) while her neighbors' farms were not. In 2007, she finally decided to cast aside the advice of her church's leaders and started planting biotech corn. In Evelyn's case, it was the local UKL cooperative that eventually converted her to being a biotech corn farmer in 2009.

Fellow farmers and seed company technicians were the most influential persons in adoption in Brgy. Klinan-6. They were often the sources of information on biotech corn as well. A few of them explained during the FGDs that there was a strong tendency among farmers to "copy or replicate" what others were doing in their farms, especially when the results were good and favorable.

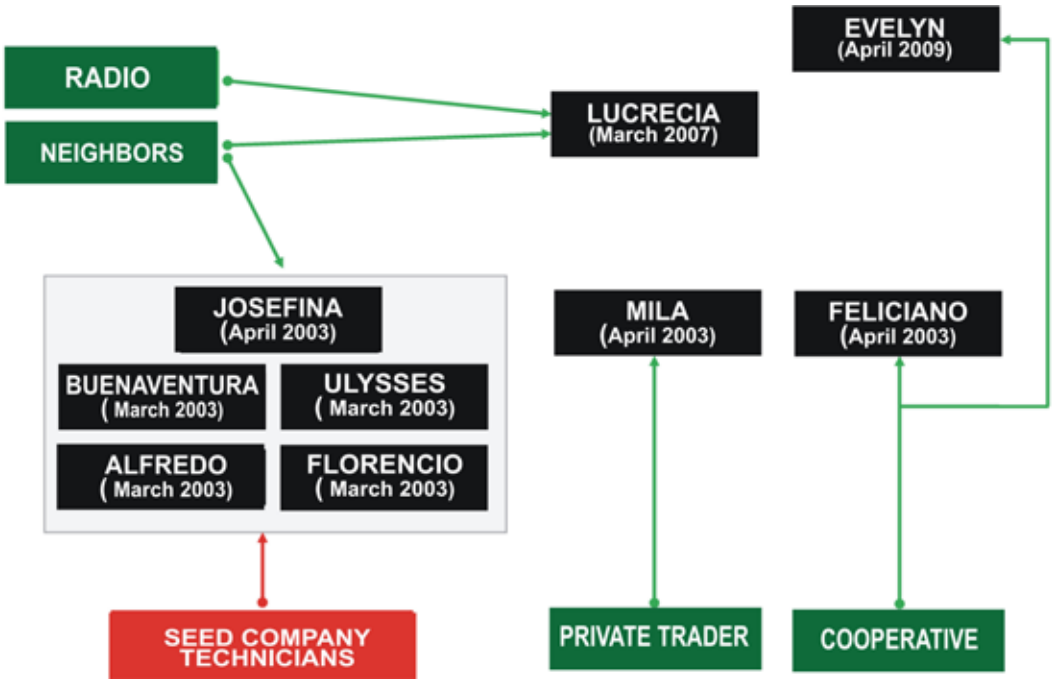


Figure 10. Uptake pathway of biotech corn among farmers in Brgy. Klinan-6, Polomolok, South Cotabato

On the other hand, farmers cited a number of problems in biotech corn production that hampered adoption rate and could discourage them from continuing planting the crop if not attended to: (a) very low market price during harvest season; (b) lack of capital for high cost of farm inputs; (c) lack of financial and material support from government, as well as private organizations; (d) absence of irrigation; and (e) drought or dry season that is becoming more frequent. The needed support that they identified were as follows: (a) subsidy for farm inputs; (b) government regulating selling price, especially during harvest season; (c) farm-to-market roads; and (d) drying facilities.

c.3 Brgy. Lamlahak, Lake Sebu

Lake Sebu became a municipality of South Cotabato on November 11, 1982. It is famous in Mindanao for its lake where it got its name. Aside from freshwater fish, like *tilapia*, Lake Sebu is known for agricultural products, such as rice, corn, and *balinghoy* (cassava). The good words about biotech corn, however, did not spread fast among its farmers in the early years of its commercialization.

The results of the Innovation Tree activity revealed that farmers from this part of the country were generally late adoptors. Rudy, for example, was the earliest adoptor among the 12 participants in the Innovation Tree activity (Figure 11). He learned about biotech corn from technicians of a seed company in 2004, one year after farmers in other parts of the country had already been planting the crop. And even then, the succeeding

adoptors, namely Rudolfo, Nora, and Johnny started planting biotech corn only in 2007 and 2008. They claimed that it was only in 2007 and 2008 that the two seed companies established demonstration farms in their barangays.

Then they passed on their experience to Benedicto, Bonying, Salazar, and Solly who, in 2009, also started planting the biotech corn variety. Romel followed suit in 2010, and he relayed the technology to Jonny, Rechie, and Noel, his fellow farmers in the adjacent farms. A few farmers were informed by the private traders when they were availing themselves of loan for corn production. One of them was Nora, who served as a model farmer in Brgy. Lamlahak and became influential in the decision of many other farmers in the barangay to adopt biotech corn.

Adoptors relied on the following people for information on biotech corn: fellow farmers, agricultural technicians, technicians of seed companies, and traders. Knowledge of biotech corn was also often shared with fellow farmers, neighbors, and family members. After cultivating the crop for at least one season, these farmers informed and convinced their relatives, neighbors, and friends in Lamlahak and other barangays of Lake Sebu. Aside from the promise of good income, factors - such as less expenses and reduced time and effort for weeding - led the farmers to adopt.

Some of the late adoptors mentioned that they were already aware of biotech corn more than a year before they decided to adopt it. Their delayed adoption was due to lack of capital, unaffordable farm inputs

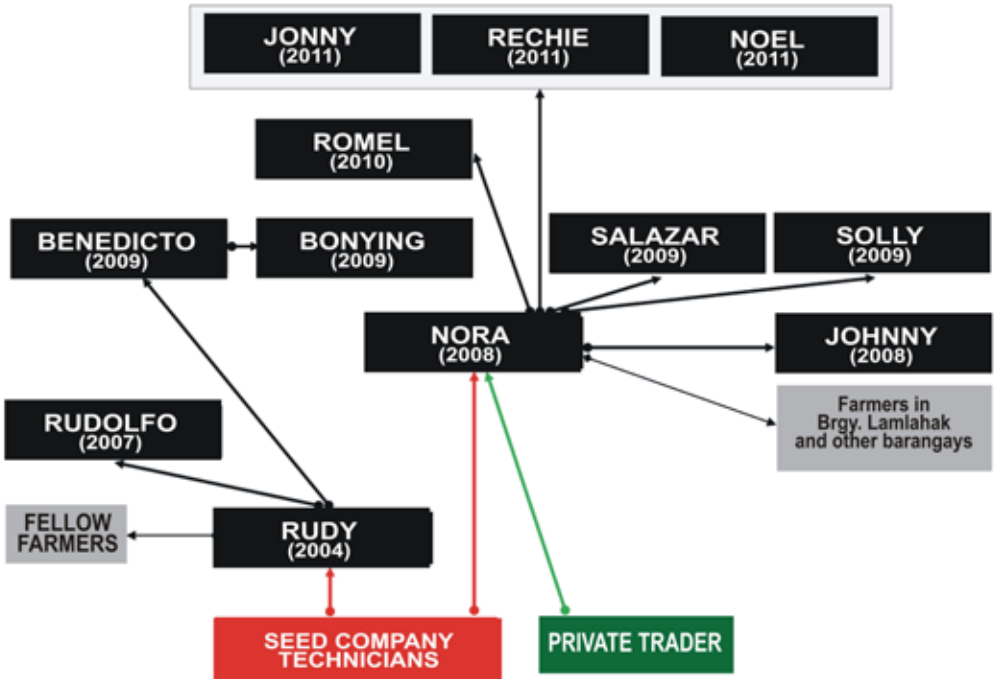


Figure 11. Uptake pathway of biotech corn among farmers in Brgy. Lamlahak, Lake Sebu, South Cotabato

(such as seeds), and lack of assurance or proof of good income. Some observed others grow the crop first to see if it would really give good harvest and income. In the area, farmers noted that about 30 per cent more farmers in their barangay were not yet biotech corn adoptors due to lack of capital.

Identified problems in biotech corn production were: (a) absence of support services from government and private institutions; (b) lack of infrastructures and machineries; (c) infestation of biotech corn plants by rats, aphids, and leafhoppers; and (d) lack of trainings or seminars on better farming practices to increase harvest. Some farmers also stopped growing biotech corn for 1-2 years because of lack of capital and debts incurred from income losses in one or more cropping seasons.

The needs identified by the research participants in relation to biotech corn farming were as follows: (a) irrigation; (b) machineries, such as tractor and dryer; (c) equipment, such as knapsack sprayer; and (d) training on how to properly cultivate Round-up Ready corn variety.

Overall Uptake Pathway

Taken together, the results of the Innovation Tree exercise revealed the individuals and groups who influenced the farmers in their decision to adopt biotech corn, the local conditions (e.g., social, economic, political, environmental) that facilitated or impeded the process of adoption, and other issues that the farmers raised with regard to biotech corn production.

Figure 12 illustrates how the adoption of biotech corn was scaled up in eight barangays in the three Philippine provinces covered by the study. The diagram was constructed using the observed patterns in the results of all the Innovation Tree activities conducted.

In general, adoption of biotech corn in the Philippine community setting started with technicians from multinational seed companies introducing the technology to the farmers. Some of these farmers, with whom the

technicians had initial links, also served as cooperators in demonstration farms for biotech corn production. The technicians also conducted seminars on the characteristics of biotech corn and the benefits from planting it, but not on the recommended farming practices of the crop. This was evident in all corn farming communities included in the study.

Farmers, who participated in seminars and demonstration farm activities, later adopted the biotech crop and influenced fellow farmers to adopt as well, especially those who were their relatives, neighbors, and friends. In addition, they convinced farmers cultivating farms adjacent to theirs to try biotech corn after one or two cropping seasons. By this time, they have already evidences to show about the benefits derived from the crop. Some farmers adopted biotech corn as soon as they learned that those in their adjacent farms would do so, fearing the threat of corn borer infestation in their own farms. In the case of Brgy. Rang-ay, Polomolok, South Cotabato, neighboring farms usually practiced synchronized farming so most of the farmlands in the barangay were planted to biotech corn in a cropping season.

The adoption of biotech corn often spreads from one community to another in two ways. First, some farmers who participated in seminars and farm demonstrations were from other communities. They became the first cultivators of biotech corn in their own communities which were not immediately reached by technicians of seed companies. Second, a farmer from a community had relatives and/or friends in other communities whom he/she convinced to try biotech corn.

Local traders, who also served as financiers or retailers of seeds, fertilizers, and other farm inputs, had direct influence on farmers' decision to adopt the corn variety. Farmers who did not have the means of production often relied on local traders for most of their farm inputs (e.g., seeds, fertilizers) and other farm expenses (e.g., labor, hauling). Without the local traders, many farmers would not have been able to plant biotech corn due to lack of capital.

The role of the Office of the Municipal Agriculturist (OMAG) and its technicians was not very evident in the uptake pathway although they supported the farmers by providing or clarifying technical information regarding the crop during seminars or farm visits. An important contribution, but was not frequently mentioned by farmers, was the monitoring by OMAG of the pest and disease problems encountered in biotech corn production. The technicians and agriculturist of OMAG were not proactive in promoting biotech corn due to the strong opposition against genetically modified organisms (GMOs) by some influential sectors, including the Catholic Church in South Cotabato province. Nonetheless, they supported the farmers' decision to adopt the crop. They even included topics on biotech corn in farmers' trainings and seminars.

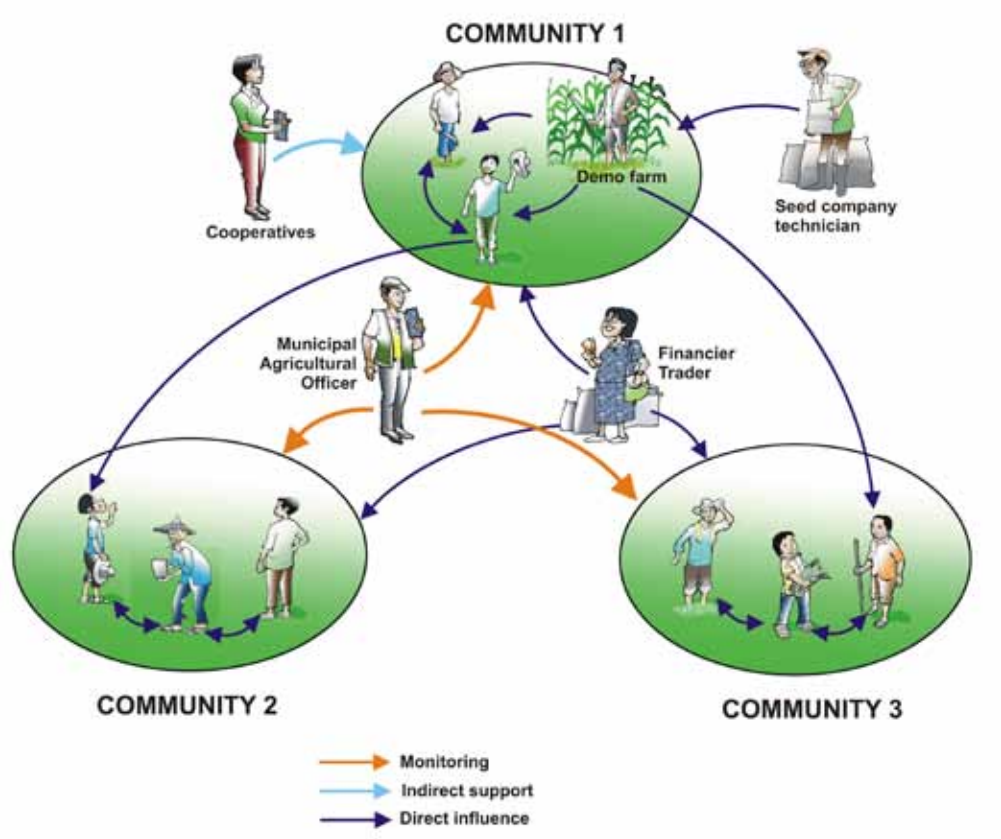


Figure 12. Overall pattern in the uptake pathway of biotech corn among small and resource-poor farmers in the Philippines

Some farmers' organizations, such as cooperatives, generally had indirect influence and provided some forms of support to their members who adopted biotech corn. In the case of Iloilo province, the support of the MODEL Farmers' Association for biotech corn farming persuaded many of its members to try planting the crop. The cooperative was headed by an outstanding farmer whose role was pivotal in scaling up biotech corn adoption in the province. In Brgy. Anao, New Mexico, Pampanga, another outstanding and well-respected farmer, who was also a former municipal councilor, served as the model of many other farmers in biotech corn farming. Hence, the emergence of local "champions" somehow facilitated the adoption and uptake pathway of biotech corn in the Philippines.

Benefits Derived and Problems Encountered

Benefits Derived from Biotech Corn Production

It came as no surprise that the bulk of income (78.7%) derived from biotech corn farming was spent on day-to-day expenses, farming being the primary occupation of the respondents (Table 22). As their second crop (and third for others), biotech corn was the means to sustain their livelihood after their rice cropping season.

It is also commendable that the farmers' improved income was invested highly in their children's education (60.9%). This strongly suggests that education remains a constant aspiration among Filipino farmers. A few shared with excitement how they were able to send all their children to college, with some even landing overseas jobs, because of their biotech corn earnings. Those with children now working abroad have big and nice houses complete with impressive furniture and appliances. But even if these farmers could afford to live a relatively well-off life at this point, they remained preoccupied with their biotech corn farming.

> *"With our income from biotech corn, many of us were able to send our children to college, even to Manila. In my family, I now have three professionals and two of them are now working abroad. I used to bring my income to Manila to pay for their tuition fees and board and lodging. I have never earned this much from any other crops."*

The third investment item for their income was house repair, together with purchase of furniture (46.0%). Many houses were upgraded into more concrete ones. Houses of biotech corn farmers were observed to be better than the typical poor households in their communities. Furniture purchased included refrigerator, television, and computer.

Though not a majority, it is also worth noting that about one-fourth (23.3%) used their income for farm capital. These few realized that they would earn higher income if they have no padded interest to pay for their loans. But as earlier mentioned, many farmers tended to rely on financiers rather than use their income or savings for farm expenses.

Table 22. Utilization of income from biotech corn production

Utilization	Frequency (n=409)*	Percentage
Day-to-day expenses	322	78.7
Children's education	249	60.9
House repair and home furniture	188	46.0
Farm capital	95	23.3
Vehicle	15	3.7
Leisure	2	0.5

* Multiple response

Though not significant in number, it is of interest and importance to cite that a number of farmers engaged in upland biotech corn farming put their investment on vehicle, such as motorcycle. For them, the motorcycle serves both domestic and farming purposes. With around Php 35,000 per unit, these farmers were able to readily pay in cash for the motorcycle unit after the corn harvesting season.

Motorcycles enabled the farmers to visit their upland farms more often. These were also used to haul their corn from one point to another. And because there was no public transport that regularly ply their communities, the motorcycles were used to ferry family members to the town proper. At two separate instances, it was observed that the motorcycle was used to load sheets of plywood for their house repair and a plow for farming.

Problems Encountered in Biotech Corn Production

Topping the list of problems associated with biotech corn farming was the occurrence of pests and diseases (44%; Table 23). Among the pests cited were plant hopper, black bug, worms, rats, and crickets. Diseases due to fungi and bacteria were stalk rot and ear rot. Farmers explained that to address the problem, they usually rested the corn field for at least a month to let the organisms die and be phased out. They cited an infestation of the brown plant hopper in Iloilo in 2011 that practically consumed their entire corn fields.

The farmers openly expressed that they initially thought of biotech corn, especially the Bt corn (the one they were more familiar with), as a “super” variety that is immune to all pests and diseases. So they wondered at some point why the crop still faced the same pest attacks common to conventional varieties.

Another problem had to do with non-germination of the seeds they bought (19.8%). Farmers returned the seeds to the supplier and were informed that these had “expired.” But nobody explained to them how and why the seeds expired.

Despite the sense of security in terms of financial assistance, there were respondents who complained about the expensive inputs, like seeds, fertilizers, and herbicides or weedicides. They noted that on top of the regular prices of these inputs, they were being charged by traders about 10 per cent more because these were on credit terms. Upon payment of loans come harvest time, they would pay another interest for the money or inputs loaned by the financier, seed supplier, or trader.

Though mentioned only by a few, low buying price of the corn was another concern that needed to be paid attention to. Buying price fluctuates and varies depending on a number of factors - location, form of corn, and buyer. Buying price for dried corn ranged from Php 12 -14 per kilo in the northern part; and only Php 11 - 12.50 per kilo in the southern part of the country. In cobs, corn were sold at Php 5 - 5.25 per kilo. Millers also tended to pay more than the traders: Php 13.60 per kilo against the traders' Php 13.20.

Of lesser concern but nonetheless valid problems were those pertaining to lack of support services to their farming enterprise. Government support and services were almost non-existent for corn. Unlike rice, corn does not get any price subsidy and its buying price is not regulated. Corn farmers also do not get assistance in terms of machineries, like sheller and dryer. In fact, farmers were saying that if government could only provide communal big tractors for rent, then it would all the more boost their biotech corn production.

Lastly, the changing weather and rainfall patterns have also been noted; farmers observed that these have adversely affected their cropping seasons in recent years. This is a natural phenomenon related to climate variability and change that farmers have yet to fully understand.

Table 23. Problems encountered in biotech corn farming

Problem	Frequency (n= 409)*	Percentage
Pests, fungal, and bacterial diseases	180	44.0
Seeds that expired and did not germinate	81	19.8
Expensive inputs	66	16.1
Low price	33	8.1
Lack of capital/support	28	6.8
Heavy rains	11	2.7
Lack of training	3	0.7
No problems encountered	68	16.6
No answer	6	1.5

* Multiple response

Relationship Between Socio-demographic Characteristics and Adoption of Biotech Corn

One of the objectives of the study was to determine the relationship between the socio-demographic characteristics of the farmers and their adoption of biotech corn. With the recommended practices in corn farming as reference, adoption in the study was defined in terms of three categories: (a) *in toto* or full adoption; (b) partial adoption; and (c) modified adoption. Chi-square and Spearman rho were the statistical tests used to determine if relationship exists between the variables.

Based on the results of statistical tests, three of the socio-demographic characteristics were found to relate positively with mode of adoption. These were age, number of children, and income from biotech corn (Table 24). The peculiar adoption mode among majority of the farmers was to modify the recommended farm practices in corn planting. The modification was mostly in terms of distance between corn plants. Instead of the usual 70 cm x 25 cm, they reduced it to 65 cm x 20 cm or 60 cm x 20 cm distance. Farmers reasoned out that reduction in distance enabled them to plant more corn plants in a given space, thus, enabling them to harvest more. According to them, there was no observed adverse impact of such distance reduction on the size of corn plants and corn ears harvested. Hence, farmers have sustained this practice.

Age and Mode of Adoption

Age was found to associate positively with mode of adoption. The older the farmers, the higher their tendency to modify their practices in corn planting. This is because as farmers age, they also gain lessons from

their field experience. They then consider these observed learnings as more reliable bases for deciding on what they will adopt. An established fact, farmers have the typical and strong tendency to "believe what they see."

Family Size and Mode of Adoption

Results have indicated that farmers with more children tend to modify their farming practices. This may be explained by the assumption that as farmers have more mouths to feed, their motivation to harvest more also increases. This then drives them to modify or try out practices that will meet their goal to harvest more. Reducing the distance between plants during planting is one such logical modification that meets their goal.

Income and Mode of Adoption

As farm income increases, farmers tend to modify their corn farming practices. This could be explained in that having gained some degree of financial security, they become more open to try out schemes which they think would contribute to better farming results. Those with low income would logically be more risk-averse as they do not have much to spare or gamble.

Table 24. Relationship between socio-demographic characteristics and mode of adoption

Independent Variable	Dependent Variable	P- Value
Age	Mode of adoption: *in toto* partial modified	0.002
Family size		0.023
Income		0.003

Relationship Between Farm-related Profile and Adoption of Biotech Corn

Relationship between farm-related characteristics and mode of adoption was also subjected to statistical tests. Three farm-related variables were found to relate positively with adoption: number of years farming, farm size, and attendance in training (Table 25).

Number of Years Farming and Mode of Adoption

Biotech corn farmers with longer years in farming tend to modify their practices through time. Being closely correlated with age, this may also be explained by the assumption that as farmers gain longer years in the farm, they also gain experience on which they base their

knowledge and practices on. And so having tried and tested that reducing distance between corn plants gives them more harvest, they modify the recommended practice on their own.

Farm Size and Mode of Adoption

As farm size increases, farmers tend to modify their practices in corn farming. Having bigger stake, they would want to try out schemes that would maximize their land areas more. Most likely having higher income, too, they are more open to risk in modifying because they have more money and other resources to tap.

Attendance in Training and Mode of Adoption

The more trainings farmers have attended, the higher their tendency to modify their farming practices. Trainings are avenues for new learnings, which could have motivated farmers to try them out in the field; and if they show promise of better benefits, farmers would certainly adopt those that maximize their benefits.

Table 25. Relationship between farming profile and mode of adoption

Independent Variable	Dependent Variable	P- Value
Number of years farming	Mode of adoption: *in toto* partial modified	0.010
Farm size		0.022
Attendance in training		0.000

CONCLUSIONS

Biotech corn adoptors are 48 years old, male, have completed high school, married, with small family size, and members of farm-related organizations. They have been farming for 23 years and have adopted biotech corn with stacked trait for 7 years. Average farm size is 2.7 ha, located mostly in marginal upland areas, and is owned. Their foremost source of farm capital are the private individual financiers and/or traders. Farmers' income per harvest is estimated at Php 20,550/ha for lowland farms and Php 33,630/ha for upland farms. As to farm activities, it is the male household head who is deeply involved, with the mother and children playing only minor roles.

Factors influencing adoption are economic, agronomic, socio-cultural, and psychological in nature. High income is the most compelling. Farmers intend to continue planting biotech corn and other biotech crops in the future, especially those which are drought and pest resistant.

Adoption of biotech corn in the Philippine community setting starts with technicians from multinational seed companies introducing the technology to the farmers through farm demonstrations and seminars. Sharing of knowledge about biotech corn is strongly biased towards their fellow farmers, relatives, and neighbors indicating the prevalent peer system.

The major benefit derived from planting biotech corn is higher income while the major problem is the occurrence of pests and diseases. Age, number of children, income, number of years farming, farm size, and attendance in training correlate positively with mode of adoption.

RECOMMENDATIONS

Based on the findings of the study, recommendations to enhance adoption and uptake of biotech corn among small and resource-poor farmers may involve actions that hinge on psychological and social factors that influence the farmers' mindset. They may also have something to do with provision of material inputs, technical and policy assistance that would drive or motivate the farmers to adopt and sustain their uptake of biotech corn. These recommendations are as follows:

1. **Farmer-to-farmer education**. Farmers exhibit strong belief in themselves and are inspired by the success of their fellow farmers. Hence, farmer-to-farmer education must be promoted and sustained. People are more likely to follow the behaviors modeled by someone

with whom they can identify. The more perceived commonalities and/or emotional attachments between the observer and the model, the more likely the observer will learn from the model.

2. **Local champions**. Champions at the local level have been identified by the farmers themselves. These local champions must be recognized and tapped as channels for uptake and adoption of biotech corn since they are being looked up to as reputable models by the farmers.

3. Seed quality. Since the technology starts with the seeds, the private companies supplying the seeds have a very important role in ensuring seed quality. Standards on seeds may need to be set and some regulations put in place to avoid the selling of "expired" seeds.

4. **Need to professionalize farming.** Farmers should be capacitated in farm record keeping to rationalize their income and profit. They should not merely be guessing their farm income and expenses. In the long run, this would help them come up with better decisions on the use of inputs and disposal of their capital.

5. **Soil conservation measures.** To be included in the package of biotech corn technology should be soil conservation measures as most farms are located in upland areas. Farmers should be made aware that sloping areas being used for corn farms would need special measures to control soil erosion.

6. **Buying price of corn.** The government may need to intervene so that a minimum buying price is set. This is to prevent the traders from abusing the farmers, especially those indebted to them in terms of capital.

7. **Marketing assistance**. The market and buyers are very important to avoid a glut in the face of bountiful harvest of biotech corn. Some arrangements between the LGUs and the National Food Authority may be established to protect the farmers from arbitrary low buying price.

8. **Credit system.** Alternative credit systems for the farmers need to be explored to eventually ease them out of the highly asymmetrical relationship with the private financiers and traders. Farmers are now captive victims of the system because there is no alternative that performs the function currently being performed by the financiers/traders.

9. **Link with experts**. Farmers need to be assisted in addressing the persistent crop pests and diseases, other than borer, that continuously attack their corn. Their faith on the resilience of biotech corn is being eroded by these occurrences. At the local level, seminars may be given by experts on this concern to enable the farmers to understand and solve the problem on their own. The local agriculturists should also be informed so that they could accordingly assist the farmers.

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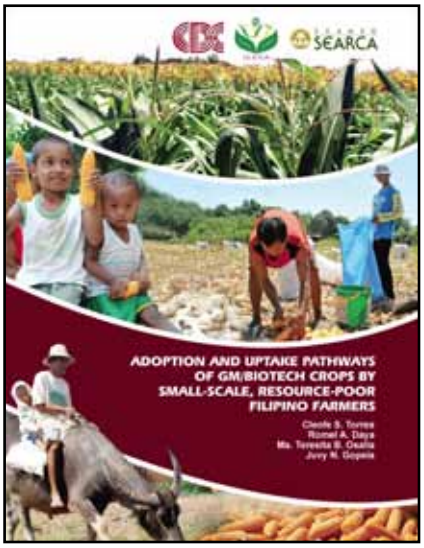

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