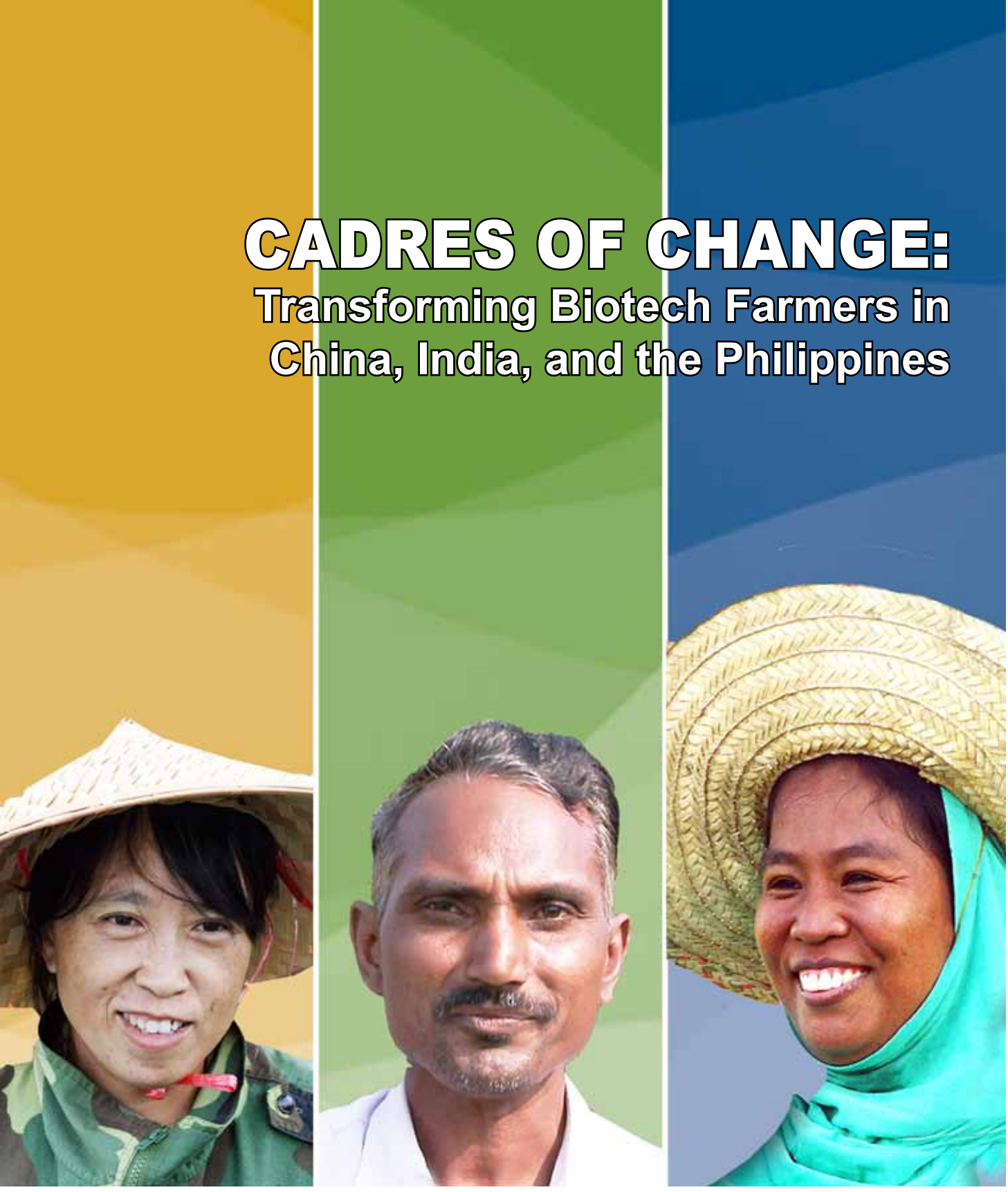
CADRES OF CHANGE:

Transforming Biotech Farmers in China, India, and the Philippines



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Transforming Biotech Farmers in China, India, and the Philippines

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A Synthesis of a Research Project on *Adoption and Uptake Pathways of Biotech Crops by Small-scale, Resource-poor Asian Farmers: Comparative Studies in China, India, and the Philippines*

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International Service for the Acquisition of Agri-biotech Applications (ISAAA)
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Indian Society for Cotton Improvement
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Collaborators

Content

Preface

Cadres of Change: Transforming Biotech Farmers in China, India, and the Philippines is an empirical testimony to how biotech crops are changing the lives of small farmers, their families and that of their communities. It is also a serious look into how technology adoption in developing countries can address key issues and concerns related to poverty alleviation, sustainability, and development.

This publication highlights the findings of a research project on the **Adoption and Uptake Pathways of Biotech Crops by Small-scale Resource-poor Asian Farmers: Comparative Studies in China, India, and the Philippines.** Working together with the International Service for the Acquisition of Agri-biotech Applications (ISAAA) which served as the lead proponent were the Center for Chinese Agricultural Policy, Chinese Academy of Sciences; Indian Society for Cotton Improvement; and the College of Development Communication, University of the Philippines Los Baños.

Much of the criticism against biotech crops has centered on the perception that it is the big farmers in developed countries who are benefitting from the technology. The research confirms that resource-poor farmers in developing countries are reaping the benefits. Farmers articulated that they had higher yields, less production expenses due to fewer pesticide applications, and harvested quality grains or bolls. As a result, farmers noted an increase in income and a better quality of life.

The adoption of biotech crops was facilitated by good news about the economic benefits of cultivating them, proof of good yields and income, presence of private traders selling seeds and providing capital loans for production. Equally important was the institutional support system from village chiefs,

local seed companies, and farmer associations. Trust and strong ties among farmers, and rapid spread of information also helped in providing a positive environment for adoption. Nevertheless, as in other agricultural crops, challenges continue to be met such as lack of capital, seed supply, land area for cultivation, and unfavorable weather conditions. Lack of knowledge and access to biotech crops also need to be addressed.

The research provides recommendations to enhance adoption and uptake of biotech crops among small-scale and resource-poor farmers. These involve actions on the part of the farmer and his community in facilitating changes in perspectives about the technology. Both government and private sector support mechanisms are also recommended particularly in terms of providing material inputs, and technical and policy assistance that would motivate farmers to adopt and sustain adoption of biotech crops.

Concrete empirical basis for understanding farmer adoption of biotech crops of which very little information was previously available from the developing world is the major contribution of this research project. We thank the John Templeton Foundation which provided funding to conduct this project and our collaborators from the three Asian countries. We hope the findings and recommendations forwarded in this research can be used by developing countries in designing paradigms and implementing strategies to increase and sustain farmer acceptance and adoption of a beneficial technology.

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Project Leaders














Introduction

As soon as the sun rises, an estimated 7.2 million biotech crop farmers from China, 7.2 million from India, and 375,000 from the Philippines[1] troop to their farms. Like clockwork, farmers do the daily ritual of tilling the land, planting seedlings, applying fertilizer, and tending to their plants. In between, they have more time on their hands to do other chores and income-generating tasks as they no longer have to spray insecticides against a pest (corn borer or cotton bollworm) that wrecks havoc on their plants. Farmer testimonies reveal that they attain peace of mind from planting biotech crops as they benefit from more convenient and flexible crop management, lower cost of production, health and social benefits, and a cleaner environment through decreased use of conventional pesticides. Come harvest time, bales of cotton bolls or sacks of corn cobs bring smiles to their faces as higher yields compared to conventional varieties mean additional income and good quality produce assures a ready market.

As with any other agricultural crops, farmers still face challenges that demand support and appropriate intervention from government and the private sector. Problems regarding seed supply and quality, technology information sharing, and agriculture-related constraints still demand to be solved.

But overwhelmingly, farmers have a key message: Biotech crops are changing their lives and that of their families, and in the process, improving their community. Farmer leaders and village chiefs or cadres have become local champions of biotechnology as they remain committed to share their knowledge with fellow farmers within and beyond their community.

A project on the *Adoption and Uptake Pathways of Biotech Crops by Small-scale, Resource-poor Asian Farmers: Comparative Studies in China, India, and the Philippines* was spearheaded by the International Service for the Acquisition of Agri-biotech Applications (ISAAA) with funding from the John Templeton Foundation to give a human dimension to the statistics on farmer adoption and uptake pathways of biotech crops and the changes these have brought about in resource-poor farmers' lives. It was conducted with collaborators from the Center for Chinese Agricultural Policy, Chinese Academy of Sciences; Indian Society for Cotton Improvement; and the College of Development Communication at the University of the Philippines Los Baños.

[1] James, Clive. 2012. Global Status of Commercialized Biotech/GM Crops: 2012 ISAAA Brief No. 44. ISAAA. Ithaca, NY.

Additional support was provided by ISAAA and the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA).

This monograph highlights answers to the following questions: Who are the biotech farmers? What are the factors that farmers consider in adopting biotech crops? How have they benefitted from adopting the technology? Who influenced them in adopting biotech crops?

The three countries represent an unmatched wealth of critical information and insights towards a better understanding of the social environment that favors biotech crop adoption particularly in developing countries. This research hopes to provide evidence-based foundation for developing paradigms and strategies to increase farmer acceptance and adoption of agricultural biotechnology. Data were gathered using survey, focus group discussion using a tool known as Innovation Tree, and key informant interviews.

The Scenario

First widely commercialized in 1996, biotech crops are the fastest adopted crop technology in recent history. The 2012 ISAAA report indicates that 170.3 million hectares are planted to biotech crops in 28 countries. This is a hundredfold increase in biotech crop hectarage in about two decades.

Of a record 17.3 million farmers planting biotech crops, 90% are resource-poor farmers in developing countries. About 14.7 million of them are farmers from China, India, and the Philippines. This finding negates the widely perceived idea that biotech crops only benefit farmers from developed countries.

In this research, four provinces in China (Hebei, Shandong, Anhui, and Henan) were studied representing the Huang-Huan-Hai cotton production zone. Farmers in these provinces were among the very first to adopt Bt cotton technology in the late 1990s when Bt cotton was released in the country.

In India, three major cotton growing states namely, Maharashtra, Andhra Pradesh, and Punjab represented three distinct cotton growing zones covering irrigated, semi-irrigated and rainfed conditions.

For the Philippine study, the research areas were Pampanga, Iloilo, and South Cotabato. These provinces, located in each of the major islands of the country are known to be major corn producing areas. The Philippines remains to be the first and only Asian country that has commercialized biotech corn.

Biotech Farmers in Three Asian Countries

Gender. Biotech farming is an enterprise dominated by married males in all the three countries. Male household heads have the major responsibility in most of the farm activities including the marketing of farm produce. Filipino female farmers in particular are partners of male household heads in decision making processes. Women farmers, who tend to be younger than their male counterparts, are far more involved in entrepreneurial and managerial concerns, leaving the more strenuous farm activities such as plowing, planting, and harvesting to the males. Indian female farmers are more engaged in farm operations particularly in weeding, picking, cleaning, and other similar activities in the field. Consistent with the existing literature, there appears to be the feminization of cotton production in China. Female farmers are benefitting from the adoption of Bt cotton.

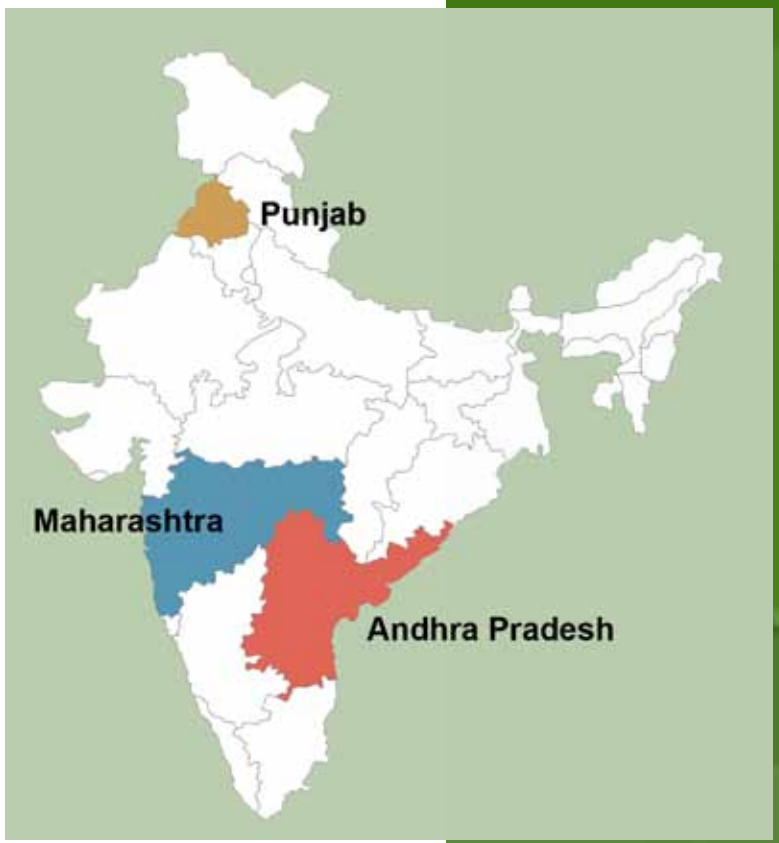
Age. Biotech crop farmers are middle-aged and at the peak of productive years. Farmers in India tend to be younger with 53.4% falling within the 21-40 age bracket. This is the next generation of farmers in India to whom the older parents are passing on the mantle of cotton cultivation. Those from China and the Philippines tend to be older: 40% in China are in the 41-50 age range while 52.8% in the Philippines are in the 41-60 years age bracket. In terms of adoption, the younger farmers in India and China are more open to adopt Bt cotton. In the Philippines, the younger generation is shying away from farming leaving the occupation mainly to their parents. The older farmers then take on the biotech crop more readily because having gained more experience, they could discern what would likely work or not. Convinced of the evidence they gathered about the biotech crops' performance in the field, it is not hard for them to readily embrace the technology.

Education. In general, majority of the biotech crop farmers have gone beyond primary schooling. India has the highest number of farmers with secondary schooling (62.5%) and college (20%), followed by the Philippines with 43.3% having reached secondary school and 16.4% having gone to

China


Hebei
Shandong
Henan
Anhui

India


Punjab
Maharashtra
Andhra Pradesh

Philippines

or completed college. Chinese farmers have completed about six to nine years of schooling.Those who attend trainings on biotech crops were more likely to adopt Bt cotton. In the Philippines, biotech corn adoptors are those with higher level of education. In India and China, education does not come out as a strong determinant of biotech crop adoption.

Family size. Biotech crop farmers tend to have few children. In the Philippines, majority of the farmers (40.6%) have only 1-3 children while in India, more than half of the farmers (56%) have only 1-2 children. Average number of children for Chinese biotech farmers is 4. This indicates that family size of small-scale, resource-poor farmers are decreasing compared to findings of earlier studies depicting farm families as big.

Membership in organizations. A large proportion of biotech crop farmers in India and in the Philippines are members of organizations (79.9% and 66.5%, respectively). In the Philippines, grassroots organizations popularly known as POs (people's organizations) focusing on rice farming are common. Most biotech corn farmers are also rice farmers, hence, they are also members of rice farmers organizations. In India, the cooperatives at the State level are the most functional organization where most of the biotech farmers are members of Self-help groups (SHGs). These cooperatives are supported by the State governments and are common in villages. In these SHGs, it is not uncommon to see women farmers or wives actively participating in the activities of SHGs.

Farming years. Fifty percent of the farmer respondents in India have been planting Bt cotton for more than six years while the rest (42%) have been for three to five years. Bt cotton was commercialized in the country in 2002, and planting commenced in 2003. There are more Filipino 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 is 6.9 years. In China, most of the farmers have been planting Bt cotton for more than five years based on a survey conducted in 2004. Assuming that they have continued planting Bt cotton from 2004, they would have adopted the Bt cotton for more than 10 years. Bt cotton was commercialized in the four provinces between 1997 and 1999. Based on the foregoing information, it would seem that biotech crop adoption progressed faster in

China and India. Hence, in terms of coverage, nearly 100% of cotton farmers in these two countries are already into biotech farming, whereas, the Philippines has yet to reach this mark.

Farm size. The average farm size of 2.1 hectares among Indian biotech farmers is quite close to that of the Filipino's 2.7 hectares. Bt cotton farmers in China, on the other hand, own smaller lands with an average farm size of only 0.66 hectare. Since China's government implemented the Household Responsibility System 35 years ago, land has been equally distributed to rural households under the coexistence of individual land use rights and land ownership at village collective.

Source of capital. The primary source of capital for biotech crops varies significantly across countries. In the Philippines, majority of the farmers (54%) obtain their capital as loan through informal arrangements with 'financiers.' Financiers differ from conventional money lenders in that they give loans only to biotech corn farmers who agree to sell their harvest to them. In India, more than half of the farmer respondents (57.5%) sourced their capital from banks and other formal credit institutions. In the Philippines, very few (8.8%) obtain their capital from these formal credit institutions. Traders are the second most sought after capital source of biotech crop farmers in India (27.3%) and in the Philippines (24.5%). Aside from providing cash loans, traders also offer other inputs such as seeds (India and the Philippines), fertilizers and pesticides (India). As payment, the farmers in turn sell their produce to the traders. In both countries, very few biotech farmers use their own money or savings to finance their farming venture.

Selling of produce. Majority of the biotech crop farmers in India (60.5%) and in the Philippines (86.5%) sell their produce to traders. Farmers in the Philippines are indebted to the traders or the 'financiers' through informal loan arrangement. As part of the payment scheme, financiers get the right to buy the corn produce from the farmers. Though farmers are assured of a market for their products, they could not, however, take advantage of the higher selling price outside this informal arrangement.

In India, a large number of farmers sell their produce to cotton ginners and/or traders involved in the cotton value chain. The second most preferred way to market Bt cotton in many

States in India is through open *mandi* or market (23.4%). However, the case in the State of Maharashtra differs in that more farmers prefer to sell their cotton to cooperatives as the payment goes directly to their cooperative accounts.

Net income. Upon adoption of biotech crops, farmer respondents in India and in the Philippines obtain a significant increase in their net income per hectare. Net income of lowland biotech farmers (Php 20,550/ha or US$ 513.75/ha) in the Philippines is two times higher than what they used to earn in farming using non-biotech corn varieties. For upland areas where total farm expense is lower, the reported earning is as much as three times their previous earnings (Php 33,630 or US$ 834/ha).

In India, the average net income of Bt cotton farmers is Rs. 41,837/ha (US$ 804) which is significantly higher than what they used to earn prior to planting biotech crop. Farmers in China earn an average of RMB 4049/ha (US$667) - considered to be three times of what they earn from non-biotech cotton.

Farm expense. In India, 46% of the farmers' gross income from Bt cotton goes to farm expenses. On the other hand, a larger portion of gross income of Filipino biotech corn farmers went to farm labor and input expenses (73%). About 60% of the total farm expenses among Filipino farmers are spent for seeds, fertilizers, and herbicides while the rest (18%) goes to farm labor, irrigation, rentals, and food expenses. Total farm expense tends to be lower in upland areas due to absence of tillage.

Expense for farm labor gets highest percentage among cotton farmers in India and China, while it is lowest for biotech corn farmers in the Philippines. This is because picking of cotton bolls requires more labor hours than harvesting of corn.

Factors that Farmers Consider in Adopting Biotech Crops

While biotech farmers across the three countries have multiple reasons for adopting biotech crops, some reasons are, however, deemed more important than the others. In India, farmers adopt biotech cotton due to its agronomic

traits, particularly its resistance to pests. On the other hand, farmers in the Philippines are categorical in saying that their main consideration for adopting biotech corn is its economic benefits.

More than 86.3% of Bt cotton farmers in India claim that freedom from or reduced bollworm spraying is the topmost consideration why they shifted to biotech crop farming. Even the economic factors they considered significant (i.e. higher profit margin) in adopting the technology are attributed to the reduction of chemical sprays on cotton.

In the case of Filipino biotech corn farmers, economic factors particularly higher yield and income are the main driving force for adopting biotech corn. Aside from income, a notable factor that favors adoption of biotech corn is the availability of financial assistance from financiers, traders, and even seed suppliers (46.7%). Lesser expense (37.7%) is also a major factor for adoption. Since the biotech corn varieties ensure no borer pest attack, the use of costly pesticides has been practically eliminated. Similarly, availability of biotech corn seeds (32.2%) is an important factor that motivates the farmers to adopt.

Most biotech farmers in India and the Philippines have the intent to continue planting biotech crops (76.6% and 93.2%, respectively). In both countries, higher yield that eventually leads to higher income is a major influence of adoption.

In China, the dramatic reduction in pesticide use is a significant motivation to adopt Bt cotton. Less labor input and higher yield with good quality cotton are other positive factors.

Awareness of other biotech crops in the pipeline is low in all the three countries. Most of the farmer respondents (77.5%) in the Philippines are not aware yet of the other forthcoming biotech crops. However, majority are willing to plant Bt eggplant (58.4%) and Golden Rice (57.9%), even if they do not know anything yet about these crops. Here, low awareness does not seem to affect farmers' intention

Faustino Astrero Jr.
Banga, South Cotabato, Philippines

In our place, large seed companies organize a harvest festival for farmers. Aside from free food, they also give us samples of their products and they conduct seminars on Bt corn. When I started to plant Bt corn, I felt more relaxed because there is less labor in planting Bt corn unlike with conventional corn where you still need to till the land. One no longer needs to spray insecticide. It also reduces my time for corn farming and I can spend more time with my other crops. We also get higher yield from Bt corn.

Venkatayya
Hussainpur, Sankarapalli Mandal
Andhra Pradesh, India

We used to plant conventional cotton varieties but yield was poor. We used insecticides every other day or once every two days. Yet we got only 3-4 quintals (300-400 kg) yield per acre. But after using Bt cotton seeds we now yield 1 ton. We are using less insecticide and the crop quality is good. Before we had debts because we spent a lot on insecticides. We are clearing those debts now with the profits from Bt cotton.

to adopt. Farmers' good experience with biotech corn is an important precedent that convinces them of the benefits they would derive from these future biotech crops.

Uptake Pathways of Biotech Crops

Sources of Information on Biotech Crops

Farmers in India and the Philippines gained firsthand information on the technology from their fellow farmers who have planted biotech varieties much earlier. These early adoptors demonstrated convincing results, and then shared their success stories to other farmers in their community. The case of farmers in China differs in that it is the seed companies which provides them the first hand information and drive the uptake of biotech crop forward.

In the Philippines, 91.9% of the farmer respondents admit that it is their co-farmers who convinced them to adopt biotech corn. Most of the information they gained from their fellow farmers center on benefits derived from the crop (71.6%). These benefits are largely economic in nature (i.e. better yield and higher income).

On the other hand, 30.9% of farmers from India claim that they learn useful information on the technology from progressive village farmers. Most of the information gained prior to adoption is about pest and disease resistance properties (79.5%) of hybrid cultivars.

Bt cotton farmers in China learn about the technology prior to adoption. Many farmers in Hebei and Shandong are convinced by seed companies to start Bt cotton demonstration fields through the village committees. The large proportion of farmers, particularly in Henan and Anhui province (around 40%) gain primary information about the technology from the technicians. The China experience indicates that many farmers obtain firsthand information about Bt cotton and its cultivation from the training programs organized by the government's extension bureau, village committees, and at times supported by the seed companies. As biotech crop farmers in India and the Philippines adopt

the technology, they have come to learn more about the technology not just through their peers but through traders/ seed suppliers as well.

There was relatively small percentage of farmer respondents in India (11.5% for agriculture officers and 9.9% for other public sector extension services) and in the Philippines (34%) who gained information about biotech crops from government agencies on agriculture. Institutional and policy reviews on the role of public institutions in supporting technology adoption of resource-poor farmers should be given attention.

Attendance in Trainings/Workshops

There was no consistent pattern for the three countries on this aspect. While majority of farmers (66.5%) in the Philippines have attended formal trainings related to biotech crops, those in India (68.4%) have not done so at all. Farmers in China attended training programs conducted by technicians or seed companies. However, not all eventually adopted the technology. Trainings attended by farmers in the Philippines were organized mostly by the private companies that provided the biotech seeds, indicating that efforts to enhance uptake and adoption of biotech crops were mostly private sector-driven. For future trainings, many of the farmers signified their interest to participate.

Sharing of Knowledge

Knowledge sharing about biotech crops among the farmers and other actors in the farming system was highly interpersonal and face-to-face. The top two groups with whom Indian farmers shared their knowledge were their fellow farmers and traders/dealers; whereas, in the Philippines, it was their fellow farmers and their relatives. In China, the role of village cadres in the diffusion of Bt cotton is very important. They coordinate with the

Wang Yuping
Zhangzhai, Nancheng, Xiajin
Shandong, China

I used to plant ordinary cotton but bollworm infestation was a problem. I even wanted to give up until I was introduced to Bt cotton through a seed technician. He said Bt cotton is a transgenic crop and it is resistant to pests. I then bought seeds from the Bureau of Agriculture and began to grow Bt cotton. Everyone in our village is already planting Bt cotton. The production of cotton is higher than the traditional variety by more than 50 percent. Bt cotton is really good. It is productive, it is profitable, and it saves labor and pesticide.

Aquino Gozun
Lacmit, Arayat
Pampanga, Philippines

We started to plant Bt corn in 2004. The Office of the Provincial Agriculturist organized a Farmers' Field School in our place where they also conducted farm demonstrations. I was one of the cooperators in their farm demo. That was the very first time I planted Bt corn. I initially saw the big difference between Bt corn and conventional corn. The pests always eat the conventional corn that's why we sometimes end up with no earning at all. When Bt corn was introduced to us, it brought good results to farmers as we no longer need to apply insecticide and we even have more yield. This gives us an income twice more than what we get from the conventional corn. That's why almost every farmer in my place is planting Bt corn.

Chen Jianbin
Da Lisi, Wangkou, Xinji City
Hebei Province, China

We were introduced to Bt cotton when a seed company worker visited our village and distributed the seed variety. I tried it and found it good. My crop was not infested by pests so I continued to plant the variety. We save labor and time; the production is also high so our income increases too. Because of planting Bt cotton, we have built a big house, earned more money, and now we live a better life. Most of the cotton planted in our village is already Bt cotton. The ordinary cotton which is not pest-resistant has almost disappeared. We farmers always share our experiences in growing Bt cotton with each other and we apply the good practices we learned from our fellow farmers.

Sudhakar Vasudevrao Bhamkar
Kamthi Khanapur, Vardha
Maharastra, India

For the last 25-30 years, I have been planting cotton referred to as white gold. Farmers need to adopt new scientific technology to improve production as well as earn more money. Growing Bt cotton helps farmers to save more by reducing labor cost otherwise spent for pesticide spraying. There is no need to spray pesticide on Bt cotton. I hope that agricultural research institutes can also focus their research to control other insect pests and diseases which infect Bt cotton.

technicians to arrange trainings and convince farmers to participate in farm-related activities. Technicians or seed sellers also play important roles in knowledge sharing.

Farmer-to-farmer sharing is a product of the prevailing strong peer system among farmers. Believing that they share a common lifeworld, farmers believe that they owe it to themselves and their fellow farmers to share the information which could benefit everyone in the community. Sharing with relatives especially in the Philippine setting is an outcome of the prevalent kinship system that governs relationships among farmers in rural areas.

As to traders, farmers in India see this connection node as very important in getting the latest price information and the market forces affecting them. With common interest on supplying the goods, they both need to share whatever knowledge or information there are that would help improve their production and markets.

Benefits Derived and Utilization of Income

Increased income is the foremost benefit that accrues to the farmers from the cultivation of biotech crops. Utilization of income derived from planting of biotech crops is similar among the three countries. House repair and purchase of home appliances and furniture are common to farmers in India and the Philippines. Among Indian farmers,

priority goes to repayment of loans. This could have been the case also for Filipino farmers except that for them, the amount for repayment is already a given as this amount is automatically deducted from the sales of their harvest by the seed traders from who they have borrowed money. Filipino farmers reckon their income as the amount left when everything else in their loans has been deducted from their sales.

Surprisingly, the use of income to finance their farm capital is not a popular response in the Philippines where only 23.3% made mention of it. Farmers note that their farm capital is an assured commitment from the traders and financiers. And because of this, they might as well use their income for their urgent domestic needs and for items requiring bulk expenses such as education of their children.

Problems Encountered

Problems confronting the biotech farmers in the three countries are related mostly to the high cost of inputs and other pests and diseases attacking the plants. These concerns are also common to other agricultural crops. The cost of biotech seeds is about three times the cost of conventional varieties. Fertilizers and herbicides further add to expenses. For cotton growers in India and China, labor account for most of the input cost as it is more labor-intensive to pick cotton bolls than to harvest corn.

While biotech crops are resistant to attacks of bollworms (in the case of cotton) or borer (in the case of corn), they are not

Melinda Diaz
Lacmit, Arayat, Pampanga, Philippines

I learned about biotech corn from a seminar and from the traders in our place. They said that you no longer need to use pesticide with this variety so I tried planting it. Fortunately, the result was good. We had a bountiful harvest and spent less on inputs since we no longer use pesticide. As a single parent, it helped me sustain the education of my two children.

necessarily resistant to other fungal and bacterial diseases. Biotech farmers in the Philippines have a misconception that biotech crops are totally infestation-free from any kind of pests, fungi, or bacteria which is not the case.

Other concerns particularly in India are irrigation, price fluctuation, and lack of knowledge. There is also the high cost of labor because sowing, weeding, and harvesting operations are mostly manual. Many farmers (70%) point out the high cost of seeds. In Punjab, the farmers note the increased number of sprays for sucking pests of cotton in early stages of growth due to high susceptibility of the hybrids used there. On the other hand, the Chinese farmers'primary concern are the supply of seeds and lack of information about the technology.

Mohamad Habibbudin
Hussainpur, Mandal Shankarpali
Andhra Pradesh, India

I have been growing Bt cotton in the last five to six years. Previously I was growing conventional cotton but I suffered a huge loss in yield due to bollworm infestation. Since Bt cotton was introduced, my yield has increased to 10-12 quintals (1,000 to 1,200 kg) per acre. Planting non Bt cotton used to yield only 400 to 500 kg/acre. Previously we were spraying pesticides 10- 12 times on non Bt cotton. Now we are spraying only 2-3 times.

Introduction of Biotech Crops in Communities

The initiative to introduce biotech crops to farmers primarily comes from multinational and local companies developing, producing and/or selling biotech seeds. Their technicians usually hold talks with village chiefs and farmer leaders to convince them about the benefits of the new biotech products. They also conduct field demonstrations in cooperation with farmers interested to try biotech crops.

Seed technicians are technical staff of multinational companies (MNCs).

Li Wenjing
Da Lisi, Wangkou, Xinji City
Hebei, China

Bt cotton was recommended to us by a Chinese agricultural company. The village council also persuaded us to grow Bt cotton as they said that the variety has lots of benefits compared to the conventional cotton. Ever since I planted Bt cotton, it saved me labor and money as I do not buy pesticide. We gain higher income unlike when we were growing ordinary cotton. Bt cotton is productive and the pests are minimal. The cotton bollworms were hugely reduced too. Since we planted Bt cotton, we had higher family income. We renovated our house, bought a new tractor, and a colored TV as well. I already saw its benefits and potentials so I recommended it to my relatives and friends in other villages.

In China and India, many of them also come from smaller local seed companies at the state (India) or county (China) level.

Through field demonstrations, many farmers personally observe the advantages of biotech crops over their non-biotech counterparts - improved physical characteristics of plants, higher yields, and resistance to pests. Most of the farmers who participate as cooperators or observers in field demonstrations become the first adoptors of biotech crops in their communities. Some adopt quickly in a year's time, while others take more years later mainly because they lack capital to buy the expensive seeds and farm inputs.

In many cases, seed company technicians organize local seminars to inform farmers about the advantageous characteristics of biotech crops, the benefits of planting them, and the scientific bases of their safety to human health and the environment.

The key messages on biotech crops that seem to resonate well among the first adoptors are about the crops' resistance to pests and the promise of better harvest and income from cultivating them.

With demonstration farms as entry points for introducing biotech crops, seed companies partner with the agriculture offices of local government units in the Philippines in establishing them. These demonstration farms are complemented by the holding of seminars among farmers. In China, the assistance of village cadres and extension technicians is tapped in introducing biotech

Xu Derong
Zhangzhai, Xiajin,
Shandong, China

I started to plant Bt cotton in 1998. They initially introduced Bt cotton to young people since they are open-minded. People in our village did not want to grow Bt cotton, they did not believe it is resistant to pests. I could not believe it as well. At first, there were only 30 families who were growing Bt cotton. Then my uncle introduced Bt cotton in our village. On the first year, I planted a little. Since then, I began to expand my Bt cotton farm. Aside from my existing 0.13 ha cotton farm, I leased another mu (0.13 ha) for Bt cotton, and later on I expanded my Bt cotton farm to another 7-8 mu (0.47-0.54 ha). I think Bt cotton is better. With ordinary cotton we only got production of over 150 kg per 0.067 ha. Now we get 250-300 kg harvest per 0.067 ha. Before, we all thought that the input cost is too high. Seeds are expensive too. But those who didn't grow Bt cotton gained nothing after the harvest period. Now, people realize that planting Bt cotton can make more money.

Indalencio Supan
Balitucan, Magalang
Pampanga, Philippines

I have been farming since I was 20 years old and now I am already 73 years old. Before Bt corn was commercialized, I was planting sweet corn but the crop is prone to borer infestation. I learned about Bt corn through seed technicians from the government and private seed companies. They encouraged us to plant this variety to increase our earnings. We were convinced because Bt corn really yields more than the conventional variety as the latter is usually eaten by the corn borer. We started to plant Bt corn in 2003 and we are still planting it up to now. Because of planting Bt corn, we were able to buy a house and lot, farm machineries and even farm land. But we still want to learn more from seed technicians during seminars. We also look forward to government support especially in terms of financial assistance so that we can minimize borrowing from traders.

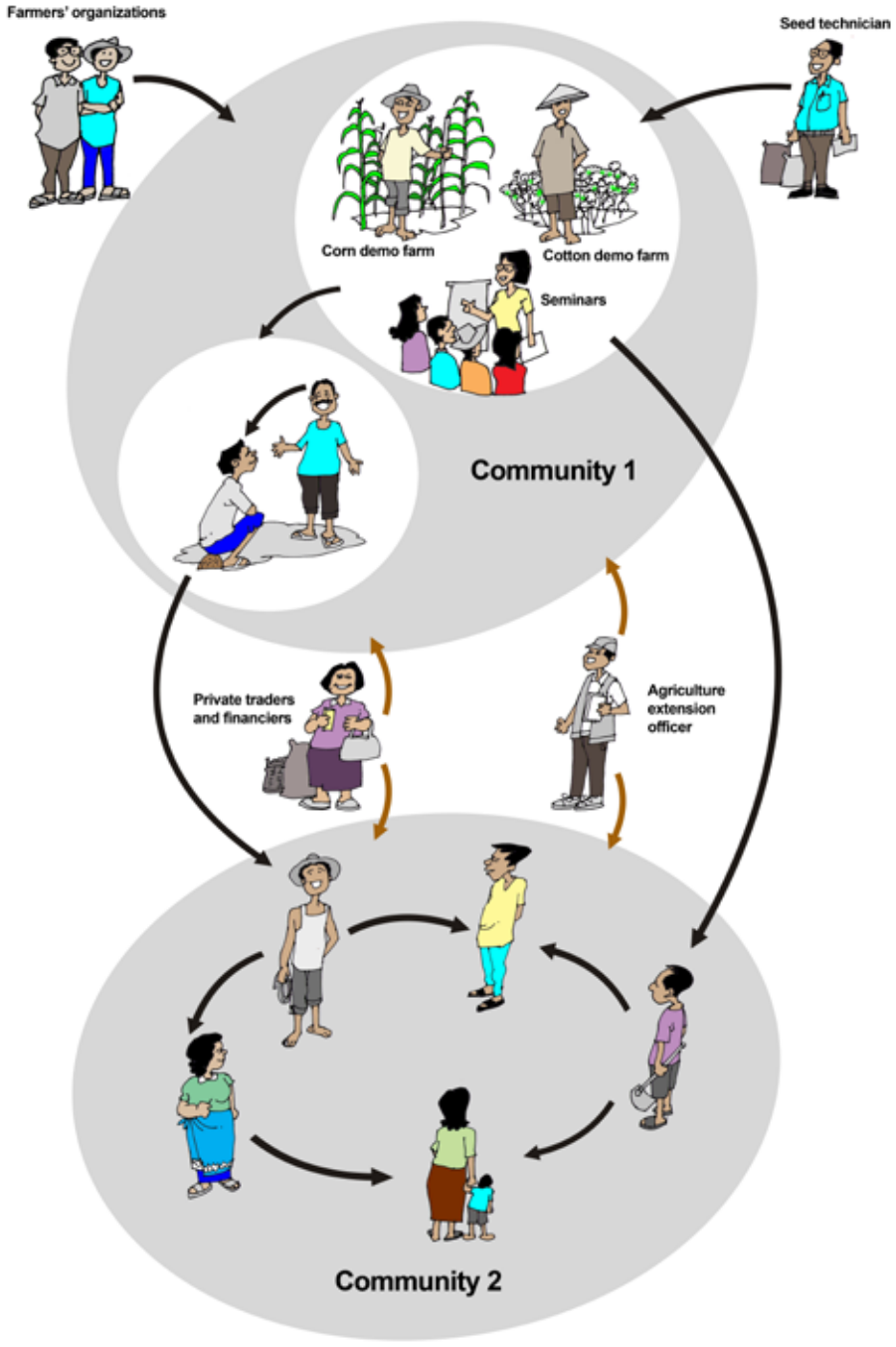


Figure 1. General pattern of adoption and uptake pathway of biotech crops in China, India, and the Philippines

cotton to farmers and in managing field trials. In India, big field demonstrations are established, and participated in not only by thousands of farmers, but also by scientists of state agricultural universities and extension workers.

The following factors facilitate the early adoption of biotech crops in villages in the three countries within the year after their commercial release: 1) nod given by trusted village chiefs, farmer leaders, and agriculture technicians for biotech crop production; 2) close ties among farmers; and 3) avoidance of heavy losses incurred by farmers in cultivating non-biotech crops before.

Trusted community leaders are likely to influence the decision of farmers to adopt or not to adopt biotech crops. For instance, fast adoption of Bt cotton has been experienced in villages in China where the cadres or village chiefs are among the first adoptors. On the other hand, slower adoption occurs in Chinese villages where the cadres do not give outright support for the crop. In the Philippines, it is generally the farmer leaders who sway several other farmers into planting biotech corn after it has been approved for commercialization.

Aside from community leaders, farmers themselves convince each other to give biotech crops a try, especially since they value and trust strong community ties. In the Philippines, there are farmers who decide to plant biotech corn upon learning that their close relatives, neighbors or friends would do so. Some farmers decide to switch to biotech crop farming not only because of the good news about the crop's strong performance but also due to the assurance from fellow farmers that they would adopt the crop as well.

Meanwhile, farmers who experience heavy losses with non-biotech crops are most likely to try planting biotech crops especially upon

Ma Congbiao
Mazhuang Village, Xinji City
Hebei, China

We have been planting Bt cotton on a five mu (0.34 ha) farm for more than a decade. Our village leaders influenced us to plant Bt cotton by organizing a meeting to introduce the benefits of planting Bt cotton to farmers. Planting Bt cotton saves labor and time. Pests were also minimized thus the use of pesticides was reduced. Most of all, we increased our cotton production. Because of this, Bt cotton became very popular to farmers. We have acquired new appliances and furniture for our house. Compared with the past, our life has really improved. To further improve our Bt cotton cultivation, we farmers talk about our harvest and who grows Bt cotton better. We also share our knowledge and experiences on planting the crop.

Crisanta Ocampo
Balitucan, Magalang,
Pampanga, Philippines

As a wife of a biotech farmer, I help my husband by suggesting what seed to plant that fits our budget. I also list down all of our expenses including food, farm inputs, and the payment to our hired laborer. Since I am not the one planting in our farm, I only get information from my husband about biotech corn. He said that it has better yield. My elder brother also started to plant this variety upon hearing positive feedback about it.

knowing about their resistance to pests and weeds. In China's case, for example, many of the early adoptors are those who had gotten very frustrated with non-biotech cotton due to its vulnerability to bollworm infestation.

In other villages, biotech crops have been introduced to farmers either by seed company technicians or other individuals a few years later after commercialization. These individuals include the following: 1) farmers from neighboring counties (China), municipalities (Philippines), or provinces (China, Philippines); 2) private traders selling seeds and/or other farm inputs; and 3) agriculture or extension technicians of village, town or county.

Ramu Dasrat Khoth
Nandora, Maharastra
India

My father used to grow traditional cotton varieties. Due to help from the government, we are now growing Bt cotton. Bt cotton technology helped increase yield. Previously, yield of non-Bt cotton was 6-7 quintals (600 to 700 kg) per acre but now we get up to 8-9 quintals (800 to 900 kg) per acre with very less expenses.

Adoption and Uptake Pathways of Biotech Crops in Communities

Key Players in Adoption and Uptake Pathways

After biotech crops are introduced to farmers, adoption is scaled up in their communities in the succeeding cropping seasons. Aside from the seed company technicians, the key persons responsible for informing farmers about biotech crops and convincing them to adopt are the following: 1) first farmer-adoptors, and 2) private traders.

First Farmer-Adoptors. The first adoptors are mostly the farmer elites - farmer leaders and village chiefs - and farmer cooperators and observers during field demonstrations.

In the Philippines, farmer leaders include outstanding farmers who have been successful in their farm ventures and some elected village officials who own and cultivate farmlands. Some of them are regarded as "local champions of biotechnology" because of their unwavering commitment to

Delson Sonza
Sara, Iloilo, Philippines

Farmers from our province are one of the early adopters of biotech corn. Iloilo is a mountainous province and some of its hilly grasslands are idle, thus there was a need to convert these grasslands to corn farms. Before biotech corn was commercialized in the country, farmers only earn during rice farming season (May-July), sugarcane planting season (October-January), and harvesting of rice and sugarcane (October -December). In 2005, when glyphosate tolerant corn was introduced in the Philippines, dialogues with farmers in Iloilo were conducted to convert our grasslands into corn farms. With farmers convinced to adopt the biotech crop, technology transfer initiatives took place. The adoption of biotech corn was able to uplift our lives as farmers. This gave us an income of roughly Php30,000 (US$750) per hectare which is far higher than income derived from conventional corn. Also, we no longer need to plow and weed, hence, we have more time to find other means of livelihood. Because of higher income, we can now afford to buy appliances, renovate our houses from nipa hut to concrete shelters, and acquire service vehicles such as motorcycles or even a truck. We can also send our children to school and we can even invest in post harvest equipment.

share their knowledge of biotech corn to farmers within and even outside their villages. These champions are risk takers who have shown to their fellow farmers that their personal success stories are proofs that biotech corn is worth the try.

The first adoptors of biotech cotton in India include risk-averse and progressive farmers who champion biotech crops among fellow farmers not only in their own village but in many other villages as well. Some of them have participated in the open field trials of Bt cotton before it was commercialized in the country.

In China, many village chiefs or *cadres* are leading the adoption of Bt cotton. They promote the crop in their communities and even enter into a contract with local seed companies to ensure adequate supply of seeds of Bt cotton. The case is different in the Philippines, where village chiefs locally known as *barangay* captains are generally not as influential as their Chinese counterparts as far as biotech crop adoption is concerned.

Farmers who participate in the field demonstration usually influence many of their relatives, neighbors and friends not only in their own communities but in other areas as well.

Private Traders. The private traders are mostly local businessmen involved in selling seeds and other farm inputs such as fertilizers and herbicides needed for biotech crop production. In India, the network of dealers, distributors, and retailers of seed companies help mobilize farmers to participate in field demonstrations and popularize information on Bt cotton using local languages. In China, the traders are mainly seed retailers or seed sellers at the village obtaining biotech seeds from extension station at township or seed company at county level. In the Philippines, many traders also venture in lending money and farm inputs to farmers and buying their harvest as a strategy to entice farmers. This explains why many Filipino farmers claim that they could not possibly afford the cost of biotech corn farming without help from local traders. Across countries, local traders emphasize the beneficial traits of and high income from biotech crops when selling biotech seeds to farmers.

Other Key Players. There are other players in adoption who ensure the diffusion of biotech crops in other communities - government technicians and farmers from other communities. In some villages in China, local technicians from technology

Li Yizheng
Qinahuozhuang, Xinshengdian, Xiajin
Shandong, China

I was introduced to Bt cotton when our county's cotton improvement office recommended the seed to us. When we planted Bt cotton, we saved on labor and had a more productive yield. Bt cotton reduces need for pesticide so we work less in the field, but earn more. To improve our Bt cotton farming, I and my fellow farmers share each other's methods on proper cultivation. I hope the government will continue to promote good varieties of cotton.

extension stations at counties and townships also take the initiative to promote Bt cotton among smallholder farmers. They give training on Bt cotton and even support the conduct of field demonstration by local seed companies. In India and the Philippines, agriculture technicians of the municipal governments often take supporting roles in biotech crop production, i.e., they give farmers training on biotech crop production or advice on courses of action to take in their farm activities.

Facilitating Factors in the Adoption and Uptake Pathways

Numerous factors facilitate the adoption process and scale up of the number of biotech crop adoptors in communities in China, India, and the Philippines. Some factors are unique to a country or to particular villages. A few could be considered as common adoption realities in the three countries, although

Table 1. Facilitating factors in the adoption and uptake pathways of biotech crops

Nature	Facilitating Factors
Economic	• Financial benefits of cultivating biotech crops (e.g., good physiological and physical traits of crops, high quality and volume of harvests, less expenses for labor and pesticide) (all countries) • Proof of good yield and income provided by first and succeeding adoptors (all countries) • Presence of private traders selling seeds of biotech crops (all countries), providing capital loans for biotech crop production (India, Philippines), and buying harvests (all countries) • Availability of other financiers who provide the necessary capital for biotech crop production (Philippines) • Experiences of financial losses from planting non-biotech crops in previous years (China, Philippines)
Political	• Village cadres help to coordinate Bt cotton training seminars and organize visits to Bt cotton demonstration fields (China) • "Breeding contract" between local seed companies and village chiefs for seed production (China) • Presence of farmer associations providing support such as cooperatives (India, Philippines)
Cultural	• Trust and strong ties among farmers (all countries) • Rapid spread of information on biotech crop (all countries)
Agriculture-related	• Synchronized farming (Philippines) • Variety portfolio (China)

the local contexts in which they are experienced are very much different. These factors are mostly economic, political, cultural, and agricultural production-related in nature, as summarized in Table 1.

Economic. Among the economic factors, the financial benefits obtained by the first adoptors from planting biotech crops give their relatives, neighbors, and friends a compelling reason to follow their example. This is true in all the three countries. In the case of India, adoption rate was slow in the first three years of commercialization of biotech cotton, but it soared up by leaps and bounds after farmers saw the good performance of the biotech crop.

Access to biotech seeds and loans is also crucial to adoption. In the Philippines, for instance, the choice of corn seeds to plant sometimes depends on what are being offered or sold by local traders. In all the three countries, adequate supply of biotech seeds from traders allows more farmers to cultivate biotech crops.

In India and the Philippines, private traders and other financiers (i.e., friends, relatives) provide the needed capital for the resource-poor farmers.

In China, some village cadres sign contracts of agreement with local cotton and fiber industry to ensure continuous supply of biotech cotton seeds and to guarantee buyers of cotton harvests.

Political. The support of village leaders for biotech crops makes farmers confident of the new technology being offered to them. Farmers think that biotech crops must be good, otherwise, these would not be endorsed by their leaders.

A few village cadres in China promote Bt cotton by coordinating farmers and local seed companies for the establishment of field trials for cotton seed production.

Local government officials in India became

Violy Lacsamana
Balitucan, Magalang, Pampanga, Philippines

The primary concern of a farmer's wife is the budget. This includes food for laborers and their fees. We started farming since we moved here about ten years ago and we have been planting Bt corn ever since. We once tried to plant conventional variety but it had too many risks. It was easily invaded by pests and required pesticide application. With Bt corn, we have less worries.

Li Yihua
Qianhuozhuang, Xinshengdian, Xiajin
Shandong, China

I have been growing Bt cotton for eight years. Some people from the government's cotton improvement office brought the Bt cotton seeds to us. They wanted us to try the variety. That time, we could not believe that there is a kind of cotton that can resist pests. But we tried it and it turned out that Bt cotton can really resist pests. Bt cotton is also profitable. Gradually, people began shifting from ordinary cotton to Bt cotton. The production of Bt cotton proved to be high. Nearly all farmers in our village want to grow Bt cotton. At first there were only few people who wanted to grow Bt cotton. The next year, Bt cotton seeds were no longer enough in our village. In the third year, Bt cotton turned out to be the seed of choice.

involved in field demonstrations and endorsed Bt cotton to the farmers. This make the promises about biotech crops more credible to farmers, thus, hastening their diffusion in many villages.

In India and the Philippines, farmer associations not only influence farmers to plant biotech crops but also provide various kinds of support such as loans, and training for their members.

Cultural. Strong ties among farmers and their trust in one another make it easy for them to decide in favor of adoption. More often than not, farmers in a neighborhood or village adopt simultaneously in groups.

In India, one pattern of adoption is by cluster. That is, farmers in a village first try out Bt cotton farming by cluster, which in turn influence other clusters of farmers inside and outside the village. In the Philippines, farmers often interact with each other in informal conversations to talk about their farm activities, issues, and concerns. They are aware of the status of their other fellow farmers in terms of crops, farm practices, and even income. In China, rapid diffusion has been observed in villages where the first adoptors eagerly share information on biotechnology to fellow farmers.

Due to the usual close interpersonal relationship among farmers, information on biotech crops often spread fast from one community to another. In India, massive information campaigns by seed companies helped make Bt cotton more popular among farmers.

Agriculture-related. Among the agricultural practices that facilitate adoption, synchronized farming and variety portfolio are observed in some villages in the Philippines and China, respectively.

In the Philippines, farmers engage in synchronized farming by cultivating the same crop in a farming season, causing a sudden surge in adoption rate in these areas.

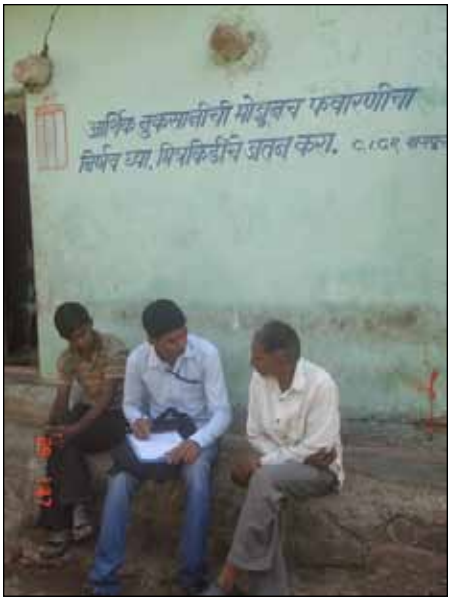
On the other hand, many Chinese farmers want to be sure that they would not lose much from their first attempt to plant Bt cotton. Through the so called variety portfolio, a scheme to reduce production risks, they plant Bt cotton in small plots first but cultivate non-biotech varieties as well. Afterwards,

Prabhu
Andhra Pradesh, India

When we used non-Bt cotton seeds we did not get much yield. By using Bt cotton on my five acre land, I can get yields of 8 quintals (800 kg) per acre. We used so much insecticides before but now life is fine.

they compare the results. Once their expectations of Bt cotton are met, they would cultivate the crop in larger plots and the neighboring farms would often follow.

Limiting Factors in the Adoption and Uptake Pathways



Contextual difficulties and personal apprehensions give some farmers a hard time deciding whether or not they would try biotech crops. Lack of knowledge and access to biotech crops are also hindrances to adoption. These difficulties, apprehensions, and deficiencies slowed down the diffusion of biotech crops in some communities in the first few years after the biotech crops were commercialized. These actors are generally economic, political, cultural, agriculture-related, and communicational in nature (Table 2).

Economic. Among the economic factors, lack of capital is the main reason for late or delayed adoption, especially in the Philippines and India. Coupled with high cost of farm inputs, it prevents a number of farmers in both countries from adopting biotech crops as early as they learned about the technology. In addition, the ambivalence among some Filipino farmers about biotech corn farming is due to absence of

Table 2. Limiting factors in the adoption and uptake pathways of biotech crops

Nature	Limiting Factors
Economic	• Lack of capital (India, Philippines) • High cost of farm inputs (Philippines) • Inadequate supply of biotech seeds due to high demand in the initial release of the crop (China) • Availability of seeds (Philippines) • Low market price of harvests (Philippines)
Political	• Indecisive local politicians (Philippines)
Cultural	• Influence of elders skeptical of biotech crops (India) • Influence of church groups who are against genetically modified organisms (Philippines)
Agriculture-related	• Lack of land areas for biotech crop production (Philippines) • Unsuitability of farm area for biotech crop production (Philippines) • Availability of alternative crops to plant (Philippines) • Unfavorable weather conditions (India and Philippines)
Communicational	• Lack of knowledge of biotech crops (all countries) • Misinformation about biotech crops (all countries)

individuals granting loans or other forms of financial support (i.e., relatives, friends, and other financiers) and fear of high interest rates on loans.

In China, farmers of some villages interested in planting Bt cotton have to wait for one or more years because local seed companies could not meet the demands for biotech seeds especially in the first two years of commercialization.

Political. In the Philippines, elected politicians in some areas are mum about their stand on biotech corn because of pressure from some influential religious groups that oppose the development and adoption of biotech crops.

Cultural. In some communities, the opinion of elders and religious groups was given credence by some farmers. In India, for instance, delayed adoption by some farmers is due to the influence of elders who are skeptical towards Bt cotton and call the shots when it comes to farming. In the case of the Philippines, several farmers heed the call of religious leaders to avoid genetically modified crops because these are "unnatural." The issue of safety of biotech crops is more controversial in the Philippines where the dominant religious group along with several social activist groups have been actively campaigning against biotech crops even before they were approved for commercialization.

Agriculture-related. Included as agriculture-related factors are non-ownership of land, kind of farm area, alternative crops, and weather conditions. Some farmers in the Philippines have learned about biotech corn years before they started planting the crop. However, they do not own or could not rent land for planting corn. A few think that their farms are more suited for rice production, especially during the rainy season. In areas where rains come even during supposedly dry season, farmers also find it difficult to cultivate biotech corn. On the other hand, the intense heat in some areas during dry season, combined with lack of irrigation, also discourage farmers to adopt and plant. In India, some farmers fear that they would incur losses from Bt cotton due to failure of monsoon rains.

Communicational. In all three countries, lack of knowledge and wrong information about biotech crops contributed to delayed adoption of the technology by farmers. For instance, farmers in Chinese villages who heard of the news about

Bt cotton two or more years after commercialization either received misleading information about the crop (i.e., crop being poisonous) or thought that the high price of seeds would not be offset by the income. In both cases, it is evident that lack of relevant information on biotech crops hamper the adoption process. Anti-biotechnology groups in the Philippines likewise, describe biotech corn, or biotech crops in general, as unsafe, unprofitable, and anti-poor.

Recommendations

Based on the findings of the study, recommendations to enhance adoption and uptake of biotech crops among small-scale and resource-poor farmers may involve actions that hinge on psychological and social factors influencing the farmers' mindset. They 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 crops.

These recommendations targeted per sector are as follows:

A. Farmers' System

1. **Professionalize farming**. Farmers should be trained in farm record keeping to rationalize their farm expenses, income and profit. The habit of farm record keeping would help them come up with better decisions on the use of inputs and disposal of their loaned capital.

2. **Adopt soil conservation measures.** The package of biotech corn technology should include soil conservation measures. Farmers should be made aware that sloping areas being used for corn farms would need special measures to control soil erosion. They need to protect and conserve their resource base to make their farming enterprise sustainable.

3. **Comply with recommended practices**. Farmers should comply with the recommended refuge requirement or planting of non-biotech seeds as a way to suppress the emergence of resistant insect pests. Farmers should be made aware that non-compliance with the refuge requirement would not prolong the life of this breakthrough technology. Similarly, recommended planting distance for biotech crops, both corn and cotton, needs to be observed to ensure their yield potential.

4. **Avoid overspraying of pesticides**. Biotech crops have been developed as resistant to specific insect pests. For other pests, however, farmers should avoid overspraying based on subjective assessment of visual presence of other insects on the crops. Rather, they should be guided by the more objective science-based methodology of economic threshold levels to optimize yield. Biotech seed suppliers should be more proactive on this by distributing leaflets and guides with easy to understand instructions and illustrations.

5. **Be active seekers, rather than passive receivers, of information and knowledge about biotech crops.** To raise their knowledge level about biotech crops, farmers should not remain as passive receivers of information that may come their way. They need to diligently seek for answers about their doubts and concerns so that they may be empowered to use the technology to their advantage. In India, they expressed this through an empowering slogan “An alert farmer is an affluent farmer”. This can be used in outreach activities.

B. Agricultural Extension Workers/System

6. **Strengthen extension support to the farmers**. The government extension systems in India and the Philippines have not been too keen in supporting the biotech farmers. For one, the extension workers have to be educated on the biotech crops themselves, especially on different varieties available and the correct practices for their cultivation. They should also be able to respond

to the farmers' problems about diseases such as stalk rot. More than doing plain monitoring, extension workers should serve as link between the farmers and scientists or experts so that technical problems about biotech crops may be properly addressed in the shortest time possible.

7. **Explore public-private partnership in extension for biotech farmers**. Since technicians of seed suppliers are already active in providing demonstration farms and to some extent, inputs for production, partnership between them and the government extension workers may be explored and formalized. This would create more synergy and benefit the biotech farmers in terms of technical advice and other support for their enterprise.

8. **Train and tap private technicians, seed suppliers, and dealers on farmer education and extension**. These are the actors who have more frequent contact with the farmers in terms of planting biotech crops. Their jobs may be expanded to include educating the farmers on the what's, why's, and how's of biotech crops. Many of them are technical people with background in agriculture but with weak skills in communication, extension and education. Such skills will benefit not only the farmers but their business as well in the long run.

9. **Maintain and sustain the incentive and award system for farmers.** Recognition of outstanding and innovative biotech farmers must be sustained to give farmers psychic reward, in addition to economic gains. These awardees can also serve as local champions whom others can emulate; or as local ambassadors who could disseminate the knowledge about biotech crops among their peers in the community.

10. **Support 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 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. Another avenue is the

formation of biotech farmers' schools in villages to serve as avenue for education and interaction.

11. **Identify and tap 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 crops since they are being looked up to as reputable models by the other farmers.

12. **Link farmers with experts**. Farmers need to be assisted in addressing the other persistent crop pests and diseases that continuously attack their crops. Their faith on the resilience of biotech crops, for instance, is being eroded by these occurrences. At the local level, seminars may be given by experts 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. A sustainable relationship can also be maintained through modern tools such as text messaging and other real time interactive tools to facilitate linkages.

13. **Evaluate implementation of refuge strategy**. As part of resistance management program, there should be an evaluation of how the refuge strategy is currently being undertaken and regulated. Results can then serve as basis for coming up with new ways of implementing it so that farmers would have no reason not to do it.

14. **Enforce the policies on refuge planting**. Farmers are bound to plant non-biotech seeds along with biotech ones, to prolong the life of the technology. But massive violation of this requirement is becoming a norm among biotech farmers. Hence, the legal aspect of adoption of this technology must also be paid attention to.

15. **Fine tune recommended farm practices**. There is a common tendency for biotech farmers to modify the recommended practices particularly in terms of seed rate, planting distance, weeding, and machine picking in the case of cotton. It may be time to reconsider the

current practices and see how the farmers' experience can help modify such practices without necessarily sacrificing the optimum yield.

C. Policy Makers and Regulators

16. **Regulate seed quality and other seed-related concerns.** Since the technology starts with the seeds, the government agencies and instrumentalities may need to strengthen regulatory mechanisms so that private companies supplying the seeds would comply with certain standards. The right of the farmers to obtain quality seeds must be ensured and protected. Some policies and guidelines addressing seed production and other broader concerns such as the price and distribution of seeds and proper labeling of varieties need to be put in place.

17. **Set buying price of the crop and regulate traders**. The government needs to intervene so that a minimum buying price of crop produce is set. This is to prevent the traders from abusing the farmers, especially those indebted to them in terms of capital. The government relevant authorities can help set up the local selling price of the produce and do the monitoring if this is being complied with. A bigger problem is that since many of the traders operate as "underground economy", they could hardly be monitored and be subjected to government rules and regulations. An effort to accredit or license the traders may be explored since they already exist as important actors in the system.

18. **Provide marketing assistance**. Related to item 17 above, the market and buyers are very important to avoid a glut in the face of bountiful harvest of biotech crops. While this role is being performed very actively by the traders, the government should set up alternative markets with competitive buying price of the crop so that farmers would not be trapped in a no-choice-except-trader situation.

19. **Explore alternative 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 these financiers and traders.

20. **Study alternatives to capital sourcing**. To address the perennial problem of farmers' indebtedness to financiers/traders, an in-depth study on this practice and its alternatives should be undertaken. It would help to analyze who the traders are, their unwritten codes and loaning systems, dynamics of their relations with farmers, co-traders, and other actors in the supply chain, among others.

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