

Unweaving the Threads: The Experiences of Female Farmers with Biotech Cotton in Colombia

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Although the literature on gender in agriculture is extensive, gender has been under studied in the published literature about biotech crops in developing countries. To explore whether gender affects access to and use of biotech cotton, we developed and tested a participatory, qualitative approach. Despite the perception that women participate little in cotton production in Colombia, some women manage their own plots, and many share production responsibilities with their spouses. Men and women perceive the costs and benefits of biotech cotton differently. Female farmers who managed their own plots stated that they preferred insect-resistant varieties over conventional varieties primarily because these reduce the number of laborers they must hire to spray pesticides, a task performed solely by men. Both male and female farmers identified the lack of adequate and timely information about biotech cotton as a major disadvantage, but the problem appeared to be more limiting for female farmers.

Key words: Colombia, gender, GM cotton, qualitative research, perceptions, women.

Introduction

The pioneering work of Ester Boserup (1970) led to extensive research on gender-differentiated adoption and impacts of agricultural innovations. Reviewing 25 years of this research, Doss (2001) concluded that whether a farmer is male or female is not, in and of itself, the most important factor affecting adoption of agricultural technologies. Instead, it is the underlying and persistent difference in access to resources (such as land, labor, and knowledge) which generates differential adoption rates between male and female farmers. In their policy review, Quisumbing and Pandolfelli (2010) also note that differences *among* women—related to their socio-economic status and roles within households—influence their capacity to adopt new varieties and the benefits they earn. They also highlight the importance of recognizing that men and women often value different crop traits, which is a reflection of their household roles and crop uses. The cumulative knowledge from decades of research on women in agriculture is compiled in the Food and Agriculture Organization of the United Nations' (FAO) State of the World Report (2011) and 2012 World Development Report (World Bank, 2012), and is too vast to summarize here.

Unfortunately, applied economics research on women and biotech crops trails far behind this work. A systematic review of the literature about the impacts of adoption of biotech crops in developing countries confirmed that, so far, researchers have paid scant attention

to understanding the differences among men and women as users of biotech crops. Of the more than 125 papers that assess the economic impact of genetically modified (GM) crops on farmers (see introduction in this issue), we found only a few that made explicit references to gender.

For instance, when conducting detailed interviews with 32 households growing Bt cotton in Makhathini Flats, South Africa, Bennett, Buthelezi, Ismael, and Morse (2003) concluded that reducing the number of insecticide sprays would allow for more free time for women, with subsequent benefits for the family. They noted that that an "equal number of men and women do the spraying" (Morse, 2003, p. 5) but that a day's labor saved is more important to women given their many household responsibilities. Sixty percent of households in their sample were headed by women.

Thirtle, Beyers, Ismael, and Piesse (2003) documented the fact that during the first planting season of Bt cotton in the Makhathini Flats most farmers who were offered Bt seed were the larger cotton growers; these farmers were mainly men. In the second season, after seeing the success of the technology, women were more active in securing the seed so they could plant it. Forty-two percent of households interviewed in their sample of 100 were headed by women. In a later article, using company records from Vunisa Cotton, Morse, Bennett, and Ismael (2006) found that during the first three years of adoption, the majority of adopters were

women; however, aside from reporting the number of female growers, they did not explore differences between male and female adopters.

In Kanzara Village of Maharashtra, the largest cotton growing state of India, Subramanian and Qaim (2009, 2010) were able to capture gender-differentiated labor market and income effects of Bt cotton by using a micro-social accounting matrix. Cultivation of Bt cotton increased the number of female laborers participating in the production as daily workers hired for sowing, weeding, and harvesting operations. Reduction in the number of insecticide applications led to less labor by male family members, since this task is typically theirs. More income generally favored men because they could use their free time in more productive (income-earning) activities outside the farm—activities that were not open to female laborers.

In this qualitative, pilot study, our first objective was to explore whether and how gender affects access to and use of GM cotton. A second was to formulate a clearer, more complete set of research questions to pursue in future quantitative studies. A third was to test a research methodology that can be utilized in other studies of gender and biotechnology.

We explored several hypotheses. First, based on informal interviews undertaken during a statistical survey among 364 farmers in 2007-08 (Zambrano, Fonseca, Cardona, & Magalhaes, 2009), we hypothesized that although cotton is widely considered to be a man's crop in Colombia, women might be more involved than previously thought. Given what we had learned from the general literature on women in agricultural development, we also hypothesized that because GM seeds are more expensive and require additional information, women are in a less advantageous position than men. We considered, however, that some biotech crops could be particularly beneficial for female farmers because of specific traits or characteristics. We had anecdotal evidence that female farmers might be more open to Bt cotton than male farmers.

To explore these hypotheses, the team developed qualitative instruments to facilitate discussion among farmers and other stakeholders regarding the participation of women and men in cotton farming and their experiences with growing biotech and non-biotech cotton.

The study was conducted in the main cotton-producing regions of Colombia. Next, we provide background information about GM cotton production in Colombia. We then present the qualitative methodology used and interpret our findings. We conclude the article with a

summary of main findings and an assessment of the limitations we encountered during the implementation of this project.

Background

Colombia has two main cotton-producing areas with very distinct characteristics and planting seasons. The main region is located in the Caribbean coastal region of the country, where cotton farmers have very limited access to irrigation and machinery and, relative to the interior region, a higher concentration of both larger- and smaller-size cotton farms. The second region, in the interior part of the country where 40% of the cotton is produced, has a more commercialized agriculture with access to irrigation.

In 2004, the government established mechanisms for the establishment of an “association-managed” credit line targeting smallholders, with more favorable financial conditions than credit from commercial banks. Under this scheme, regional associations act as financial intermediaries for this type of credit line, backed up by their own assets, thus providing credit access to individual smallholder farmers who otherwise would find it unaffordable. The association in turn benefits as an input intermediary since farmers have to use their credit to purchase products and services provided by the association.

In a preceding study conducted by the International Food Policy Research Institute (IFPRI), which was based on a statistical sample of 364 farmers, Zambrano et al. (2009) concluded that cotton producers from the interior region (Tolima), where the technology was widespread, had benefited from the adoption of Bt cotton. Evidence on the benefits of Bt cotton in the coastal region (Córdoba and Sucre) was inconclusive, however. The main pest in the coastal region is the boll weevil rather than the bollworm, which is the pest targeted by Bt cotton.

The cotton situation in Colombia has also evolved since this earlier study. At that time, the only commercialized variety was a single Bt variety, known in Colombia as Nuopal; this variety was imported, introduced, and commercialized in Colombia by Monsanto Company or its local representatives. After 2008, other GM varieties came onto the market and Nuopal is now rarely planted in Colombia. In addition, one of the herbicide tolerant (HT) varieties introduced in 2008-09 appeared not to have had very favorable results for farmers, and in some cases caused large yield and revenue losses. It remains to be proven whether these losses

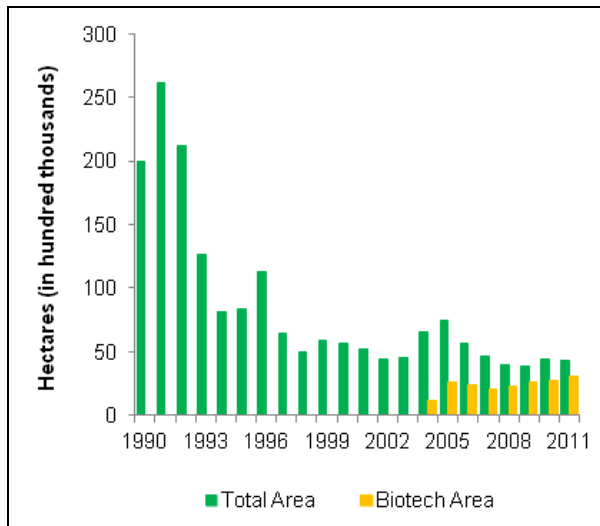


Figure 1. Cotton area planted in Colombia, 1990-2011.

Source: CONALGODÓN (2012)

were attributable to the type of GM trait, germplasm, poor agronomic practices, or weather variability. Farmers appear to be more optimistic about stacked (insect resistant [IR]-HT) varieties introduced in 2009, although cotton areas have not recovered since their decline in 2006 (Figure 1).

The sample of farmers interviewed during 2007-08 was not stratified by gender, but the survey was designed to elicit some gender-disaggregated data, particularly with regard to hired labor. The survey confirmed that most female laborers were hired for harvesting cotton, consistent with general perceptions in Colombia. However, a few women were also involved in weeding and fertilizer application. An inventory of male and female hired laborers demonstrated that although women represented a minority, they were employed in the full range of operations included in cotton production—from land preparation to stalk destruction—for both biotech and non-biotech cotton. The total number of hired female laborers was less for plots planted with Bt cotton compared to conventional cotton. The survey did not disaggregate family labor utilized in cotton production by gender.

The first study also revealed that the number of plots managed by women in the 2007-08 sample was only 2%. In informal interviews conducted during the structured survey, these female managers suggested that they had a more open attitude toward Bt cotton than men. For example, female managers seemed more willing to adopt the new practices recommended with the technology and also mentioned growing Bt cotton as a way to save on labor costs because it was no longer necessary

to hire men to spray the crop. In Córdoba (one of the three sites of study), wives of men who managed plots of non-Bt cotton were also significantly more likely to work full-time or occasionally on the farm (27%) than wives of men who managed Bt cotton. Households growing Bt cotton were generally better off, but even in these, 13% of wives participated in production.

Methods

The instruments proposed were focus groups and interviews with stakeholders, including managers of local cotton-producer associations, technical assistants, and female and male farmers. Given restrictions in the project budget, the scale of the study was limited. Although there are 96 cotton-producing municipalities in Colombia, we chose the two main cotton-producing areas, which account for roughly 22% of the total cotton area and production. The first municipality is Cereté, located in the Department of Córdoba in the northern coastal region of the country, and the second is El Espinal in Tolima in the central part of Colombia. These two cotton-producing regions have very different characteristics, from agroecological and climatic conditions to mechanization scale. The two municipalities were purposely chosen in consultation with the Colombian Confederation for Cotton (Confederación Colombiana del Algodón, CONALGODÓN), an organization that has been performing cotton cost surveys in the area for the past six years. We also took into account the results of the Zambrano et al. (2009) sampling to select these two municipalities. Within these municipalities we randomly selected female and male farmers for the focus group exercises.

Selection of Focus Group Participants

The first step in the field work was the selection of workshop and focus group participants from each of the two municipalities. Female and male farmers planting either transgenic or conventional varieties were the first group identified.

In Colombia, because of phytosanitary regulations, all farmers who plan to cultivate cotton are required to register their plots with the national regulatory agency, the Colombian Agrarian Institute (ICA). The responsibility for implementing registration is then assigned by ICA to local grower associations. Cotton farmers are free to choose affiliation with a particular association, but all must register their plots so ICA can maintain a complete list of plots. This requirement aids in monitoring and controlling for stalk destruction at the end of the

Table 1. Number of registered and verified male and female cotton farmers.

Variety planted	El Espinal					Cereté				
	All	ICA registry		Actual farmers		All	ICA registry		Actual farmers	
		Men	Women	Men	Women		Men	Women	Men	Women
Conventional	62	58	4	62	0	973	882	91	911	62
Transgenic	160	124	36	145	15	107	88	19	100	7
Total	222	182	40	207	15	1,080	970	110	1,011	69

Source: ICA registry (2009/10) and verification from authors.

cotton season. In their role as credit and input intermediaries, the associations cooperate in this process because it is to their advantage to have lists for planning purposes.

To select farmers for participation in the focus groups, we used the 2009-10 ICA/Associations' lists or registry. The ICA plot registry contains the name and identification of the producer, plot area, location, GIS coordinates for the plot, variety used, the name of the technical assistant, as well as the name of the local association under which each plot is registered.

A count of the number of female farmers in the ICA lists for El Espinal and Cereté showed that at least 30% of plots were registered to women—a surprisingly large number of female cotton farmers. Our 2007-08 survey showed that only 2% of the 364 farmers surveyed during the 2007-08 season were women.

In order to draw a sample that included female farmers growing both conventional and GM cotton, our first task was to identify all women in ICA lists for Cereté and El Espinal and verify which of those women listed were in fact managing the plots registered under their names. Since, in most cases, the ICA registry records the technical assistant of each farmer, CONALGODÓN regional coordinators were able to contact them and verify if indeed those women listed were managing the plots. Table 1 shows the results of this exercise.

Although we expected to find that some women listed in ICA registry records were not responsible for production, we found that a large share of registered female producers was not actually farming. According to TAs and other stakeholders, it is a common practice for women to register plots under their names although it is their husbands or other male family members who manage the plot.

The predominant reason is that men have defaulted in their payments with the association in previous seasons, so they are unable to access the credit lines offered due to their bad credit standing. Since women usually have a good credit standing, the men who had previously defaulted are able to gain access to these

resources. Another reason for registering a plot managed by a man under a woman's name is that it is easier for men to have their wives' names in the credit paperwork, since the only person authorized to request and receive inputs and services offered by the association is the credit signatory. That person has to travel to the association and sign for inputs, losing hours or even a day's work on the farm. Of course there are other mechanisms that men could rely on to access these resources, such as a certified authorization, but those would require notarization certificates that are cumbersome and require additional processing time and cost.

The extent to which women actually have decision-making power regarding the management of the credit they obtain and the overall management of the crop is yet to be studied. Some of the managers of the cotton associations perceive that women are more cautious in managing their credit line and will tend to demand resources more conservatively than men. Nevertheless, the perception is also that women have limited access to these credit lines, as they tend to have fewer assets to back their credit application and often need the assistance of a willing co-signer.

Based on the final list drawn from the farmers who were verified to be women, a group of 15 women were selected. The regional CONALGODÓN supervisor contacted each in advance to ascertain their availability to participate in the workshop. Despite the advanced notice and provision of transport and meals, some of the women selected were unable to attend. The participation in El Espinal was particularly limited.

Technical assistants were also targeted because they play an active role in Colombian cotton production (Zambrano et al., 2009). Although no longer required by law, every farmer seeking subsidized credit from a regional association must have a technical assistant. Since the regional associations extend credit lines to their affiliates but are financially responsible for credit repayment, associations rely on the visits of technical assistants and their advice to farmers as a way to ensure that the plots of their affiliates are managed well and

Table 2. Activities developed with farmers in Cereté and El Espinal.

Activity	Description	Location	Type of group	All	No. of participants by group			
					Conv fem	GM fem	Conv male	GM male
Focus group	Map of cotton activities	Cereté	Plenary session	25				
		El Espinal		14				
	Variety preferences matrix	Cereté	Four groups	2	6	4	7	4
	Priority action matrix	El Espinal			3	5	3	3
Interviews	One-to-one, semi-structured	Cereté	Individual	7	1	3	2	2
		El Espinal		6		3	1	1
	Farm map	Cereté		7	1	3	2	2
		El Espinal		6		3	1	1
Surveys	One-page quantitative	Cereté	Individual	21	6	4	7	4
	Survey	El Espinal		14	3	5	3	3

Note: "conv. fem": women who plant conventional cotton, "GM fem": women who plant GM cotton varieties; "conv. male": men who plant conventional cotton, "GM male": men who plant GM cotton varieties.

that farmers will produce enough to repay the association. Technical assistants are also targeted by technology developers and chemical industry representatives to provide information about and promote their products among farmers.

The selection of technical assistants was a much easier process than selecting farmers because the regional coordinators that CONALGODÓN has posted in the area know most of these agents professionally and personally. Although there were more invitations accepted than assistants to the workshop, the number of technical assistants that worked with us in these workshops was acceptable, particularly for Cereté.

Managers of local cotton associations are the third group of stakeholders who play an important role. These act as financial intermediaries and suppliers of agricultural inputs and services. CONALGODÓN regional coordinators were also able to secure personal interviews with managers of local cotton associations in El Espinal and Cereté.

Instruments

Participatory observation, interviews, focus groups, and textual and documentary instruments are some of the techniques that compose qualitative methods. The depth and time devoted to each of these instruments can vary widely. Given our time and resource restrictions, the instruments employed were limited to interviews and group techniques applied during a two-day period. Individual interviews were semi-structured. Group techniques included focus groups and smaller group discussions. The instruments were developed with participation of the research team and particularly CONALGODÓN; the instruments were pre-tested, and

implemented in two-day workshops convened with the farmers, technical assistants, and association directors in each of the two sites in December 2009. To record exact wording of participants, as well as problems in the dynamics of implementation, activities were tape-recorded after obtaining the consent of participants. Maldonado et al. (2010) includes a more comprehensive description. The distributions of participant types by location and activity are shown in Table 2.

A plenary with focus groups, which involved all farmers, was the framework for principal activities. In the first plenary activity, we explored the involvement of women in cotton production and the difference in their engagement between GM and conventional cotton crops. Tasks and responsibilities performed by men and women during and after the cropping season were identified and discussed in detail, from the decision to plant and secure a plot (if the plot was rented) to receipt of the final payment from the association at the end of the season. We also elicited farmers' opinions about the operations in which women participated, their roles, and if there were differences between biotech and non-biotech operations among women who managed them. The format for this exercise was developed using a detailed cost by operation and activity that CONALGODÓN has developed to collect annual cost data; this also used in the 2007-08 survey. The number of activities listed in CONALGODÓN cost-of-production format was roughly 30, but with feedback from farmers the number grew to 34 in El Espinal and 45 in Cereté.

To explore the hypothesis that some biotech crops could be particularly beneficial for female farmers because of specific traits or characteristics, we implemented a second activity. Participants were split into

Table 3. Activities developed with technical assistants (TA) and managers in Cereté and El Espinal.

Participant	Instrument	Description	Location	Tech. assistants	
				Male	Female
Technical assistants	Focus group	Information flow matrix (from GM seed developer/distributor to TA)	Cereté	11	1
			El Espinal	4	0
	Interviews	One-to-one, semi-structured	Cereté	11	1
			El Espinal	4	0
			Cereté	10	1
			El Espinal	4	0
Association managers	Interviews	One-to-one, semi-structured	Cereté	2	1
			El Espinal	3	0

four groups according to gender (M/F) and the cotton type they planted. Each was asked to rank non-biotech, Bt, HT, and stacked Bt-HT varieties according to criteria in a “Variety Preference Matrix.” Criteria included costs, wages, time, yields, fiber quality, profits, and preferences.

Facilitators asked farmers to compare biotech cotton varieties against a pre-assigned value given to non-biotech varieties. Each criterion for non-biotech cotton had a value of 10 beans and each participant was given a set of beans to rank the criteria for other types of cotton. Once farmers assigned a bean count to a type of cotton within one criterion, the facilitator moved to the next type and so on until the entire matrix was completed. The facilitator never asked if the variety was better or worse. Consensus required discussion, and the group was permitted to reevaluate as they worked on the matrix.

The third plenary group activity explored the hypothesis that information was a limiting factor in the adoption and use of GM cotton. An instrument labeled the “Priority Action Matrix” was presented in two tables with an open-ended question format. The first table had just two columns with two related questions: 1) what problems were associated with change in seed type? and 2) what is required to solve these problems? The facilitator asked each participant to mention his or her identified problem and the facilitator transcribed the responses in the matrix. Once each participant had identified a problem, the facilitator asked for suggestions for solving the problem. Despite the fact that the facilitator asked the participants to write answers individually, in most cases the participants opted to conduct this activity as a group exercise. Following this process, the participants were asked to prioritize problems using bean counts. Once again, prioritization required group discussion and consensus.

The last exercise was a series of individual interviews conducted with participants selected from the plenary and sub-group sessions based on the researchers’ perception of farmer knowledge and potential contribution to issue identification. Semi-structured interviews included 25 previously constructed questions designed to encourage the respondent to expand and elaborate on points of interest. The interviews provided an opportunity to ask for information without group pressure and a comparison of responses among individual participants.

At the close of the interview, the facilitator asked the farmer to draw his farm/plot, detailing the location of the house (if applicable), water sources, the location of cotton or any other crop, animals, or other economic activity on farm, with roads and water sources in or around the farm. The respondent was then asked to specify who worked in each of the places. The participant placed a red sticker to specify where women worked, a blue sticker for the places where men worked, and a yellow sticker for children. Even farmers were often surprised to see women’s participation depicted in their own drawings. The afternoon sessions in each of the locations were devoted to focus groups and interviews with technical assistants and managers of local associations, as indicated in Table 3.

Technical assistants (TAs) were also interviewed in groups and individually. For the first information-flow matrix, TAs began by describing the media, frequency, and content of the information they received from the seed developer or distributor. In practice, TAs became immersed in a heated debate about the attitude and practices of the seed developer and/or distributors.

For the second information-flow matrix, TAs described the information they gave to male and female farmers by crop operation. They reported the time spent (distribution of 100 beans among each of the 11 operations), the media used (written on notecards), and their

Table 4. Main characteristics of farm participants.

	Women			Men			All
	Non-biotech	Biotech	Total	Non-biotech	Biotech	Total	
Number	9	9	18	10	7	17	35
Head of household							
Yes	4	2	6	10	7	17	23
No	5	7	12	0	0	0	12
Age, average	49.1	48.4	48.8	48.9	44.0	46.9	47.9
Marital status							
Has partner	5	8	13	10	6	16	29
Single/widow	4	1	5	0	1	1	6
Education, years	8.0	10.0	9.2	8.0	10.0	8.8	9.0
Works on farm							
Full time	6	3	9	8	5	13	22
Occasionally	1	4	5	2	1	3	8
N.R.	2	2	4	0	1	1	5
Works off farm							
No	5	5	10	5	5	10	20
Yes	3	1	4	5	2	7	11
N.R.	1	3	4	0	0	0	4
Cotton experience, years	6.3	5.5	5.9	10.6	10.3	10.5	8.5
Land tenure							
Own	7	4	11	7	4	11	22
Rent	2	5	7	3	3	6	13
Yield, ton/ha (previous season), average	3.5	2.7	3.1	3.3	2.3	2.9	3.0

Source: Authors' results

opinions regarding farmers' receptivity to the advice provided (in terms of percentage).

Individual interviews were then conducted to ascertain each TA's opinion regarding whether or not there were differences in the technical assistance provided to men as compared to women, and their perceptions regarding the role of women in the decision to plant cotton, access to credit, and seed selection. Other questions asked about the role and participation of women in cotton cultivation in each of the operation phases.

The interviews with association managers were conducted with 25 questions, the majority of which were open-ended. Interestingly, one of the associations interviewed in Cereté was headed by women. Most of the questions explored the perspectives and procedures adopted by managers and associations with respect to use and distribution of transgenic seeds. Perceptions regarding biotech cotton varieties, and opinions about women's management of credit, were also elicited from managers.

Results

Survey

Basic socioeconomic characteristics of participants are shown in Table 4. Only two of the women who were in charge of cotton plots were household heads. Of the 18 women in our sample, 13 have a spouse or a live-in partner. The average age of our sampled farmers is slightly below the average age of Colombian cotton farmers, which is around 50 years of age. As in the 2007-08 survey, which was statistical, the number of years of education of women who plant biotech cotton appears higher than that of female farmers who do not. The age difference appears to be even greater among men, despite the fact that experience with cotton is similar among all men, regardless of their age. Women who plant cotton have less experience with cotton than men, and among participants, women who plant biotech cotton had the least experience (Table 4).

Table 5. Participation of men and women in cotton activities.

Timeline cotton activities	Number of sub-activities identified	Number of sub-activities where men or women participate, by technology							
		Women/biotech		Women/non-biotech		Men/biotech		Men/non-biotech	
		EI Espinal	Cereté	EI Espinal	Cereté	EI Espinal	Cereté	EI Espinal	Cereté
1 Planting decision	1	1	1	1	1	1	1	1	1
2 Credit application	1	1	1	1	1	1	1	1	1
3 Land preparation	2	1	1	0	1	1	1	1	1
4 Crop Registration	4	2	4	1	4	2	4	2	4
5 Planting, replanting, and thinning	3	2	1	1	2	2	3	1	2
6 Fertilizing	4	3	1	3	3	3	4	3	4
7 Manual Weeding	2	2	1	1	1	1	2	1	2
8 Pest management	4	3	2	2	2	3	4	3	3
9 Regulation of growth and work prior to harvest	4	4	0	4	1	4	2	4	3
10 Harvest	7	7	2	6	5	7	5	7	4
11 Administrative tasks	5	4	4	5	5	4	5	4	5
All	37	30	18	25	26	29	32	28	30

Source: Authors' results

Cotton Activities

Table 5 summarizes the activities that women perform as opposed to men. Supervision was listed separately.

The first surprise in Table 5 is the scope of women's involvement in cotton activities—ranging across almost all of the 30 activities, including the decision to grow cotton, ability to obtain credit, registration, administration, money management, hiring labor, as well as all productive activities, harvesting, delivery, and stalk removal. One important exception is spraying of insecticides, which is recognized as particularly toxic for women. Spraying is delegated to male household members or, in their absence, hired male labor. One of the advantages that female farmers saw in the use of Bt cotton was that the need to hire labor declined with fewer pesticide applications.

Another surprising aspect that emerged from this exercise was that women were involved in a number of “invisible” activities that had not been included in the 2007-08 statistical survey; that survey had been based on the detailed template used routinely by CONALGODÓN. These activities included requesting advance payment from the association, delivering cotton to the association for ginning, as well as administrative activi-

ties, such as weighing the cotton, recording the weight, estimating harvest costs, accounting, and final payments.

All farmers noted that the high cost of GM seed has brought changes in several practices. The first is the amount of seed planted by hectare. Before the introduction of GM seeds in Colombia, farmers planted 15-17 kg/ha. With the introduction of Bt seed (which costs three times more than other seeds), farmers have reduced planting densities to 10-12 kg/ha. Eventually, adjustments were also apparent in non-Bt seed. Farmers with resources and access to rented planting machines are of course more successful in achieving these lower densities. The evidence from our workshop suggests that access to planting machines is limited.

The second change is that only farmers who plant GM seeds perform soil analysis, although TAs recommend these for all cases and farmers. A possible explanation for this is that because GM seeds are so much more expensive, farmers pay more attention to soil quality. A third aspect is that GM cotton growers are more likely to hire a private technical assistant in addition to the one required by the association. All farmers who planted transgenic varieties in Cereté hired private TAs.

Private assistants paid more visits to farmers and gave more personalized attention relative to the TA required by the association.

On behalf of the association, the TA plays a more supervisory role, with a responsibility to ensure that the credit extended to each farmer is used according to the association's best interests. These interests are not necessarily aligned with farmers' interests. Women in El Espinal said that they followed their TAs' instructions, and TAs also reported that as compared to male farmers, female farmers are more likely to follow their advice. With HT varieties, fewer female laborers are hired for the arduous activity of manual removal of weeds. Because it is customary for women to stay away from pesticides, the application of glyphosate for HT cotton is accomplished primarily by men.

Variety Preferences

The variety matrix exercise confirmed that there were differences between the two regions and within the regions between male and female farmers. Regardless of variety planted, women in El Espinal had the opinion that all biotech cotton varieties cost less than non-biotech varieties, required less in terms of daily wages to hired laborers, and were less demanding in terms of time management. Women who grew only biotech cotton saw freed time as its best characteristic, since they could devote additional time to other domestic and productive activities on their farm and in their household. In contrast, male farmers in El Espinal who plant biotech cotton were vocal about their high costs, at the same time acknowledging that it yielded more. Both female and male farmers in El Espinal favored biotech varieties in terms of the profits.

In Cereté, women also ranked biotech cotton lower on the criteria of "wages" and "time spent" than they did non-biotech cotton, with the exception of women who planted non-biotech varieties. This group stated that they had no opinion about biotech cotton. Both male and female farmers made a distinction between the two previous seasons because farmers in this region were hit with substantial economic losses in 2008. Farmers perceived that the biotech cotton planted in that season were not good.

Priority Action

Farmers identified the following categories of problems regarding the use of biotech cotton: (1) insufficient or poor information about the technologies; (2) high cost of biotech cotton; (3) emergence of new pests and dis-

eases; (4) seed availability, regardless of cotton type; and (5) questionable adaptability of biotech cotton varieties. Despite the fact that the discussion was open-ended, most farmers consistently identified the same set of problems, focusing on poor quality of information and poor availability of seed, whether for biotech or non-biotech cotton. Seed scarcity and inadequate information are a chronic problem for cotton producers in Colombia.

What all farmers wanted from private seed companies, associations, and technology owners was more and better information, more frequently provided, and available through various media. They also expect this information to be made available to TAs so they can pass it to farmers. Lack of information appeared to be a more pressing problem for female farmers, who placed it at the top of their list of priorities. Despite the fact that biotech cotton seeds are three times more expensive than non-biotech seeds, among four women's groups, seed cost was identified as an important issue only by the group of women who planted transgenic cotton in Cereté. By contrast, all men's groups mentioned it.

Personal Interviews

Individual interviews were conducted with 13 of the 35 farmers who participated in the pilot study. Both men and women interviewed agreed that there was no differential treatment of men or women with respect to credit application or seed availability. According to those interviewed, associations will extend credit to all farmers who can provide the necessary documentation and fulfill their asset or co-signer requirements. Whether female farmers have equal capacity to fulfill these requirements is an open question. Wives do not appear as owners of household assets titled solely under their husband's name. Regarding seed availability, as noted above, both female and male farmers perceived seed supply was inadequate because they sometimes ended up planting what was available at the association and not their preferred variety. It appears that farmers with more resources tended to have their requests met first, while smallholder farmers were left to adjust their needs to the seed type still available. (Alternatively, it may be that farmers with more resources submit their requests earlier and repay their credit earlier.)

Of all the advantages of transgenic varieties that farmers discussed, the main theme appeared to be the fact that transgenic varieties required less hired labor and less time invested in managing the crop. Some farmers viewed this as a disadvantage because hiring



Figure 2. The farm map, drawn by E.

less labor could create more unemployment. Some women reported that knowing their plots would not be attacked by bollworms was “priceless” because of peace of mind.

All of the women and more than half of the men who were personally interviewed identified changes brought by the introduction of transgenic seeds. Similarly to groups, the most frequently mentioned factors included the drop in numbers of hired laborer and a reduction in time spent managing the crop. Men and women identified some activities that were no longer performed or are performed differently, but the net effect of changes varied among respondents and is a research question that would require further examination.

All individuals interviewed were asked to draw farm maps, but men were less willing than women to complete the details. A good example of a completed map was drawn by E. (Figure 2), a single mother who lives with her elderly parents and is in charge of all tasks in her household, from food preparation to managing and working in the field. E. is not the land owner. She turns in all profits to her father for him to distribute among all family members, including her absentee brothers and sisters.

In E.’s drawing, stickers represent who is in charge of the specific activity (red for women, blue for men). E. is in charge of the field work and hires male laborers for the application of insecticides. E., her mother, and her daughter work in the mango fields and keep the pigs and chickens that the family has for sale and home consumption.

Of the 13 women in Cereté and El Espinal who drew farm maps, no remarkable difference was evident between single women and women with male partners. The only discernible difference was that women who are single (and not necessarily the head of household) devote the most time to the crop operation, while women who have a male partner will rely more on his help.

Information Flow Between Technology Owners and Technical Assistants

Technical assistants from both Cereté and El Espinal agreed that Monsanto—and more recently, Bayer—representatives provide them with information regarding biotech cotton. The information is delivered at the beginning of each season, before farmers have planted. Usually delivery of information is limited to a one-day

meeting convened by the Monsanto or Bayer representatives to showcase the varieties that will be made available during the season. During that day and throughout the season, representatives supply written materials. Most of the TAs considered that this information was insufficiently detailed. It was not until the unfavorable results of the 2008 season that Monsanto, under pressure from farmers and their associations, organized a three-day training meeting for TAs with international experts.

In the opinion of some TAs of Cereté, failure of HT cotton in 2008 was a consequence of incorrect information provided by Monsanto's local representatives. According to TAs, the timing and dosage of glyphosate that these representatives specified was faulty, a fact under dispute.

Information Flow Between Technical Assistants and Farmers

TAs in El Espinal spend proportionately more time giving advice regarding the use of insecticides, as well as managing weeds and diseases. TAs believed that both male and female farmers generally followed their advice, although those who did not were more likely to be men. In personal interviews, TAs offered various opinions. For example, many TAs stated that women followed their advice because women are more careful in managing their plots. On the other hand, TAs also said that female farmers follow their advice because female farmers are less informed than male farmers, lacking the experience or time to look for such information. For this reason it is the opinion of TAs interviewed that female farmers will probably plant the variety that their TA suggests, particularly if they are the plot managers.

The exercise in El Espinal failed to capture any potential differences brought about by the introduction of biotech cotton. For this reason the exercise was changed when applied in Cereté, where the team explicitly inquired about these differences. TAs reported that compared to non-biotech plots, they spent less time in biotech cotton plots advising on weed and insect control. This finding is logical given that ideally, insect-resistance and herbicide-tolerant varieties will reduce the number of insecticide applications and simplify weed management. What is surprising is that all TAs agreed that biotech cotton demands more attention from them in the areas of disease management, use of regulators, and pre-harvest activities.

As in the case of El Espinal, in most cases TAs in Cereté thought that their advice and opinions were fol-

lowed. The "perfect score" was ascribed to female farmers who plant biotech cotton, since these followed TA advice in every operation. The least agreeable farmers were men who planted non-biotech cotton. Some TAs think that women tend to follow their advice because they are more careful with the management of their financial resources and will pay more attention in order to secure the best possible return on their investment.

This last explanation seems to be more in line with the perception of female farmers. What was clear is that, aside from their TAs, women have a very limited circle of people from whom they can obtain advice. While it is possible for male farmers to reach out to other farmers (as neighbors, friends, or acquaintances), female farmers have a very limited number of socially acceptable opportunities to exchange information with other farmers.

Conclusions

This study explored the differences in the experiences of men and women in the main cotton-growing regions of Colombia regarding biotech cotton, based on the application of qualitative research methods.

There are two very obvious findings that are important for research on biotech cotton in other areas of the world. The first is that, even with the exhaustive template used by the Colombian farmers' association to record costs of cotton production, some activities—and particularly those in which women are more likely to engage—were "invisible" until this qualitative work was conducted. Thus, qualitative methods such as focus groups, interviews, and map drawing implemented in a particular sequence and with well-structured facilitation are an important complement to any quantitative research. Remarkably, this is true even on a topic as well understood as crop production costs, and especially if labor and decision-making in crop production are to be disaggregated by gender.

Second, the customary assertion in Colombia (and elsewhere) that women do not and cannot grow cotton needs revision. Although there are few female cotton farmers, this study showed that cotton is a viable economic opportunity for women. The findings suggest that insect-resistant varieties of cotton, such as Bt cotton, may be especially attractive to female managers as a way to save on labor costs. This study advances the effort to make visible the strengths and contributions of women as farmers. For the first time in Colombia, research has shown the potential of women as successful cotton farmers. Both CONALGODÓN and local cot-

ton associations now have greater awareness of the potential of women as clients, and client recognition constitutes good business.

Findings, and the process of conducting the study, have uncovered several potential areas for future research. First, the variation in the marital, social, and economic status of female cotton growers in Colombia underscores the need to better understand the determinants of women's decisions to grow cotton, their decision to grow biotech cotton, and the heterogeneity among female clients. This is a methodological point that has been underscored in the general literature about gender and agricultural development (Quisumbing & Pandolfelli, 2010). Understanding the heterogeneity among both male and female clients enables growers associations, and companies to better address the needs of their market.

Access to information, and how access differs according to the gender and other socio-economic characteristics of farmers, deserves in-depth attention. We posit that the reason why women have less access to information compared to men is not because the information has been targeted to men but because women have a wider array of responsibilities that interfere with their chances to attend meetings or interact with other farmers. Their social circles and their leisure time are quite limited, making it difficult for them to meet other female farmers to talk about their experience with cotton. Social capital and social networks, and how these influence gender-differentiated access to information about biotech crops outside of formal associations, are one area of future research.

It is important to highlight as well the lack of information from seed providers, which may jeopardize both profitability of the crop for farmers and confidence on these providers. As shown above, women relied more on TAs as sources of information than men, so the better trained they are by the seed providers, the better the chances that good information can reach women interested in these new technologies.

Methods Considerations

The obvious shortcoming of the methods used here is that they are not generalizable because of small and voluntary samples. Hypotheses raised in this study, such as the notion that female farmers prefer to grow biotech cotton because it saves them labor and management time, could be tested in a larger, stratified random sample of growers in which the preferences choices, expenditures, and income of female managers and wives of

male managers are each compared statistically to male managers. We recommend tools such as these as one component of mixed methods.

The study was designed to explore gender perceptions, use, cost, and benefits of biotech cotton that are not always easy to spot with the traditional quantitative household surveys. Instead of relying on the perception of the researchers or multiple-choice survey questions, the qualitative method allows the subject of research to become active participants. The researcher limits his/her intervention to the design of tools that facilitate the engagement of farmers and others in a fruitful discussion. For this specific exercise, one of the most useful methods to elicit information from farmers was the use of the detailed cost of production activities presented to farmers, which they corrected and detailed even further. Through this method we were able to uncover the wide participation of women in many activities; some tasks are perceived as invisible, particularly all the administrative and support tasks that women play in the production process. It also allowed us to uncover the changes in the production process that biotech has introduced. The generalization of the findings of this method requires the design of a randomized sample where we can actually compare between women by type of technology, and among men and women.

One limitation of this type of participatory time-intensive method was the actual participation of women. Despite the fact that every possible measure was taken to secure the participation of the selected farmers in the organized workshops, the number of no-show female participants was higher than expected. Women's time demands are greater, compared to their partners or fellow male farmers, as the domestic chores and responsibilities are unequally carried by them.

The validity of participatory research also depends on the trust that has been established between participants and organizers, as well as among participants. The process of building trust is not only costly but also time-consuming. This first set of exercises opened an opportunity for dialogue, and it is expected that future contacts with the community will result in a higher participation rate. Gradually, women will be more at ease and motivated to share their knowledge and their time. This implies that in order to have a more comprehensive understanding about women's roles in cotton production, community work needs to allow confidence to be built among all participants. Regional cotton associations and CONALGODON can play a role in this direction.

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