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ANTICIPATED BENEFITS FROM FLEX COTTON: RESULTS OF A BELTWIDE SURVEY

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Abstract

This paper summarizes selected results from a national survey of cotton farmers in Spring, 2003. The survey focused on farmers' expectations and valuation of Roundup Ready Flex® cotton, due to be commercialized in 2006. We report farmers' valuations of both pecuniary and non-pecuniary characteristics of the new cotton technology relative to Roundup Ready cotton and to non-Roundup Ready (conventional) cotton. Mean values are presented by adopter type and by region. Some differences were found among adopter types, but for the most part, valuations across adopter types were not significantly different. Significant regional differences were found in farmers' valuation of the product's characteristics and their adoption intentions. Farmers' stated values for the total bundle of characteristics ranged from about $11/acre/year to $45/acre/year.

Introduction

The purpose of this paper is to report some results from a Beltwide survey of 500 cotton farmers conducted in the spring of 2004. The survey focused on respondents' attitudes and intentions toward Monsanto's new Roundup Ready Flex® (RRF) technology, due to be introduced commercially in Spring, 2006. RRF technology allows glyphosate to be sprayed over the top of cotton plants well beyond the 5th leaf stage, which is the current upper limit on over the top application for Roundup Ready (RR) cotton, up to layby and potentially longer.

The survey, which was designed by the authors and administered as a computer-aided telephone survey by Doanes' Market Research, was focused on farmers' valuations of the characteristics of RRF cotton compared to RR cotton *and* to non-RR cotton. These included both pecuniary and non-pecuniary characteristics, individually and in total. A copy of the survey instrument is available from the authors upon request.

The remainder of the paper is as follows. The next section presents comparisons of respondents' general perceptions about the relative profitability of the new technology and the valuation of some non-pecuniary characteristics of the new technology by adopter type. Adopter types are: 1) *Non-Adopter* - Did not adopt RR cotton on any cotton acres in 2003; 2) *Partial Adopter* - Adopted RR cotton on some, but not all, cotton acres in 2003; and 3) *Full Adopter* - Adopted RR cotton on all cotton acres in 2003. The fourth section contains the same information as the third, but with respondents broken out by geographic region. The regions are: 1) *High Plains* – Oklahoma and Texas; 2) *Lower Delta* – Arkansas, Mississippi, and Louisiana; 3) *Upper Delta* – Missouri and Tennessee; 4) *Southeast* – Alabama, Florida, and North Carolina; and 5) *West* – California and New Mexico. The final section summarizes the results and presents conclusions and further work.

Figure 1 shows the distribution of the 500 observations across the regions described above. There were no observations in the sample in South Carolina, Georgia, or New Mexico. This is just an artifact of randomization of the sample.

Selected Statistical Highlights by Adopter Type

Initial Impressions and Anticipated Production Changes by Adopter Type

Respondents' initial impressions, the likelihood of adoption, the anticipated on-farm diffusion curve, and their best estimate of the expected price of the technology, along with some anticipated changes in production practices are presented in Table 1. Those respondents who planted any RR cotton in 2003 had a significantly higher initial impression of the technology than those who did not plant RR cotton in 2003, although all ratings were above seven on a ten-point scale. The likelihood of adopting RRFlex is also higher among current adopters of RR cotton compared to non-adopters, although again, the mean likelihood is relatively high across all adopter types. Looking at intended RRFlex acreage, all adopter categories plan to increase their acreage over time. Full adopters expect to

pay a significantly higher price for the technology than non-adopters, while the expected price for partial adopters is not significantly different from the other two. Across adopter types, there is no significant difference in anticipated seed passes with RRFlex, but full adopters intend to significantly reduce their seedbed passes on any non-RRFlex acreage they plant. This may be an indication that they plan to use no-till across all their cotton acreage. Full adopters anticipate significantly higher savings in weed control passes relative to their RR acres across their cotton fields

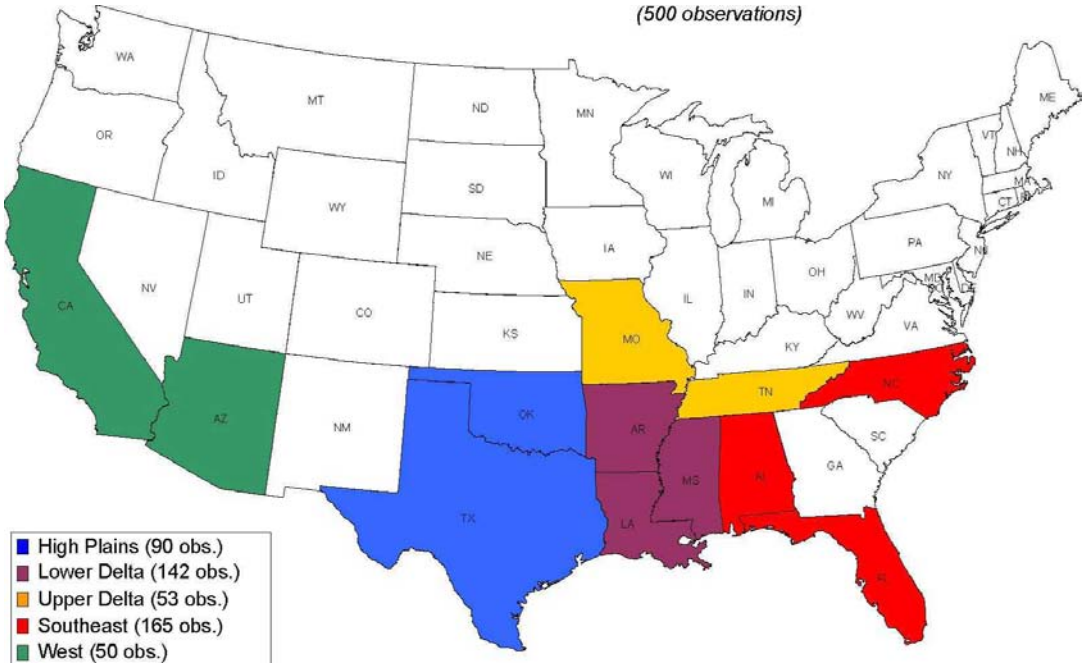

Figure 1. Regions and Distribution of Sample Observations

Table 1. Respondents' Initial Impression and Anticipated Production Changes with RRFlex by Adopter Category[a]

	Adopter Category		
Variable	*Non-Adopter*	*Partial Adopter*	*Full Adopter*
Initial Impression (Scale 1-10)	7.50[f,p]	8.24[n]	8.49[n]
Prob. Will Adopt RRF	54.11[f,p]	77.41[n]	79.93[n]
Planned RRF ac. in 1 yr	284.65[f]	469.42	581.84[n]
Planned RRF ac. in 3 yr	462.83[f]	605.81[f]	802.65[n,p]
Planned RRF ac. in 5 yr	495.83[f]	622.98[f]	808.93[n,p]
Expected Price of RRF	15.53[f]	19.06	19.68[n]
# Seedbed Passes w/ RRF	.	2.41	2.54
# Seedbed Passes w/ NRR|RRF	2.87[f]	2.62[f]	0.80[n,p]
# Weed Sprays Saved vs. RR	.	1.03[f]	1.22[p]
# Weed Sprays Saved vs. NRR	1.21	1.13	1.71

[a] Note: All means are statistically significantly different from zero at the 95% level of confidence. [n, p, or f] indicates the mean is statistically different (at the 95% level) from the non-adopter mean, the partial adopter mean, or the full adopter mean, respectively.

relative to partial adopters, although each group anticipates a significant savings of over one pass per year. The number of weed control passes saved relative to non-RR cotton is significantly different from zero and more than with RR cotton in each case, although the savings is not significantly different across adopter types.

Valuation of Pecuniary and Non-Pecuniary Characteristics by Adopter Type

The term *non-pecuniary* comes originally from the law. It means a loss or a gain that cannot be expressed in terms of an amount of money. In a legal case, non-pecuniary damages are those things that detract from one's well-being (what economists refer to as "utility"), that are not traded in markets and so do not have a market price with which damages can be calculated. An example is "pain and suffering." In terms of crop production, non-pecuniary characteristics of a production system could be the simplicity of it, its effect on various aspects of the environment, or its effect on human health and safety, to name a few.

Respondents were asked first if they thought there was any additional value to them of the various characteristics of RRFlex. If they said there was no additional value, then their response to the question "If so, how much value would you place on the additional amount of the characteristic?" was set to zero. Otherwise, the stated value from the second question was entered as the additional value on a per-acre/per-year basis. Tables 2 and 4 show the mean values (with the zeroes) for the various characteristics of RRFlex and then the mean values for the total change in value relative to Non-RR cotton and to RR cotton, respectively. The two pecuniary values elicited were the additional value for weed control and the additional value for cotton quality. The rest of the characteristics in Tables 2 and 4 have at least some non-pecuniary aspects. Table 4 is discussed in the next section.

Table 2. Stated Value of RRFlex Characteristics by Adopter Category[a]

		Adopter Category	
Variable	*Non-Adopter*	*Partial Adopter*	*Full Adopter*
		$/acre/year	
RRF Addt'l. Value for Weed Control	18.45[p]	9.26[f,n]	12.87[p]
RRF Addt'l. Value Ease and Simplicity	10.25	8.81	9.28
RRF Addt'l. Value with No-Till	10.16	8.92[f]	11.31[p]
RRF Addt'l. Value to the Environment	7.57	8.77	11.65
RRF Addt'l. Value of Hum. Safety	9.11	8.46	10.51
RRF Addt'l. Value of Application Flexibility	8.54	8.70	9.61
RRF Addt'l. Value of Cotton Quality	11.36	10.76	13.96
Total Additional Value vs. RR	**.**	**12.52**	**14.36**
Total Additional Value vs. NRR	**33.21[p]**	**18.71[n]**	**22.00**

[a] Note: All individual means are statistically significantly different from zero at the 95% level of confidence. [n, p, or f] indicates the mean is statistically different (at the 95% level) from the non-adopter mean, the partial adopter mean, or the full adopter mean, respectively.

Partial adopters reported a significantly lower value for the additional weed control characteristic of RR Flex compared to the current technologies compared to both the non-adopters and the full adopters. This result was unexpected. One would expect partial adopters to report a blended value of RRFlex relative to both non-RR and RR cotton, which should lie between the value placed on additional weed control by the non-adopters and the full adopters. As expected, though, the non-adopters placed a higher value on the additional weed control than those who were comparing only to RR cotton weed control. The same qualitative result occurs with the additional value

of RRFlex in terms of additional cotton quality, additional ease and simplicity, additional value with no-till, and additional value of human safety. In the case of the additional value to the environment and the additional value of application flexibility, partial adopters' mean values lie between those of non-adopters and full adopters, as expected. One interpretation of these results is that the non-adopters' values for some of the characteristics may be overstated because of lack of precise knowledge of the technology closest to the new technology. This does not explain why some of the relative values are in line with expectations, however. Notice in Table 2 that all of the individual values are substantial, each being over $7.00/acre/year. However, when the respondents were asked how much *total* additional value they would place on the new technology as a separate question, their response is always less than the sum of the values of the individual characteristics. This makes theoretical sense in that, by the law of diminishing marginal utility, the last added characteristic of the group of characteristics embodied in the technology should result in less additional utility than the first characteristic. This assumes the characteristics are mostly substitutes, which is a reasonable assumption in this case.

Selected Statistical Highlights by Region

Initial Impressions and Anticipated Production Changes by Region

As was discussed earlier, the respondents were divided into regions reflecting loosely the different cotton growing conditions across the U.S. Table 3 contains the adoption intentions and anticipated production changes within each region. Notice that the High Plains and West regions are statistically equal to each other in terms of initial impression and the probability of adoption and they are both significantly lower than the other regions in those two categories. Again, the overall magnitudes of the initial impression response and the likelihood of adopting RRFlex are all quite positive. The High Plains, Lower Delta, and the West all plan to increase RRFlex acreage over time, while respondents in the Southeast and Upper Delta anticipate planting fewer acres in the 5th year after adoption than in the 3rd year out. This result could be that the respondents in those regions expect an even better cotton technology to be introduced by then. Respondents in the Lower Delta expect to pay significantly more per acre than those in the other regions. Respondents in the high plains expect to pay a lower price for the technology than those in the other regions. Respondents in the High Plains and the West reported equal expected seedbed preparation passes with RR Flex, and all other regions reported significantly less seedbed preparation passes over the field compared to the High Plains and the West. The number of expected seedbed passes with non-RR cotton, given the adoption of RRFlex is highest in the High Plains. The number of passes over the field spraying

Table 3. Survey Respondents' Adoption Intentions and Anticipated Production Practices by Region[a]

	Region				
Variable	*High Plains*	*Lower Delta*	*Southeast*	*Upper Delta*	*West*
			\$/acre/year		
Initial Impression (Scale 1-10)	7.66^{l,s,u}	8.54^{h,s,w}	8.94^{h,l,w}	8.50^{h,w}	7.86^{l,s,u}
Prob. Will Adopt RRF	71.46^{l,s,u}	79.86^{h,w}	83.85^{h,w}	79.12^{h,w}	65.02^{l,s,u}
Planned RRF ac. in 1 yr	653.89^{u,w}	640.16^{u,w}	708.08^{w}	379.04^{h,l}	275.82^{h,l,s}
Planned RRF ac. in 3 yr	873.75^{u,w}	848.84^{u,w}	850.52^{w}	592.37^{h,l,w}	380.04^{l,s,u}
Planned RRF ac. in 5 yr	956.61^{u,w}	861.60^{u,w}	818.92^{w}	578.35^{h,l,w}	393.43^{l,s,u}
Expected Price of RRF \$/ac.	13.50^{l,s,u,w}	24.02^{h,s,u}	19.06^{h,l}	16.31^{h,l}	22.12^{h}
# Seedbed Passes w/ RRF	2.96^{l,s,u}	2.20^{h,u,w}	2.10^{h,w}	2.52^{h,l}	2.85^{l,s}
#Seedbed Passes w/ NRR|RRF	3.06^{l,s,u}	2.32^{h,w}	1.56^{h,w}	2.28^{h}	2.80^{h,s}
# Weed Sprays Saved vs. RR	0.81^{l,s,u}	1.24^{h}	1.10^{h}	1.33^{h}	1.00
# Weed Sprays Saved vs. NRR	0.70^{l,s,u}	1.28^{h}	1.37^{h}	1.71^{h,w}	1.03^{u}

[a] Note: All individual means are statistically significantly different from zero at the 95% confidence level.
$^{h, l, s, u, or\ w}$ indicates the mean is significantly different (at the 95% level) from the high plains mean, the lower delta mean, the southeast mean, the upper delta mean, or the west mean, respectively.

for weeds that are expected to be saved if RRFlex is adopted ranges from 0.81 in the High Plains to 1.33 in the Upper Delta. The smallest savings in weed sprays were reported in the High Plains and the West. The number of weed sprays saved with RRFlex relative to non-RR cotton is higher in all cases relative to the expected savings relative to RR cotton except in the High Plains. The number of sprays saved ranges from 0.70 in the High Plains to 1.71 in the Upper Delta.

Valuation of Pecuniary and Non-Pecuniary Characteristics by Region

Respondents' stated values for selected characteristics of RRFlex appear in Table 4. All the means in the table represent respondents' average willingness to pay for the additional level of the characteristic expected with RRFlex in terms of $/acre/year. The value placed on the additional weed control is clearly higher in the West relative to the other regions, more than twice that reported by farmers in the Southeast region. The value placed on the additional ease and simplicity is also significantly higher in the West relative to that in the High Plains, but not significantly higher than that reported in the other regions. The additional value of RRFlex with no-till ranges from $8.90 in the High Plains to $12.83 in the West, but none of the regional means are significantly different from each other. The same holds for the additional value to the environment and the additional value of application flexibility. The additional value of human safety is significantly lower in the Southeast relative to the Lower Delta, but the rest of the regions are not significantly different. The additional value of RRFlex in terms of cotton quality ranges from $9.71/acre/year in the Lower Delta to $15.38/acre/year in the Upper Delta. As explained above in the section reporting the result broken down by adopter category, the last two rows of Table 4 present respondents' mean valuation of the total additional value expected from RRFlex relative to RR cotton and non-RR cotton, respectively. The total additional value relative to RR cotton is significantly high in the Southeast and West relative to that reported in the High Plains or the Lower Delta. The additional value relative to non-RR cotton is significantly higher in the West relative to all other regions. That value in the West is more than four times the value reported in the High Plains and more than twice that reported in all other regions.

Table 4. Stated Value of RRFlex Characteristics by Region[a]

			Region		
Variable	*High Plains*	*Lower Delta*	*Southeast*	*Upper Delta*	*West*
RRF Addt'l. Value for Weed Control	10.32^{w}	11.54^{w}	10.31^{w}	12.43^{w}	20.77^{h,l,s,u}
RRF Addt'l. Value Ease and Simplicity	7.84^{w}	9.52	8.69	8.79	14.25^{h}
RRF Addt'l. Value with No-Till	8.90	10.20	10.22	11.50	12.83
RRF Addt'l. Value to the Environment	8.88	10.05	11.50	10.21	15.73
RRF Addt'l. Value of Hum. Safety	8.28	9.89^{s}	5.55^{l}	11.96	7.90
RRF Addt'l. Value of Application Flexibility	9.22	8.97	9.91	8.51	12.30
RRF Addt'l. Value of Cotton Quality	13.40	9.71^{u}	15.25	15.38^{l}	10.68
Total Additional Value vs. RR	**11.79^{s,w}**	**12.46^{s,w}**	**16.64^{h,l}**	**14.48**	**18.56^{h,l}**
Total Additional Value vs. NRR	**11.82^{s,w}**	**18.58^{h,w}**	**15.80^{w}**	**23.25^{w}**	**44.75^{h,l,s,u}**

[a] Note: All individual means are statistically significantly different from zero at the 95% confidence level. $^{h, l, s, u, or\ w}$ indicates the mean is significantly different (at the 95% level) from the high plains mean, the lower delta mean, the southeast mean, the upper delta mean, or the west mean, respectively.

Conclusions and Further Work

The knowledge gained about how farmers value non-pecuniary characteristics is significant. Apparently, producers are willing to pay a fairly substantial amount in terms of $/acre/year for the additional non-pecuniary benefits they expect to gain from RRFlex and these values increase, for the most part, when the comparison is between RRFlex and non-RR cotton. These values, along with the pecuniary, or profit, gains, are close to the amount farmers expect

to pay for the technology in most cases. They are also on a par with growers' valuation of the pecuniary characteristics. With the results of this study, it is clear that if one were to attempt to calculate the total value of RRFlex cotton to compare, for example, to the research and development costs, these non-pecuniary gains cannot be ignored. This information is also useful for pricing the technology correctly according to the additional value placed on it in different regions of levels of current RR cotton adoption.

Further work includes a follow-up study using the same survey questions to see if these values stay the same after the technology is adopted and used. It will also be important to determine the farm, farmer, and market factors that may influence these values.

Note

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