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Abstract

Using information from precision farmer surveys conducted in the southern United States in 2005 and 2013, we evaluated changes in the use of precision farming information sources among cotton producers. Although Extension remains an important source for producers interested in precision farming information, the percentage of cotton producers using Extension to obtain precision farming information has decreased over time. Results from our study should motivate Extension professionals to re-evaluate the precision farming information they provide to producers and the practices they use to provide such information in efforts to maintain Extension's importance as an information source.

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Precision farming technologies may enable producers to lower costs of crop production, increase profits, and decrease negative environmental impacts of their operations (Bongiovanni & Lowenberg-DeBoer, 2004; Bullock, Lowenberg-DeBoer, & Swinton, 2002; Roberts, English, & Larson, 2002; Torbett, Roberts, Larson, & English, 2007; Velandia, Buschermohle, Larson, Thompson, & Jernigan, 2013; Walton et al., 2010). Farmers' decisions to use precision agriculture technologies may be influenced by how information about these technologies is

disseminated to them. Previous findings have suggested that Extension may be an important source for farmers seeking information about precision farming technologies. Specifically, Extension effectively communicates information to producers about these technologies and their benefits (Hall, Dunkelberger, Ferreira, Prevatt, & Martin, 2003; Schnitkey, Batte, Jones, & Botomogno, 1992; Watcharaanantapong et al., 2014).

However, Extension is not the only information source available to farmers and, in fact, may not be a producer's only choice if he or she has the opportunity to obtain information from other sources, some of which are more directly connected with businesses developing precision farming technologies (e.g., farm equipment dealers). Previously researchers have evaluated the role of Extension in combination with other private and public sources in disseminating information to producers (Lasley, Padgitt, & Hanson, 2001; Schnitkey et al., 1992; Velandia et al., 2010). Although private information sources, such as farm equipment dealers, are the most used precision farming information sources among row crop producers (McBride & Daberkow, 2003; Velandia et al., 2010), most use more than one source when gathering information about these technologies (Velandia et al., 2010).

Similar to an earlier study (Velandia et al., 2010), the study described here involved examination of the sources used by cotton producers in 11 southern states to obtain information about precision farming technologies. We evaluated changes in the cotton producers' use of information sources and information source importance ratings from 2005 to 2013. We also evaluated differences in producer and farm business characteristics between Extension users and non-Extension users in 2005 and 2013. The results of our study may help Extension personnel better meet the needs of producers seeking information about precision farming technologies. In contrast, as more information becomes available to producers through interaction with other producers (i.e., adopters) and the credibility of the information from sources that develop precision farming technologies increases over time, results from our study may help Extension redefine its role as a source of precision farming information. Previous studies have emphasized the need for Extension to work in concert with other information sources (Velandia et al., 2010). The results from the study described here shed light on whether a concerted effort is still needed or Extension should focus its efforts in a different direction.

Methods

In January 2005, a survey was mailed to 12,243 cotton producers in Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, Tennessee, and Virginia, and 1,214 surveys with usable records were returned (Velandia et al., 2010). After elimination of questionnaires that were returned undeliverable or from producers no longer growing cotton, the overall response rate was 10% (Velandia et al., 2010). Another survey was mailed in February 2013 to 13,566 cotton producers in Alabama, Arkansas, Florida, Georgia, Kansas, Louisiana, Mississippi, Missouri, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia (Zhou et al., 2015). In total, there were 1,811 surveys with usable records, for a 14% response rate (Zhou et al., 2015). For both survey years, the list frame of potential producers was furnished by the Cotton Board in Memphis, Tennessee, and the survey was mailed to all individuals included on the list. The survey instruments were developed by a group of researchers from six universities in the southern region. The questionnaires were pretested with cotton producers in Tennessee.

With both surveys, the researchers gathered producer and farm business information including age, educational attainment, percentage of household income from farming, and acreage managed during the 2 years prior to the survey. The surveys also included questions related to producer adoption of precision farming technologies and importance ratings for various sources of precision farming information. The information source options included crop consultants, farm equipment dealers, Extension, Internet, news and media, other farmers, and trade shows.

In accordance with previously completed work (Velandia et al., 2010), we categorized the information sources into four groups: private (crop consultants and farm equipment dealers), Extension, other farmers, and media (news/media and Internet). States not surveyed in both 2005 and 2013 (i.e., Kansas, Oklahoma, and Texas) were eliminated from our sample. We used independent-samples *t*-tests to evaluate differences in producer and farm business characteristics between Extension users (i.e., those using Extension alone or in combination with other sources) and non-Extension users in both years. Additionally, we used an equality proportion test (StataCorp, 2013) to evaluate statistical differences between the proportion of users of Extension and the proportions of users of other information sources in a given year.

Results

Average ages of producers responding to the 2005 and 2013 surveys were 50 and 56 years, respectively. In 2005 and 2013, about the same percentages of respondents (37% and 35%, respectively) indicated having a bachelor's or graduate degree. The average percentages of income from farming were the same for survey respondents in 2005 and 2013 (72% both years). It appears that survey respondents in 2005 and 2013 had similar characteristics, although respondents in 2013 were older compared to respondents in 2005. This difference in age may reflect the fact that the average age of U.S. farm operators has increased over time (U.S. Department of Agriculture, 2007, 2012), or it could be because the target populations for the 2005 and 2013 surveys were similar and, therefore, the respondents' ages increased over time.

Details of respondents' use of various information sources are shown in Table 1. About 66% and 30% of survey respondents used Extension as a source of precision farming information in 2005 and 2013, respectively. The percentage of cotton producers using Extension as a source of precision farming information was lower in 2013 than in 2005, whereas the percentage using only private sources (e.g., crop consultants and farm equipment dealers) increased from 3.5% to 22.3%. Producers obtaining information only from other farmers also increased, from 2.4% to 10.3%. In addition, the percentage of survey respondents using a combination of all information sources decreased from 49.1% to 4.6% between 2005 and 2013.

Table 1.

Percentages of Respondents Using Various Sources of Information

Information source combinations	2005 (%)	2013 (%)
Used only Extension	2.55	3.73
Used Extension and private sources	3.05	5.27
Used Extension and other farmers	1.40	2.45
Used Extension and media	1.40	0.82
Used Extension, private sources, and other farmers	4.70	11.50
Used Extension, private sources, and media	2.14	1.27
Used Extension, other farmers, and media	1.48	0.64
Used Extension, private sources, other farmers, and media	49.05	4.64

Total Extension users	65.76	30.36
Used none of the sources considered in the survey	16.71	10.27
Used only private sources	3.54	22.27
Used only other farmers	2.39	10.27
Used only media	3.95	1.91
Used private sources and other farmers	1.73	18.55
Used private sources and media	2.72	2.27
Used other farmers and media	1.23	1.00
Used private sources, other farmers, and media	1.98	3.09
Total non-Extension users	34.24	69.64

Table 2 presents a summary of the proportions of respondents using Extension, private sources, other farmers, and media as precision farming information sources. Using a test for equality of proportions (StataCorp, 2013), we evaluated statistical differences between the proportion of users of Extension and the proportions of users of other sources in a given year (i.e., 2005 or 2013). In 2005, we found no statistically significant differences between the proportion of Extension users and the proportions of users of other information sources. On the other hand, in 2013, differences between proportions of Extension users and users of other information sources were statistically significant for all information sources evaluated. The proportion of respondents who indicated using private sources was about 35% higher than the proportion of those who indicated using Extension. Additionally, the proportion of respondents who indicated using other farmers was about 22% higher than the proportion of those who indicated using Extension.

Table 2.

Percentages of Respondents Using Extension, Private Sources, Other Farmers, and Media in 2005 and 2013

Information source	2005 (%)	2013 (%)
Used Extension	65.76	30.36
Used private sources	68.89	65.74***
Used other farmers	63.95	52.18***
Used media	63.95	15.64***

***Statistical significance of the difference between the proportion of Extension users and the proportion of users of other sources in a given year at the 1% level.

Table 3 presents comparisons of producer and farm business characteristics relative to Extension and non-Extension users in 2005 and 2013. The 2005 survey data indicate that respondents who were Extension users

were younger and more educated, had higher household incomes and larger farms (i.e., number of cotton and other crop acres planted in 2004 and 2012), and owned smaller percentages of their farmed acreage than those who were non-Extension users (Velandia et al., 2010). In contrast, although the 2013 survey data also indicate that Extension users were younger and more educated than non-Extension users, significant differences between users and non-users of Extension were not present for household income and farm size. Furthermore, the 2013 respondents who were Extension users owned larger percentages of the acres they farmed than those who were non-Extension users (37% and 33%, respectively).

Table 3.

Variable Means for Extension Users and Non-Extension Users in 2005 and 2013

Variable	2005		2013	
	Extension users	Non-Extension users	Extension users	Non-Extension users
Average age of producers as of 2004 (in years)	48.52***	53.44	55.18*	56.55
Proportion of farmers with a bachelor's degree (%) ^a	32.75***	22.63	29.91	28.00
Proportion of farmers with a graduate degree (%)	8.91**	5.11	12.99***	5.55
Proportion of farmers with a bachelor's or graduate degree (%)	41.66***	27.74	42.90***	33.55
Proportion of farmers with income higher than \$150,000 (%)	36.00**	30.00	32.00	29.00
Average percentage of income from farming (%)	73.00	71.00	72.00	72.00
Farm size (in acres) ^b	1,510.64***	1,062.98	1,155.96	1,010.36
Land tenure (owned acres divided by owned acres plus rented acres) (%)	39.00**	45.00	37.00*	33.00

^aEducation represents highest education level rather than degree attained, as was seen in Velandia et al. (2010). ^bAverage farm size was calculated as total cotton and other crop acres planted in 2004, 2012.

*Statistical significance at 10% level. **Statistical significance at 5% level.

***Statistical significance at 1% level.

Table 4 shows details of respondents' ratings of importance of information sources used for making decisions about adoption of precision farming technologies (i.e., adopt or do not adopt). There appears to have been an increase from 2005 to 2013 in the importance survey respondents placed on all such information sources. This finding suggests that the quality of information provided by all sources may have improved over the years, perhaps due to the accumulation of more practical evidence about the actual benefits of precision farming technologies. The largest increase in average importance rating from 2005 to 2013 was for crop consultants. Other farmers received the highest rating in 2005, whereas crop consultants received the highest rating in 2013. On average, Extension received the second highest rating in 2005 but the second lowest rating in 2013. Although all sources seem to have improved regarding the role they play in providing cotton producers with information about precision farming technologies, the ratings indicate that crop consultants either have improved the quality of information they provide or have increased their credibility as an information source as compared to other sources.

Table 4.
Information Source Importance Ratings by Users

Information source	2005 (M)	2013 (M)
Extension	3.32	3.56
Dealers	3.05	3.59
Crop consultants	3.02	3.75
Other farmers	3.33	3.67
News media	2.44	2.84

Note. Users rated the importance of information sources using a 1–5 scale, with 5 being the highest importance level.

Summary and Discussion

Extension was considered an important source of precision farming information by cotton producers surveyed in 2005 and 2013. Nonetheless, the percentage of survey respondents using Extension only or in combination with other information sources to obtain precision farming information decreased from about 66% in 2005 to 30% in 2013. Additionally, Extension and non-Extension users shared more similarities in 2013 than in 2005. However, Extension users still tend to be younger and more educated than non-Extension users. Extension user characteristics are consistent with the characteristics of precision agriculture adopters, as discussed in previous studies (Larson et al., 2008; Roberts et al., 2004; Walton et al., 2008, 2010).

In 2013, private sources were the most used information sources among survey respondents, with 22% of producers using only crop consultants or farm equipment dealers to gather precision farming information. The second most used information source category was a combination of private sources and other farmers. Clearly, private sources are important for producers seeking information about precision agriculture. Indeed, survey respondents' ratings of importance of information sources revealed increased confidence in private sources, with crop consultants receiving the fourth lowest rating in 2005 and the highest rating in 2013.

The results from our study suggest that other information sources are being used more intensively than Extension but not the direction Extension should follow to stay relevant in the area of precision farming. Nonetheless, results from the study should motivate Extension professionals to re-evaluate the modes through which they disseminate precision farming information. A recommendation stemming from the earlier survey of southern cotton farmers (Velandia et al., 2010) involved creating resources for the typical Extension user, but with users and non-users becoming more similar over time, this approach may no longer be useful. Because Extension information is not typically used alone, strategizing to better serve producers by working in combination with other information sources could improve the experience of producers seeking precision farming information for the first time (Velandia et al., 2010). Additionally, Extension personnel could determine what unique information to provide to new precision farming users that would complement the information provided by crop consultants and farm equipment dealers.

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