

## Tailoring Extension Efforts for Promotion of Diversified Crop Rotation Systems

### Abstract

We conducted a survey in the northern Great Plains to better understand farmer-preferred learning sources and formats, influential factors, and challenges related to adoption of diversified crop rotation systems. University Extension was ranked as the second most preferred learning source, lagging only behind other farmers. Most farmers listed short seminars and Extension fact sheets as their most preferred learning formats, and most viewed crop productivity and soil health as the most influential factors for new-practice adoption. Our findings can help Extension educators better facilitate future adoption of diversified cropping systems as a conservation practice.

**Keywords:** [conservation practices](#), [diversified crop rotation system](#), [crop productivity](#), [soil health](#), [Extension](#)

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## Introduction

In the midwestern United States, crop production systems are dominated by monoculture or 2-year corn-soybean rotations (Union of Concerned Scientists [UCS], 2017). Rising crop prices from 2006 to 2013 provided economic incentives for producers to further increase acreage planted for corn and soybean, at the expense of other crops and grassland (Wang et al., 2017). In recent years, however, various aspects of the sustainability of such specialized production systems have been challenged.

Besides vulnerability of income to price shifts (Schneppf, 2017), monoculture or simple rotation systems can cause serious environmental problems. For example, corn-soybean rotation, frequently coupled with tillage practice, exacerbates soil erosion (UCS, 2017) and depletes soil organic matter (Huggins, Clapp, Lamb, & Randall, 2007). In addition, monoculture systems have caused increased insect problems, herbicide-resistant weeds, greater incidence of crop diseases, and heavier reliance on fertilizer use (Derksen, Anderson, Blackshaw, & Maxwell, 2002; Porter, Chen, Reese, & Klossner, 2001; UCS, 2017). Fertilizers, pesticides, and

eroded soil may further cause an increase in the amount of pollutants leaked to rivers and lakes and, therefore, may greatly impair surface water quality (UCS, 2017).

Recent research has demonstrated that in contrast to simple corn–soybean rotation systems, diversified cropping systems can result in benefits that include weed suppression, increased yields and profits, and reduced need for fertilizer and herbicide inputs (Davis, Hill, Chase, Johanns, & Liebman, 2012). By keeping the soil covered for a longer period, diversified cropping systems have a great potential to decrease soil erosion (UCS, 2017). Furthermore, reducing agrichemical inputs helps reduce the amount of nutrient pollutants in ground and surface waters. Yet these productivity and environmental benefits can be reaped only if farmers choose to adopt diversified crop production systems.

Extension serves the public good by addressing long-term concerns such as soil erosion and nutrient runoff (Al-Kaisi, Elmore, Miller, & Kwaw-Mensah, 2015). Accordingly, Extension professionals can play a key role in promoting the dissemination of new practices such as increased adoption of diversified crop rotation systems by farmers. To meet the needs of farmer clients, Extension educators need to understand farmers' preferred sources and formats for learning about new practices, key factors they consider when making adoption decisions, and their perceptions about challenges related to new conservation practices. In this article, we use survey findings to shed light on these issues so as to help Extension educators better facilitate future adoption of diversified crop rotation systems.

## Methods

In the summer of 2016, we conducted a survey in the northern Great Plains of the United States, where agricultural production plays a critical role in the region's economy. We distributed an institutional review board–approved survey questionnaire by mail to 3,500 selected agricultural producers in Nebraska, North Dakota, and South Dakota. To obtain the agricultural producer addresses used for our survey, we used free online sources including federal farm subsidy databases, the White Pages, and Manta. The eight-page survey questionnaire consisted of sections addressing preferred information sources and formats, perceptions of crop rotation practices, type of agricultural operation, and demographics. Altogether, 46 questions were asked, most of which were multiple-choice items.

We used the Dillman method in conducting the survey (Dillman, 1978), with five waves of mailings taking place between mid-June and the end of July, 2016. In mid-June, a postcard informing selected producers about the upcoming survey was mailed. A week later, we sent the survey questionnaire along with a return envelope and a colorful refrigerator magnet as an incentive to fill out the questionnaire. During the fourth week of June, a reminder or thank-you letter was sent. For those who had not filled out the survey by mid-July, we sent a second questionnaire packet. Finally, in late July, a reminder or thank-you letter was sent to all selected producers.

Six hundred seventy-two farmers completed and returned the survey, resulting in a response rate of 21.2%. The use of publicly available addresses was likely a reason for the low response rate. The free online sources we used did not update addresses on a timely basis. As a result, 323 surveys were undeliverable or inapplicable due to reasons such as addressees who had died, had moved either temporarily or permanently, were no longer operating a farm business, or so on. The timing of the survey also may have negatively affected the survey response rate as the survey was conducted during a busy season for the agricultural producers.

Due to the relatively small sample size, we evaluated the representativeness of our survey findings by comparing average farmer age and nonirrigation yields with state averages. The average ages of our respondents were 65.1, 61.7, and 62.5 years in Nebraska, North Dakota, and South Dakota, respectively. These ages were slightly older than the state average ages reported in the U.S. Department of Agriculture (USDA) 2012 Census of Agriculture, which were 55.7, 57.0, and 55.9, respectively (USDA, 2012). Nonirrigated yields for corn reported by our respondents averaged 143, 134, and 145 bu/ac for Nebraska, North Dakota, and South Dakota, respectively. These values were consistent with USDA National Agricultural Statistics Service (NASS) Quick Stats for 2016, which listed state average yields for corn as 147, 126, and 145 bu/ac for the corresponding states (USDA NASS, n.d.). Similarly, nonirrigated yields for soybeans were reported as 54, 38, and 48 bu/ac by our survey respondents, comparable to the state average yields of 55, 33, and 42 bu/ac for Nebraska, North Dakota, and South Dakota, respectively, as listed in NASS Quick Stats for 2016 (USDA NASS, n.d.).

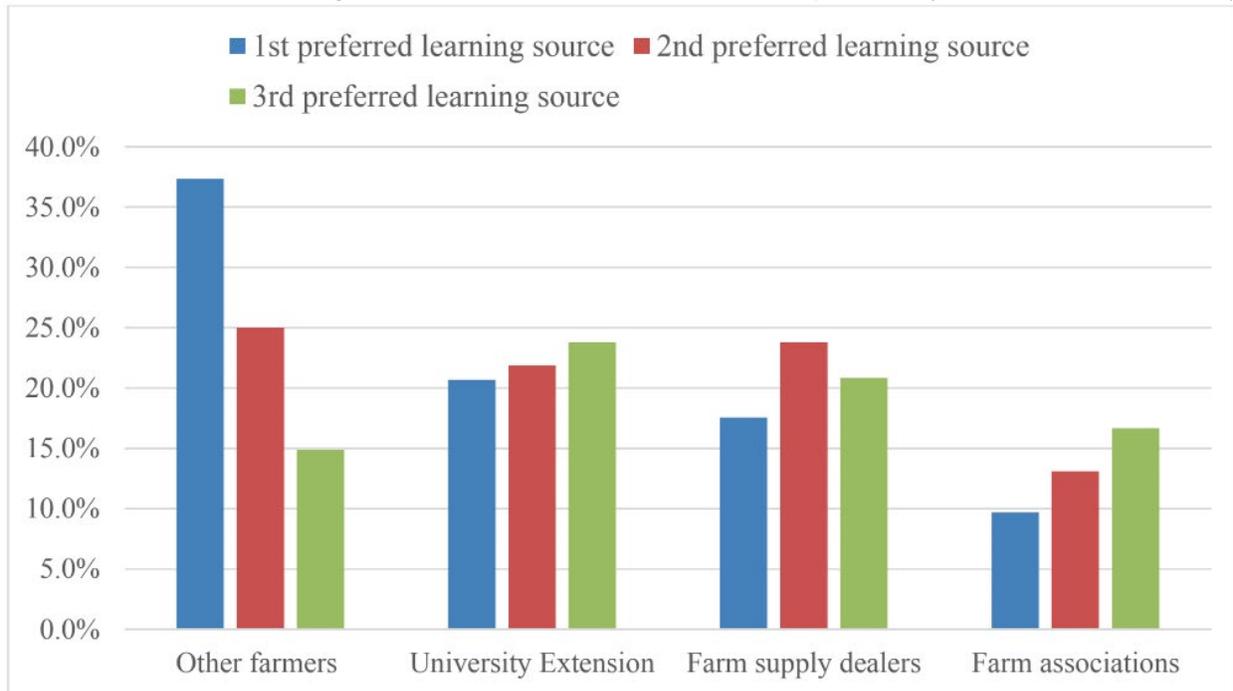
## Results and Discussion

### Farmer-Preferred Sources for Learning About New Farm Practices

When asked about their most preferred sources for learning about new farm practices (Figure 1), nearly 40% of respondents ranked other farmers as the top preferred information source, and 20% ranked university Extension as their top choice. Consistent with our finding, Sundermeier, Fallon, Schmalzried, and Sundermeier (2009) found that other farmers were farmers' most preferred source for learning tillage practices. Our results also indicate that the preference for farm supply dealers as a source for learning about new farm practices lagged slightly behind the preference for university Extension. Other research has shown, however, that on topics such as seed selection and disease management, farm supply dealers are most farmers' first choice as an information source (Arbuckle, Lasley, & Ferrell, 2012). Therefore, farmers may have different preferred learning sources depending on the type of information needed. Among the four choices given, farm associations, such as Cattlemen's Association, Stock Growers' Association, and so on, was the least preferred information source for most farmers. This finding suggests that few farmers turn to farm associations to acquire information on new practices.

#### Figure 1.

Percentages of Farmers Who Ranked Given Sources with Respect to Top Three Most Preferred Sources for Learning New Farm Practices



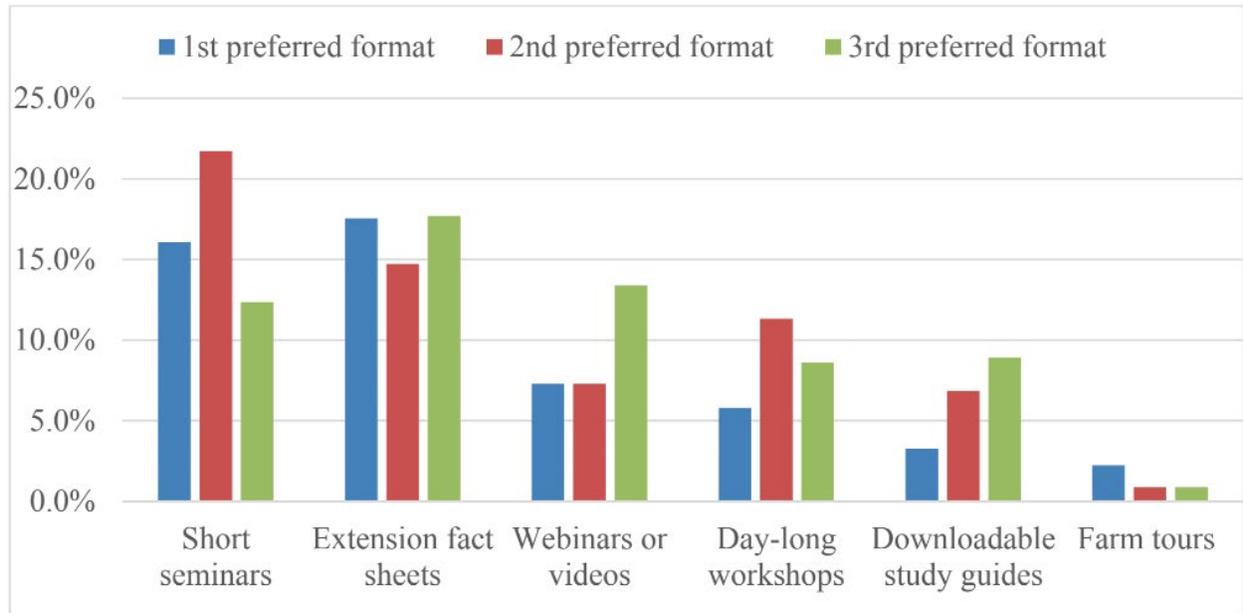
As measured by ranges of full-time-equivalent (FTE) Extension personnel per thousand farms in 2010, North Dakota had the highest density at more than 20, Nebraska was in the upper middle range with between 10 and 20, and South Dakota had the lowest density at fewer than five (Wang, 2014). With the top-ranked information source marked as 1, the second as 2, and so on, we found that average rankings for the Extension services were 2.28, 2.41, and 2.72, for North Dakota, Nebraska, and South Dakota, respectively. This outcome means that in North Dakota, where Extension had the highest FTE density, producers placed the highest ranking on Extension as a source of information, with Nebraska and South Dakota having lower FTE densities and correspondingly lower rankings. Therefore, our survey findings suggest that Extension FTE density affects farmers' perceptions of Extension.

## Farmer-Preferred Formats for Learning About New Farm Practices

To help farmers learn new farm practices, it is important for Extension professionals to use educational formats that best meet farmers' needs. When asked to rank the top three formats through which they would prefer to receive new information (Figure 2), most farmers in our study ranked short seminars and Extension fact sheets first and second. Compared to short seminars, daylong workshops were much less popular, even though both formats belong to the same interactive learning category. This difference is likely due to time constraints faced by many farmers. Additionally, Extension fact sheets were viewed as more helpful than webinars and downloadable study guides. This finding implies that for the farmer population studied, paper printed materials such as fact sheets are considered better aids than materials viewable only on a computer. Surprisingly, although most farmers indicated that they preferred to learn from other farmers, very few farmers considered farm tours a good format for learning new farm practices.

**Figure 2.**

Percentages of Farmers Who Ranked Given Formats with Respect to Top Three Preferred Formats for Learning New Farm Practices



### Top Three Factors That Affect Adoption Decisions

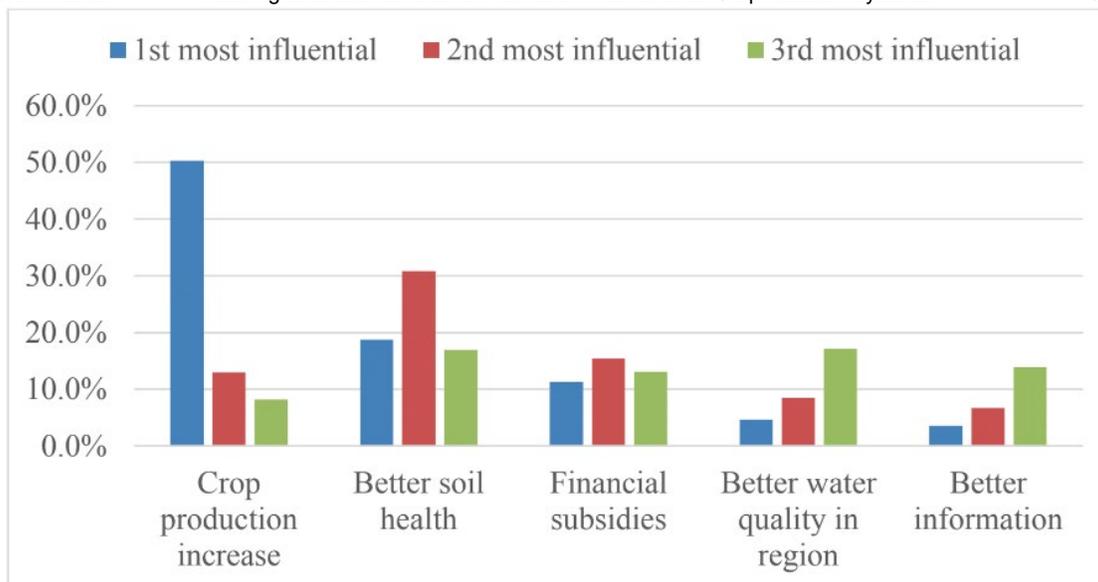
With regard to top three factors that affect adoption choice (Figure 3), half of producers (50%) ranked crop production increase as the most influential factor. Better soil health was considered by most farmers as the second most influencing factor. However, better water quality in the region was not viewed as being as influential to adoption decisions as soil quality.

Given that crop production increase and soil health were chosen as the top two priorities by most producers, future research should be targeted at investigating the effects of conservation practices on crop productivity and soil health in both the short and long term. The relationship between better soil health and increased production or profitability also warrants further research. Adoption rates likely will increase if substantial research demonstrates diversified crop rotations as a win-win solution.

We also found that financial subsidies lagged far behind crop production increase and soil health as an influencer. This circumstance implies that even though one-time financial payments through the Conservation Stewardship Program or Environmental Quality Incentive Program may help boost adoption rates, producers usually give more consideration to other benefits associated with a new practice when making adoption decisions.

**Figure 3.**

Percentages of Farmers Who Ranked Given Factors with Respect to Top Three Most Influential Factors Affecting Adoption Decisions



## Farmer Concerns About Adopting Diversified Crop Rotation Practices

Regarding the concerns farmers have about diversified crop rotation practices (Table 1), loss of production or profitability was chosen as the greatest concern by most producers. This result implies that production or profitability was these farmers' top consideration when making farming decisions and that most farmers are probably obstructed from adoption due to uncertainty about yields and marketing information on diversified crop production systems. Consistent with previous findings (Carlisle, 2016; UCS, 2017), we found that lack of access to equipment or necessary tools was a concern among our survey respondents; specifically, it was their second most important concern related to adopting sustainable farm practices. A few farmers (11.5%) were not sure about varieties of crops to include in diversified crop rotation systems. Even though a previous study showed that farmers believed more time would be required to be successful with sustainable farming practices (Drost, Long, Wilson, Miller, & Campbell, 1996), only 6.5% of farmers in our study listed lack of time or resources as their greatest concern.

**Table 1.**

Concerns of Farmers Regarding Adopting Diversified Crop Rotation Systems

Potential concern	Percentage of farmers agreeing
Loss of production/profitability	24.0%
Lack of access to equipment or necessary tools	20.1%
Lack of knowledge about cropping varieties	11.5%
Lack of time or resources	6.5%

## Conclusion

As an impartial provider of research-based information, Extension plays an important role in diffusion of knowledge and technology to the farm level. In recent years, with shrinking funding support and competition

from agribusiness representatives who provide both product and technical support, Extension has faced significant challenges (Al-Kaisi et al., 2015; Wang, 2014). To effectively manage limited resources, Extension professionals must offer education in the formats most conducive to farmers' learning new practices.

Our findings show that most farmers consider other farmers and university Extension as the two most important sources for learning about new farming practices. Therefore, when organizing Extension events, educators should include farmer panels as a resource that provides farmers with more opportunity to learn from their peers. Educators also should frequently implement farmer-preferred learning formats, such as short seminars and Extension fact sheets, to improve learning outcomes.

Regarding the adoption of diversified crop rotation systems, farmers are generally concerned about possible loss of productivity or profit. More favorable decisions will be made if new practices are shown to improve both crop production and soil health. Also, continual performance of new practices outweighs one-time financial subsidies when it comes to adoption. Future research and Extension efforts should be tailored toward the topics of yield and profitability as those factors relate to farmers' decisions about adopting diversified crop rotation systems. The relationship between soil health and profitability should be investigated as well, through the use of both experimental station and on-farm research, as many farmers' adoption decisions hinge on these factors.

### Author Notes

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