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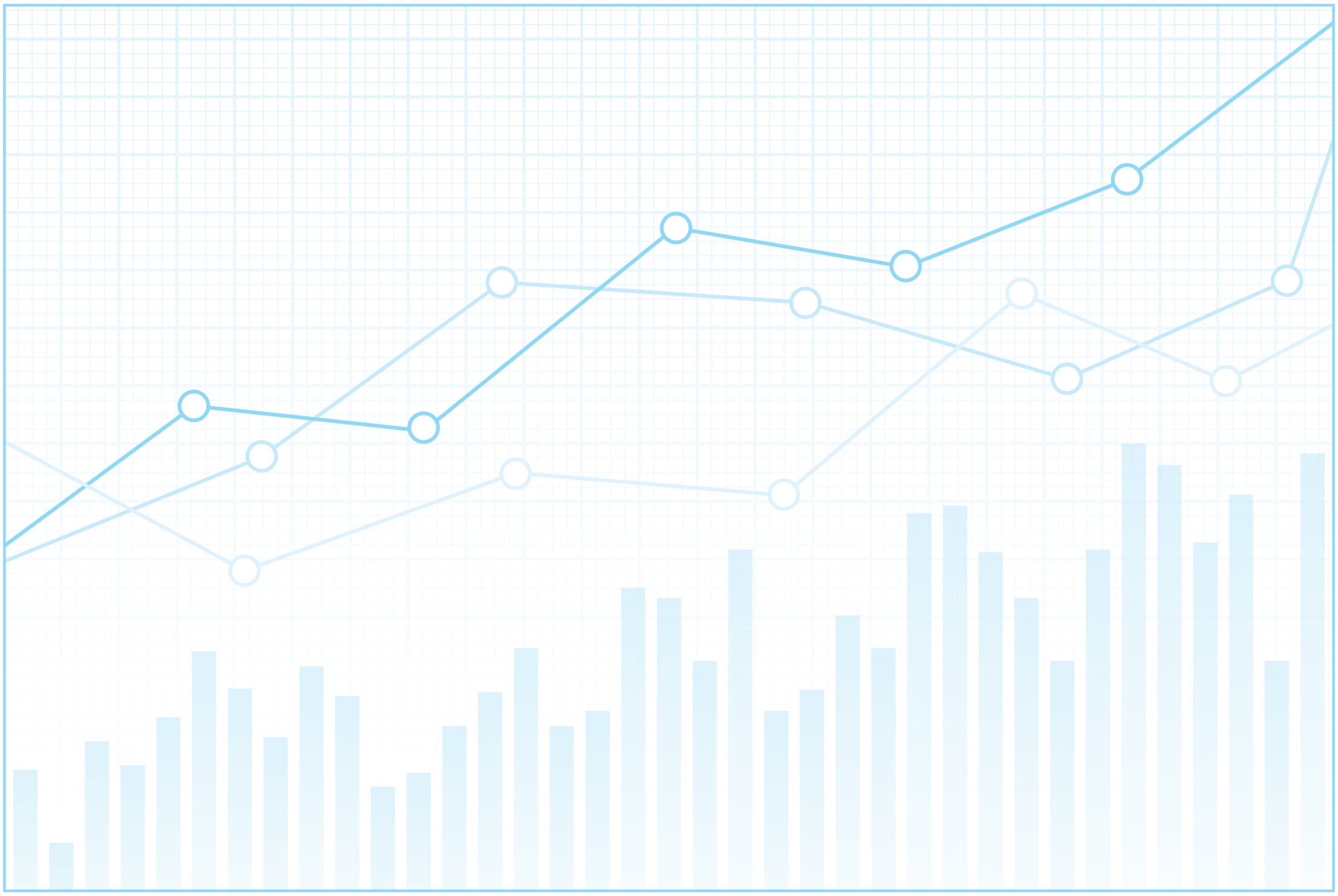

Know the Demographic Trends:

The Findings of a Three-Year Survey on Nitrogen Management and Precision Agriculture Adoption in Southern Idaho

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Nitrogen Fertilizer Use Efficiency and Precision Tools

As all growers understand, nitrogen (N) is a vital soil nutrient, whose maintenance in the soil is key to staying competitive in today's market. Yet keeping it in a cropping system poses a constant challenge. For most systems, N use efficiency is only at about 40%–50% at best (Walsh and Belmont 2015). The N loss is mostly due to runoff, leaching, volatilization, or denitrification and immobilization. Idaho's percentages are similar. Based on University of Idaho research, winter wheat, the key cereal grown in the state, takes up only about 50% of the N that farmers apply as fertilizer (Walsh and Belmont 2015). Furrow-irrigated and drip-irrigated onions grown in Idaho take up only about 40% and 60%, respectively. Consequently, farmers benefit from knowing about and implementing effective N fertilizer management strategies.

For detailed information on nitrogen use efficiency and ways to improve N fertilizer management, please refer to UI Bulletin 899, *Improving Nitrogen-Use Efficiency in Idaho Crop Production*.

Application of Precision Agriculture (PA) methodologies, such as site-specific nutrient management and crop sensors, has the potential to substantially improve fertilizer use efficiency. Yet some Idaho farmers are reluctant to use PA technologies. In order to encourage its adoption, agricultural educators and other stakeholders need to understand the current situation regarding agricultural technologies and N management methods, especially growers' attitudes toward them. Our three-year study intends to fill in some of these gaps. Between 2015 and 2017, we conducted a grower survey to gather data on the demographic trends underlying the use and nonuse of high-tech devices and procedures on farms. We targeted a small but diverse group of respondents at Extension outreach events, cropping schools, and field days via email, social media, and online. This publication summarizes the results.

For more information on crop sensors for precision nutrient management, please refer to UI Bulletin 896, *Nitrogen Management in Field Crops with Reference Strips and Crop Sensors*.

Factors Affecting Technology Adoption

In the past, increased production and higher profits were the main drivers of technology adoption in agriculture. More recently, other factors have strongly come into play, including improved quality of agricultural products, sustained competitiveness nationally and internationally, and overall sustainability (economic, agronomic, and environmental). Despite the ability of PA tools and PA-related services to support these latest agricultural goals, many growers nevertheless remain hesitant about implementing them. As past surveys indicate, although about 80% of agricultural dealers claim to sell PA equipment and its related services, only about 20% of growers actively use these tools and services in their farming operations (Blair 2013).

Many other factors affect technology adoption. Researchers have documented the trends, including the effects of a grower's level of education, income, and age; the social networks within which s/he operates; and the size of the farm owned. For example, data collected by researchers from the University of Nebraska, Lincoln, shows that farm size (acreage) particularly indicates whether or not a grower will adopt new technology (Figure 1).

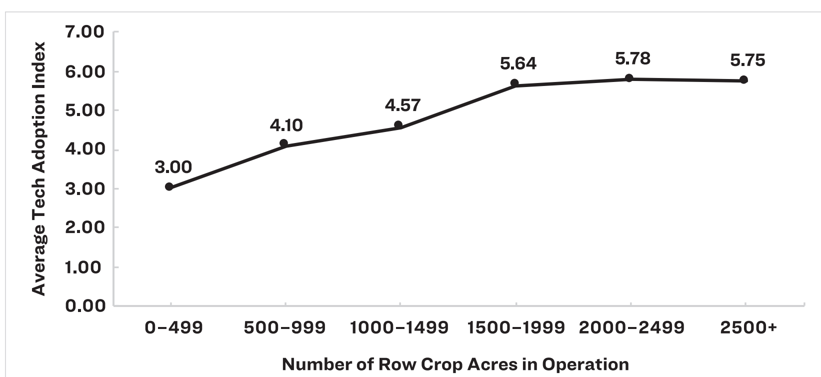

Figure 1. Average technology adoption index as affected by the number of row crop acres in operation (Castle et al. 2016).

Other previous research has identified the same connection, one of them asserting that adopting PA methodologies is more lucrative for farm owners, particularly as farm size increases (Daberkow and McBride 1998). Part of the explanation may be that smaller-farm operators often struggle to justify the expense of investing in new technologies and thus tend not to be as interested in significantly changing their operations, even though it may bring many positive results. Regarding those prospects, a 2016 US Department of Agriculture Economic Research Service (USDA ERS) survey (Schimmelpfennig 2016) found that hired labor costs on smaller farms (140–400 ac) run typically 60%–70% lower when growers use at least one of the following PA technologies: GPS-based mapping systems guidance, auto-steer systems, or variable-rate technology.

But larger-acreage farm owners aren't exempt from cost concerns related to PA adoption. The technology can actually increase expenses, particularly those incurred from hiring information management and field operation specialists. Despite the extra labor expense, however, more and more larger-acreage growers are using these technologies. Indeed, the amount of data generated by the average farm per day continues to increase, particularly from very large farms, justifying the need to pay highly skilled specialists to collect and analyze the data (Meola 2016).

Technology Adoption in Idaho Agriculture

To put the adoption-rate trends into further perspective, consider the effect of farm size and farmer age. Figure 2 shows that 55% of Idaho farms are 50 ac or less (USDA-NASS 2017), suggesting less enthusiasm for technology adoption in the state. The fact that small farms still predominate Idaho agriculture may explain the relatively low PA adoption rates—those in southern Idaho in particular, where most farms are smaller as compared to those in the northern part of the state.

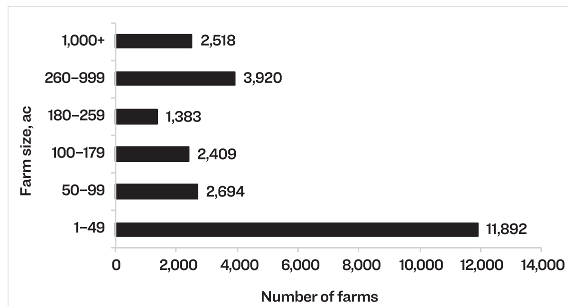

Figure 2. Idaho farms by size, based on the 2012 Census. Adapted from USDA-NASS 2017.

Age also likely affects the probability of technology adoption by Idaho farmers. As Castle et al. discovered in a Nebraska study (see Figure 3), there is a correlation between younger producers and a greater use of technology compared to more mature farmers. The study further confirms some of Daberkow and McBride's cogent 1988 assessment of socioeconomic profiles of early adopters of PA in the corn-growing sector, where they argue that profitability of adoption is much higher when farm operators are younger than 50 years of age.

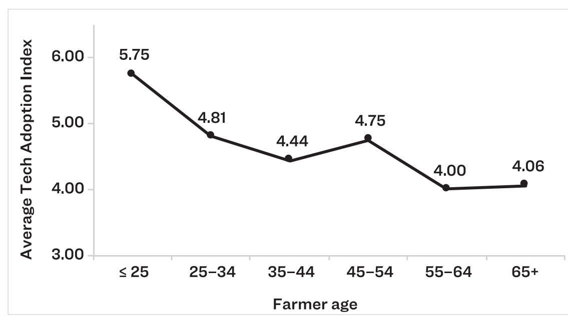

Figure 3. Average technology adoption index as affected by a farmer's age. Source: Castle et al. 2016.

In Idaho, with 50% of Idaho farmers 55 years and older (Figure 4), it's not too much of a risk to infer the effect on technology adoption. Using newer technology usually requires substantial change, something older generations often find undesirable. Indeed, most mature growers likely prefer to continue to rely on the long-term relationships they've established with local fertilizer dealers and crop advisors, along with nutrient management strategies they implemented a long time ago. This type of response resembles the common reluctance of some producers to adopt newly developed crop varieties: these

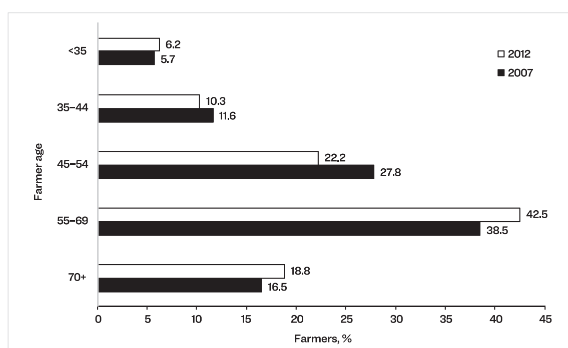

Figure 4. Idaho farm operators by age, 2007 (black bars) and 2012 (white bars). Adapted from USDA-NASS 2017.

varieties may be more high yielding and have superior disease resistance, but some growers nevertheless still prefer growing older "traditional" varieties because they value familiarity and predictability.

Yet other factors in combination with age may be in play, like the fact that farming is not the primary occupation of 50% of Idaho farmers (Figure 5). Consequently, their attention often shifts to other industries.

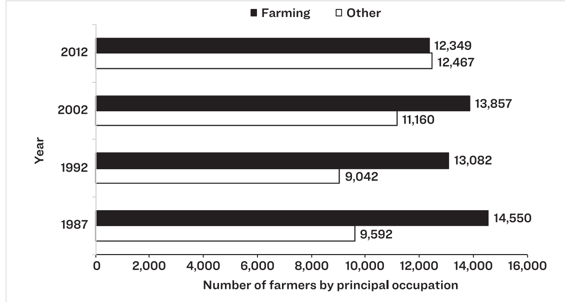

Figure 5. Idaho operators by principal occupation for selected years for 1987–2012 Censuses. Adapted from USDA-NASS 2017.

Agricultural Stockholder Survey Structure

Informed by this background scholarship and knowledgeable of its shortcomings, the Cropping Systems Agronomy, University of Idaho Parma Research and Extension Center carried out a survey in 2015–17 to assess agricultural producers' approach to N fertilizer management and their attitude to PA in southern Idaho. The responses to the eleven questions related to N fertilizer management and PA technologies were collected anonymously at grower meetings, cropping schools, commodity-specific events, PA workshops, agriculture technology fairs, and field days. In addition, an online survey campaign collected responses via commodity groups and grower-focused listservs; and a web-based campaign utilized social media via the Cropping Systems Twitter (Twitter Inc, San Francisco, California) account and a Cropping Systems website, which funneled responders to our online survey (powered by the Cloud-based software, Survey Monkey, www.surveymonkey.com, San Mateo, California) (Table 1). We recognize that we have sampled a relatively small number of stakeholders in Idaho's Treasure Valley; however, the results may reveal general regional trends.

Table 1. Survey activities by method, year, and the number of responders.

Activity	Year	Number of responders
Survey Monkey*	2015–2017	39
Cereal Field Day	2015	33
Cropping School	2016	19
Precision Planting Seminar	2016	25
Field Day	2016	15
Grower Seminar	2017	26
Total		157

*Responses obtained from Twitter and the website combined.

Agricultural Stockholder Survey Results

From a total of 157 participants, the majority identified themselves primarily as growers (Figure 6). Industry representatives and crop consultants (21.1% combined) indicated they were also growers but considered farming their secondary occupation.

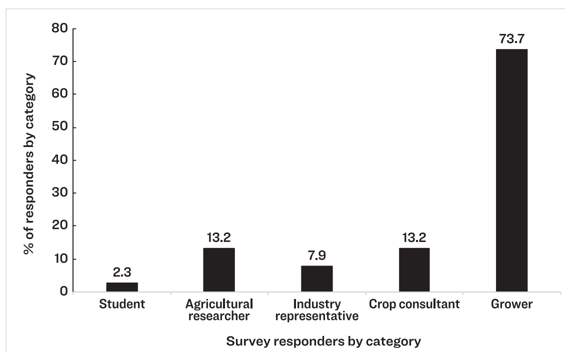

Figure 6. Job categories of stakeholders participating in the survey, 2015–17.

Over 50% of the respondents listed N fertilizer as the costliest input, followed by equipment and labor both at 21.1%. Other inputs (2.6%) included fuel and other chemicals (pesticides/herbicides) (Figure 7).

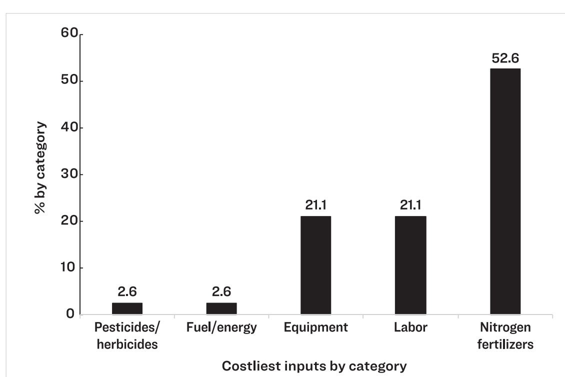

Figure 7. Responses to "What is the costliest input in your farming operation?" question, 2015–17.

One hundred percent of the respondents indicated that they could improve their N management (Question 4); also, 100% stated they consider their fields nonuniform and that their crop yield and quality vary from year to year (Question 5).

A little over half of the stakeholders (55.3%) indicated that they are aware of PA research conducted in Idaho. These stakeholders represent those interested in new ideas and who look for information relative to agricultural technologies. Furthermore, approximately half (54.10%) of the respondents also stated they are aware of crop sensors for N management.

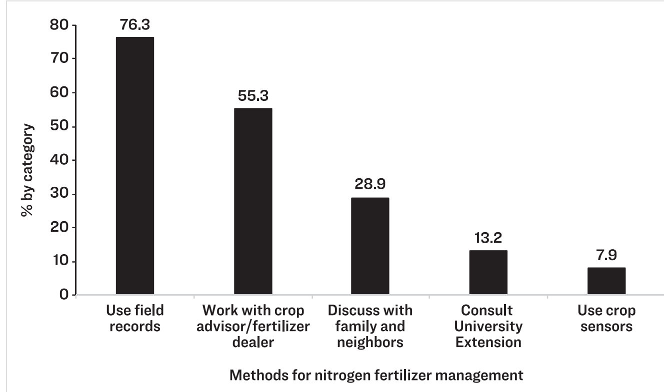

Figure 8. Responses to "How do you manage your nitrogen?" question, 2015–17.

The survey shows that the majority of stakeholders make N fertilizer management decisions by consulting with crop advisors (55.3%) and by discussing them with family and neighbors (28.9%). Almost 80% of stakeholders stated they use their field records as the basis for managing their N applications (Figure 8). Using a traditional method (a field record only) often results in nonuniform fields and yield-potential loss.

Applying fertilizer based on crop need and increased crop-yield quality were listed by most stakeholders as the two most important factors for changing N management. Almost all responders (97.4%) said they change their N management from field to field. This indicates that the majority of growers recognize the importance of addressing field-to-field spatial variation in growing conditions, depending on many factors like soil type and texture, residual nutrients amounts, crop grown, and crop rotation used. Further, 92.10% said they vary N application year to year. This response reflects growers' recognition of the importance of temporal variation in field conditions due to factors like temperature and precipitation within a growing season. The results also may indicate some growers' perception that more variability exists between the fields than between years in the same fields. Crop sensors (in combination with traditional methodologies like soil and plant-tissue testing) can estimate midseason N need, allowing growers to address temporal and spatial variability and to make economically informed and agronomically sound N management decisions. Yet despite their understanding that both temporal and spatial variability are considered very important for successful N management, and despite the fact that over 50% of them are aware of crop sensors, only 7.9% of stakeholders stated they currently utilize crop sensors (Figure 8).

Figure 9 suggests that responders' utilization of methodologies and tools has changed from 2015 to 2017. Granted, we did not periodically re-question the same stakeholders throughout our study, but the data sets (47 in 2015 and 42 in 2017) for both years primarily represent agricultural producers from southern Idaho. As expected, more of these growers use GPS and yield monitors compared to other technologies, since the latter were developed several decades ago as complementary technologies (yield monitors produce the data for GPS-based mapping).

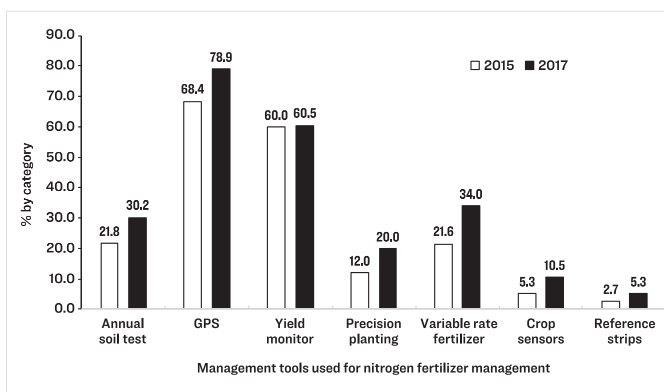

Figure 9. Responses to "Are you using any of these tools in your operation?" question, 2015 and 2017.

Although annual soil sampling is necessary for making sound N management decisions, our preliminary survey (conducted in 2014–15) revealed that only about 25% of growers sample their fields every year. However, further surveillance showed that although the number of growers conducting soil testing annually remained low, that trend was on the rise (from 21.8%

to 30.2% between 2015 and 2017) (Figure 9). Actually, all categories increased from 2015 to 2017, an encouraging development that includes GPS use, precision planting, variable rate fertilizer applications, and even use of crop sensors and reference strips, with yield monitor–use numbers just about holding steady.

Notably, the number of responders using variable rate fertilizer management in their operation is very close to the number of those who soil test their fields annually. This makes sense since soil testing allows testers to account for variability in field conditions and assists in creating management zones.

Although the number of growers claiming to use crop sensors and reference strips in 2015 and 2017 are very low, the positive trend for both methodologies is notable (Figure 9).

Lastly, a 2016 USDA ERS survey found that traditional, non-GPS-based soil testing for nutrient deficiencies tends to encourage the adoption of PA tools like GPS soil and yield mapping and automated guidance and variable rate technologies.

Clearly, more Extension outreach and communication is needed to improve the research effort on PA technologies' use in the state. Innovations are knowledge intensive. Their competent application and use require focused education and training, especially given that lack of confidence using computers and their software is a key concern for older farmers. Applied studies and demonstrations are also necessary to improve crop sensors' adoption specifically and PA tools overall. With the majority of current and newly hired University of Idaho specialists assigned to split appointments, including a large portion of Extension educators committed to research and/or teaching duties, it seems like Extension offers a very prolific and effective resource for this kind of outreach and advocacy. However, with only 13.2% of respondents stating that they use Extension as a source of information for fertilizer management (Figure 8), it is clear that Extension methodology needs modification to better address stakeholders' needs, to reach the appropriate clientele groups, and to provide either with more relevant, applied information so that they can readily integrate the new technology into their farming operations. Because many growers also work as agricultural industry representatives and crop advisors, and/or work closely with crop consultants to develop their N management strategies, Extension needs to shift more of its attention to crop advisors and the fertilizer industry.

Summary

N fertilizer remains the costliest input for most growers; applying fertilizer based on crop need and increased crop-yield quality are the most important factors considered by growers when making N management decisions. Crop advisors and fertilizer dealers continue to be an important source of decision-making information for most growers. Relatively low adoption of PA methodologies in southern Idaho may be associated with predominantly smaller farm sizes, the mature age of most farm operators, and the fact that many farm operators combine farming with other professional activities to support their households. Virtually all growers recognize the presence of spatial and temporal variability and its importance for their sustainability. There is a positive trend in terms of adoption of both traditional soil testing and PA technologies. This may be explained by growers' increased interest in various technologies overall as well as Extension outreach efforts to make PA-related information available to growers. More educational efforts should be focused towards not only growers but also crop advisors and industry representatives such as seed, chemical, and fertilizer dealers. These kinds of strategies should increase growers' understanding of soil testing and precision nutrient management, thus advancing the adoption of PA technologies in the future.

Further Reading

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