eFields – An On-farm Research Network to Inform Farm Recommendations

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Abstract. *On-farm research has been traditionally used to provide local, field-scale information about agronomic practices. Farmers tend to have more confidence in on-farm research results because they are perceived to be more relevant to their farm operations compared to small plot research results. In recent years, more farmers have been conducting on-farm studies to help evaluate practices and input decisions. Recent advances in precision agriculture technologies have stream-lined the on-farm research process, allowing data to be collected and analyzed on a sub-field level. By aggregating this data into large on-farm research datasets, it can be used to mine valuable agronomic information regardless of productivity level variations in the field. Challenges exist when determining what data should be collected and how it is aggregated, managed, analyzed, and shared. However, once standardized, this data could be used to create or improve current decision-making tools and processes.*

eFields is an on-farm research network that focuses on building local knowledge for Ohio producers. In 2017, two standardized research protocols were replicated at 22 locations across 11 counties in Ohio. Yield data collected from these locations were combined with site-specific information about agronomic management practices and publicly available data layers in order to classify the results by potential yield influencing factors. This pilot study made it possible to explore the amount, types, and quality of data that is necessary to accurately aggregate on-farm research results. Timely recording of field and crop notes is often overlooked in-season; this makes the accurate classification of results more challenging. This year's testing provided insight on the need for data collection and management strategies that optimize the transfer and sharing of agronomic data. Inconsistencies in technology adoption and understanding from farm-to-farm resulted in the need for personal contact to obtain data manually. Looking forward, a strategy for the 2018 season has been developed to improve the collection, aggregation, analysis, and reporting of future results.

Keywords. *On-farm research, data collection, yield data, farm management.*

Introduction

A primary purpose of agronomic research is to guide management recommendations and precision agriculture is increasing the potential to gain more valuable insights from increased data collection (Bullock and Bullock 2000). Traditionally, much of the agronomic research is conducted as small plot research at experiment stations (Rzewnicki 1991). The results from these small plots are then used to generate crop management recommendations. In a survey of Nebraska and Iowa farmers, Rzewnicki (1991) observed that approximately 75% of respondents felt that on-farm research was a valuable component of the university research process. They also heavily weighed the proximity of the trial to their farm when determining how relevant the results are to their operations, with 59% responding they consider distance “always” or “most of the time.” On-farm research has been shown to increase benefits beyond increasing the perception of relevance of research results. Engaging farmers in the ideation, design, and execution of on-farm research trials has been shown to provide benefits to both farmers and researchers including more qualitative evaluation of technology and better prioritization of farmer’s needs (Ashby 1986; Ashby 1987).

eFields, an on-farm research network, was developed to facilitate collaborative and participatory research between Ohio State University researchers, Extension professionals, farmers, and industry partners. In 2017, twenty-two trials were conducted using two standardized protocols designed to investigate the yield response of corn and soybean to seeding rate. The goals of this pilot study were to 1) identify challenges to collecting accurate data, 2) determine the feasibility of collecting and aggregating field scale research data, and 3) develop a communication strategy to maximize the reach and impact of the research results.

Methods

Data Collection

Two standardized protocols were used to conduct nine corn seeding rate trials and thirteen soybean seeding rate trials. Field information was collected for individual locations by providing an Excel worksheet to Extension Educators and cooperating farmers. Yield data were gathered using a calibrated yield monitor when available. Weigh wagons were used to estimate plot yields when yield monitors were not available. This data was collected through direct contact with each cooperating farmer. Yield files were transferred manually using flash drives or through cloud based file sharing services like Box.com. Extension Educators and cooperating farmers were strongly encouraged to utilize Ohio State University Precision Led On-farm Trial Support (OSU PLOTS) App, a mobile application that aids in conducting on-farm research trials by streamlining the collection of field data and observations. Weather data was collected and summarized at the county level using the Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS), which is sponsored by the National Oceanic and Atmospheric Association as well as the National Science Foundation. This network of weather reporting provides a weather source of accurate information from trained network participants that is in close proximity to the study location.

Data Aggregation

ArcMap 10.2.2 was used to isolate plot data from each spatial yield file. Plot replication and treatment were appended to the attribute data. The data was exported as comma separated text files using the Export Feature Attribute to ASCII tool and them renamed with a .csv file extension. An Excel file was created that included data from all plots including yield, seeding rate, planting date, and harvest date.

Weather data were also aggregated for each site and combined with the field operations timeline for each study in order to depict an accurate picture of the growing season faced by each crop.

Data Analysis

The OSU PLOTS App was used for the basic statistical analysis of the individual trials. This tool uses Randomized Complete Block Design (RCBD) to analyze the data. In RCBD, treatments are assigned at random to different blocks or replications. The app allocates treatments randomly to different blocks/replications, generates Analysis of Variance (ANOVA) table, computes F test, Student's T test, Coefficient of Variation (CV), and Least Significant Difference (LSD) test for comparing means of different treatments. F test and LSD are computed at the probability level of 0.1 (alpha=0.1).

SAS 9.3 was used to make comparisons of yield across several different potential yield-impacting factors such as seeding rate treatment, location, and planting date.

Results and Discussion

Individual Studies

The data collected from each trial location is shown in Table 1. It is notable that data that relies heavily on technology for collection and transfer has the lowest rates of successful collection. For example, spatial yield data was only successfully captured from 10 of 22 locations. This points to a need for more streamlined data collection methods and better training for Educators who will be tasked with assisting cooperating farmers with submitting these types of data. In-season information also presented a challenge for collection (i.e., stand counts and pesticide applications).

Table 1. Types of data collected for individual trial locations and the success rates of collecting that data type.

Type of Data	Number of Locations Submitted	Success Rate (%)
Plot Yield Averages	22	100
Spatial Yield Data	10	45
Stand Counts	14	64
Planting and Harvest Dates	22	100
Variety	22	100
Soil Type	22	100
Tillage	22	100
Row Spacing	22	100
Previous Crop	22	100
Pesticide Applications	9	41

Results were reported for each individual location. Table 2 shows the results of a trial located in Darke Co. At this location, a significant yield response was observed, with seeding rates of 30,000 seeds/ac or higher outperforming lower seeding rates. Average plant stand was 88% of the target seeding rate at this location.

Table 2. Results of Darke Co., Ohio corn seeding rate trial. Treatment means with the same letter are not significantly difference according to Fisher's Protected Least Significant Differences (LSD) test at alpha=0.1.

Treatments (sds/ac)	Average Emergence (plants/ac)	Moisture (%)	Yield (bu/ac)
22,000	20,250	19.9	199 a
26,000	23,666	19.8	201 a
30,000	24,166	20.2	206 b

34,000	28,750	20.2	206 b
38,000	35,083	20.3	209 b
			LSD = 5.24
			CV = 1.73%

A significant yield response to seeding rate was observed at 6 of the 9 corn trial locations and 5 of the 13 soybean trial locations. Average corn stands were 92% of the target seeding rate across all sites with individual locations ranging from 84% to 98%. For the soybean trials, the average stands were 87% of the target seeding rate with individual sites ranging from 78% to 98%.

Aggregated Study Results

The largest contributor to yield differences in these trials was location, especially in the soybean trials. Figures 1 and 2 show the plot yields by treatment across locations for corn and soybean trials, respectively.

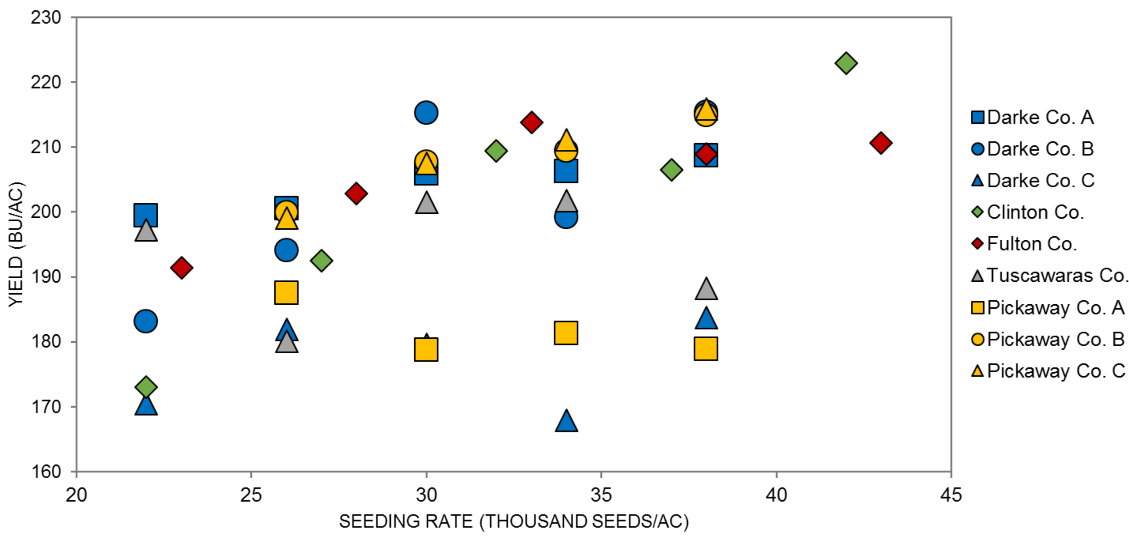


Figure 1. Corn yields by seeding rate and location. Each color represents a county and differing shapes delineate individual locations within a county.

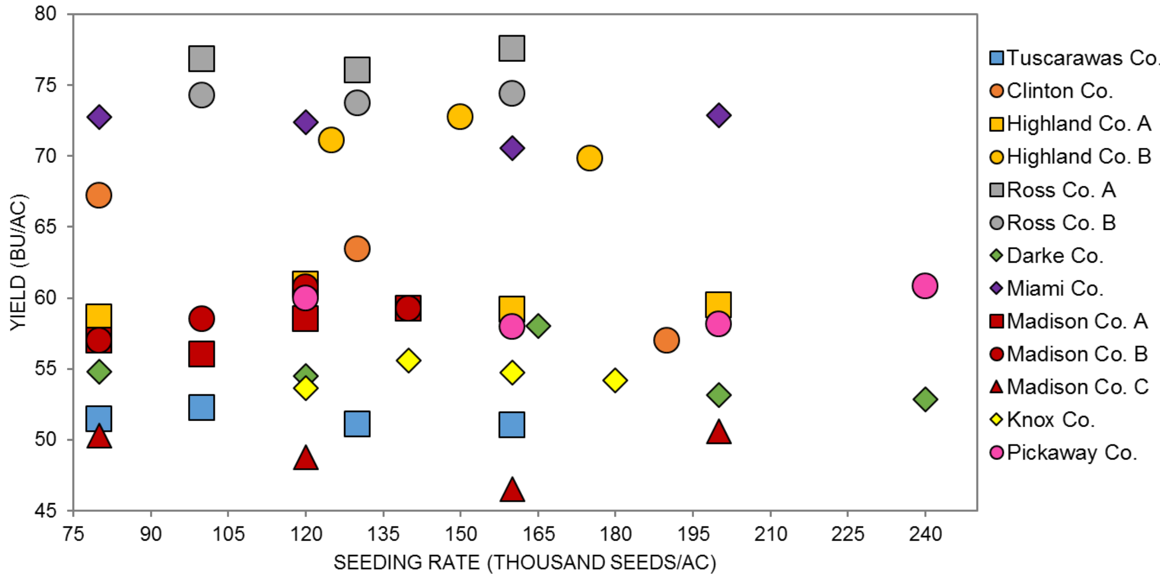


Figure 2. Soybean yields by seeding rate and location. Each color represents a county and differing shapes delineate individual locations within a county.

Figure 3 shows the yield response to seeding rate across all of the corn trial locations. The large variation between locations made it difficult to observe statistical differences in yield response to seeding rate treatments. However, trend shows an increase in yield as seeding rates increased. This result is expected, as 2017 was a year where few environmental yield-limiting factors were observed.

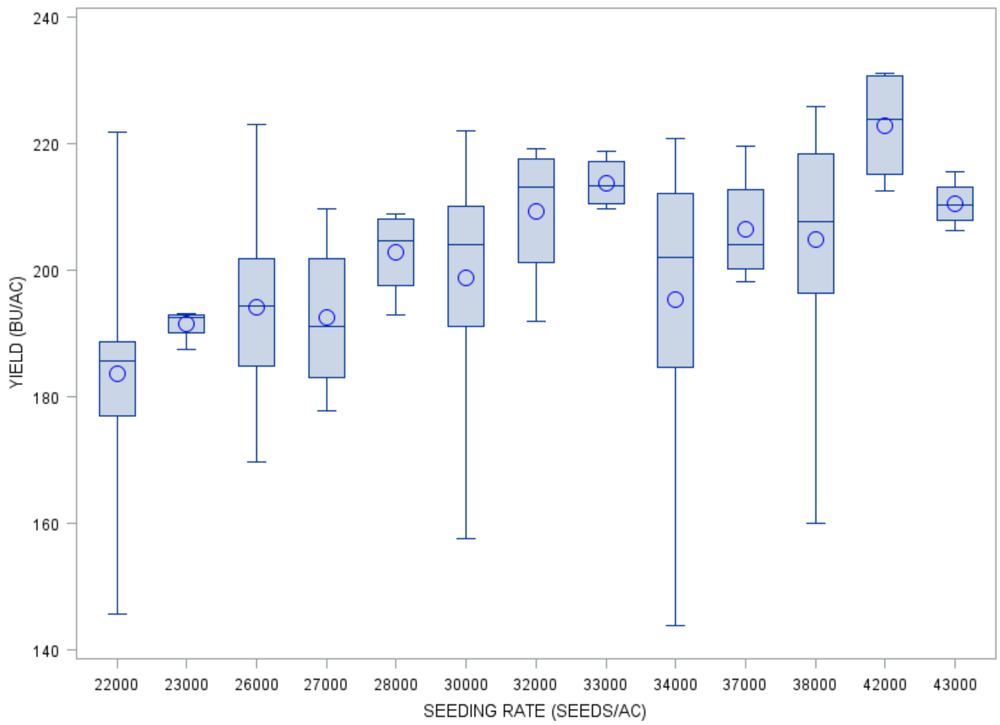


Figure 3. Distribution of corn yield by seeding rate treatment aggregated over nine trial locations.

Figure 4 shows the yield response to planting date of the 30,000 seeds/acre treatment. Results show a major yield penalty for planting on April 18, 2017. This response likely occurred due to the cold front that passed through the area shortly after this location was planted. The rest of the locations show the expected decrease in yield as planting was delayed. A similar trend was observed at other seeding rates treatments.

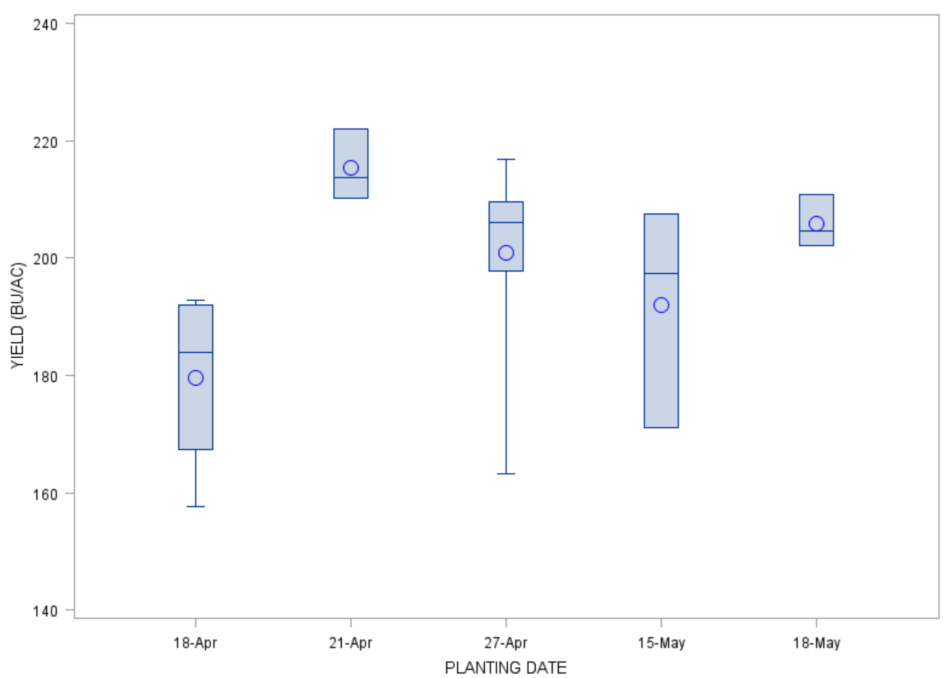
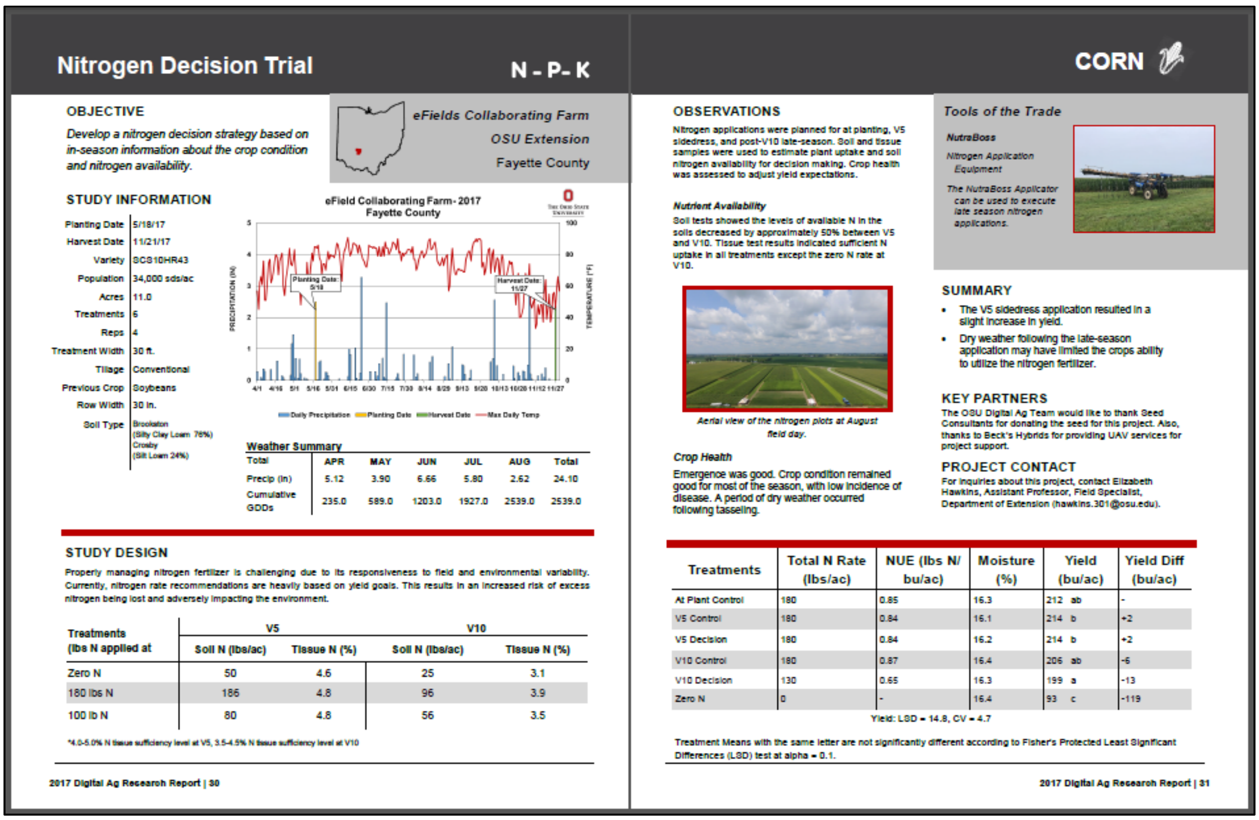


Figure 4. Distribution of corn yield by planting date at a seeding rate of 30,000 seeds/ac aggregated over locations with this seeding rate treatment.

eFields Communication Template

In order to inform on–farm agronomic decisions, timely and effective communication of these results is critical to the eFields approach. Data was collected and analyzed in December and the final report was published in early January. In order to effectively communicate the results to farmers and their advisors, the eFields communication template was developed. Figure 5 shows an example layout for a trial report in the 2017 eFields Research Report. The county where the trial was conducted is named on each study and highlighted on a map of Ohio. This makes it possible for readers to easily assess the proximity of the trial to their own farm to determine how relevant they perceive the results. Each trial report also provides detailed information about the field and management history. Details about in-season management are provided including tillage and pesticide applications. Weather conditions recorded at the county level are summarized graphically and in a table. Cumulative growing degree days and monthly rainfall are reported in the table and daily accumulations are reported in the graph. This trial information can be used by readers to gauge the similarities between the trial conditions and their own. Informative graphics, concise conclusions, and clear results tables improve readability and help readers maximize the information they take away from each trial summary.



Nitrogen Decision Trial

N - P- K

OBJECTIVE

Develop a nitrogen decision strategy based on in-season information about the crop condition and nitrogen availability.

eFields Collaborating Farm

OSU Extension

Fayette County

STUDY INFORMATION

Planting Date	5/18/17
Harvest Date	11/21/17
Variety	SCS10HR43
Population	34,000 sds/ac
Acres	11.0
Treatments	6
Reps	4
Treatment Width	30 ft.
Tillage	Conventional
Previous Crop	Soybeans
Row Width	30 in.
Soil Type	Brookston (Silty Clay Loam 76%) Crosby (Silt Loam 24%)

Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	5.12	3.90	6.66	5.80	2.62	24.10
Cumulative GDDs	235.0	589.0	1203.0	1927.0	2539.0	2539.0

STUDY DESIGN

Properly managing nitrogen fertilizer is challenging due to its responsiveness to field and environmental variability. Currently, nitrogen rate recommendations are heavily based on yield goals. This results in an increased risk of excess nitrogen being lost and adversely impacting the environment.

Treatments (lbs N applied at	V5		V10	
	Soil N (lbs/ac)	Tissue N (%)	Soil N (lbs/ac)	Tissue N (%)
Zero N	50	4.6	25	3.1
180 lbs N	186	4.8	96	3.9
100 lb N	80	4.8	56	3.5

*4.0-5.0% N tissue sufficiency level at V5, 3.5-4.5% N tissue sufficiency level at V10

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CORN

OBSERVATIONS

Nitrogen applications were planned for at planting, V5 sidedress, and post-V10 late-season. Soil and tissue samples were used to estimate plant uptake and soil nitrogen availability for decision making. Crop health was assessed to adjust yield expectations.

Nutrient Availability

Soil tests showed the levels of available N in the soils decreased by approximately 50% between V5 and V10. Tissue test results indicated sufficient N uptake in all treatments except the zero N rate at V10.

Aerial view of the nitrogen plots at August field day.

Crop Health

Emergence was good. Crop condition remained good for most of the season, with low incidence of disease. A period of dry weather occurred following tasseling.

Tools of the Trade

NutraBoss

Nitrogen Application Equipment

The NutraBoss Applicator can be used to execute late season nitrogen applications.

SUMMARY

- The V5 sidedress application resulted in a slight increase in yield.
- Dry weather following the late-season application may have limited the crops ability to utilize the nitrogen fertilizer.

KEY PARTNERS

The OSU Digital Ag Team would like to thank Seed Consultants for donating the seed for this project. Also, thanks to Beck's Hybrids for providing UAV services for project support.

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments	Total N Rate (lbs/ac)	NUE (lbs N/ bu/ac)	Moisture (%)	Yield (bu/ac)	Yield Diff (bu/ac)
At Plant Control	180	0.85	16.3	212 ab	-
V5 Control	180	0.84	16.1	214 b	+2
V5 Decision	180	0.84	16.2	214 b	+2
V10 Control	180	0.87	16.4	206 ab	-6
V10 Decision	130	0.65	16.3	199 a	-13
Zero N	0	-	16.4	93 c	-119

Yield: LSD = 14.8, CV = 4.7

Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

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Figure 5. Example layout for eFields research report.

The report was made available both electronically and in print and was distributed to farmers, crop consultants, and industry professionals at traditional Extension events, industry meetings, and via social media platforms including Facebook and Twitter. As of May 2018, the 2017 eFields Research Report has been viewed by over 7,000 people through both the print and e-version.

Conclusion

The 2017 pilot season allowed OSU researchers to identify data that could be collected to improve the utility of on-farm research projects. Data that describes the field variability, management practices, and environmental conditions can be captured and used to mine insights from on-farm yield results. This ability will be broadened as more locations are added in future years. Two main challenges were identified when attempting to collect this data: 1) technology challenges with collecting and transferring as-applied and yield monitor data, and 2) inconsistent record keeping leading to missing data at the end of season. In order to help address these challenges, new strategies have been developed for the 2018 season. A pre-harvest data workshop is being planned for August 2018 to help Extension Educators learn more about the fundamentals of collecting, storing, and transferring yield data files. This workshop will also be open to cooperating farmers. In order to more effectively capture in-season data, Qualtrics surveys have been created to capture information at key time points during the season. The first survey is sent to cooperating farmers June 1 and captures field and management information, as well as planting data. The second survey is sent in August and captures scouting data, in-season observations, and pesticide application information. The final survey is sent in November and captures yield information and final observations. This approach will make it easier for farmers to deliver information. Spacing out the data delivery also reduces the amount of analytics that must occur after harvest, reducing pressure on the timeline to deliver the final report.

Acknowledgements

Thank you to our eFields partners for their contributions to this effort.

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