Northeast S.A.R.E
Farmer/Grower Grant
Grass Roots Grant

An Economic Analysis of Precision Agriculture on Pastureland in Monroe County, WV

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Final Report
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S.A.R.E.
Final Report
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Section 1
Final Report Narrative

1)Project Name & Contact Information

An Economic Analysis of Precision Agriculture on Pastureland in Monroe County, WV.

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2) Goal(s)

The goal of the project was evaluate precision agriculture on pastureland, and to compare the economic data as to the projected expenditures to the conventional method of soil sampling.

3) Farm Profile

I am presently a part-time farmer operating in and near Union, WV. My family farm consists of three tracts of land totaling 477 grazable acres, and another 65 acres of cropland, with an addition of 40 cropable acres rented. The cropland is used primarily for making hay, with the exception of specialty crops grown, which are used for rotational cropping. This allows us to produce a crop such as sweet corn, pumpkins, or gourds, which can be sold out of the field and helps to eliminate the need for costly corn equipment needed for rotations, as well as increasing the diversity of the farm.

I have been managing the family farm since my return from college in 1996. I graduated from West Virginia University in May of 1996, and was employed by WVU Extension in December of 1996. While working with WVU Extension I was the Program Coordinator of the Greenbrier Valley Crop Management Services Program. Major responsibilities of the program were: integrated crop management programs, water quality issues, educational programming, and the induction of a precision farming program on cropland within the Greenbrier Valley. In December of 2000 I completed my Masters Degree in Agriculture from WVU, while continuing to work for WVU Extension. In May of 2001 I was employed by the West Virginia Conservation Agency as a grassland technician. In this role I worked closely with producers on their management of grassland within the Greenbrier Valley. I was mainly responsible for working with producers to develop grazing plans, adoption of new grazing techniques, and educational programming. In February of 2004 I began a new position with the WVU Extension Service as the extension agent in my home county of Monroe.

My current responsibilities are agriculture and natural resources as well as youth agriculture. Some areas that my work is concentrated in are livestock production and marketing, nutrient management, enhancement of forages and grazing systems, as well as training 4-H judging teams and working with 4-H agricultural projects.

My wife and I have recently purchased an additional 123.5 acres of farmland bordering one of my father's existing farms. This "new" farm consists of 103.5 acres of pastureland and 20 acres of crop ground, which is hayed then utilized for extended grazing in December and January. The farm currently is divided in four grazing boundaries with additional cross fencing to be built this year. Permanent water facilities are present in each boundary of the 123.5 acre tract. Our pastures consist mainly of Tall Fescue, Orchard Grass, Bluegrass, Red Clover, and White Clover. Out topography is rolling hills with some steep slopes exceeding twenty percent.

We are currently breeding fifty cows on this tract, and hope to run an additional ten cows by spring of 2006. This will bring the total number of brood cows to one hundred sixty head. Ninety of the total one hundred fifty cows are registered Angus cattle. The bull calves are placed on a performance testing feed program between October and March, and are marketed in March at our performance tested sale. Approximately thirty five to forty bulls, along with fifty replacement quality heifers are sold each year.

During the past three years as a producer, and an extension educator I see a need to increase the awareness and promotion of grazing systems. During the last three summers it has been extremely difficult to make quality hay for winter feeding, due to the amount of precipitation we have been getting in our area. Locally the majority of our first cutting hay has been less then 10% crude protein and less then 54% TDN. This same weather pattern has also continued throughout the winter months. The high amount of precipitation has made it difficult to feed, and also causes a tremendous amount of damage to our pastures and feeding areas, causing many producers to have to reseed pastures during the spring, which is costly and labor intensive. For these reasons, as well as being more cost effective, the increasing of our number of grazable days throughout the year needs to be a priority. To be able to improve our grazable days we must first concentrate of soil fertility.

Precision agriculture has been used in out area on a limited basis, but only on crop fields. Because of our relatively small crop fields, which are an average of seven acres, there normally is very little variation in soil fertility. In order for precision agriculture to be an economically effective method of sampling and nutrient application there must be more variation in fertility within a specific field. By using precision agriculture on pastures we expect to see more variation in fertility, due mainly to our topography. In addition, we acknowledge pastures can be our "high value crop," if managed properly.

By using precision agriculture on pasture we can make our pastures more productive, while potentially decreasing lime and fertilizer inputs.

4) Participants

The technical advisor for the project was Tim Fullen. Tim is a local crop consultant who primarily concentrates on pasture management. Tim provides precision agriculture technology, soil sampling, nutrient application, as well as weed control on pastures to local producers. Tim's role in the project was precision and conventional soil sampling, mapping, data analysis, and nutrient application.

Lee Godbey and Dewey Broyles, Natural Resources Conservation Service employees, aided in the outreach portion of the project by allowed me to present information on precision agriculture at a state wide grassland technician training program. This was an excellent opportunity to present the program considering all of the grassland technicians throughout West Virginia were present for this training. This allowed for information to be presented to all individuals from all fourteen conservation districts within the state.

Brian Sparks, an extension agent in a neighboring county, also allowed me to present a program on precision agriculture during a grassland field day, where in there were seventy five producers in attendance.

Educational brochures concerning soil sampling and precision agriculture were provided during both programs.

5) Materials and Methods

The initial soil samples of the project were taken on April 12, 2004. Using the precision method, forty-seven samples, representing 68.32 acres were sampled. Also on April 12, the same 68.32 acres that had been previously sampled using the precision method was conventionally sampled, by dividing the acreage into four separate fields based on topography. Fields one and two had a total of 41.77 acres, while fields three and four represented 33.69 acres for a total of 75.46 acres. In fields three and four there were 7.14 acres that were not spread-able due to woodland, and this acreage was eliminated from the total acreage. Once the fifty one samples were dried and prepared they were mailed to A & L Labs for analysis. Results were returned and fertilizer was applied on April 20' 2004 via variable rate spreading. During spreading 14,700 lbs. of DAP (18-46-0) and 9,700 lbs. of potash (0-0-60) was to 68.32 acres. Rates of P205 application ranged from 109 lbs./acre to 240 lbs./acre with a mean of 193.8 lbs./acre. (See 0-46-0 rx map) Rates of K20 ranged from 0 lbs. / acre to 275 lbs. / acre, with an average of 127 lbs. / acre (See 0-0-60 rx map). Lime was not applied, due to soil sample recommendations. Fertilizer recommendations via the conventional method were completed by averaging the soil sample recommendations on fields 1 and 2, then by averaging the recommendations on fields 3 & 4. For example, field 1 required 85 lbs. of P205 per acre while field 2 required 80 lbs. per acre bringing the average to 83 lbs. / acre, which would have been applied to both fields 1 & 2.

The second set of samples was taken on January 27, 2005 via the precision method. Soil samples were taken on the same sample point locations as previous precision samples. There were 47 samples taken, representing the same 68.32 acres. The reasoning concerning the second set of samples was to determine the reliability and consistency of the soil sample data from 2004 to 2005.

In the middle of November the data was analyzed to complete a cost comparison between the conventional method of soil sampling and the precision method of sampling.

6) Outcomes and Conclusions

Comparisons of the precision method and the conventional method had several attributes to observe. When observing the pH and lime requirements from the conventional standpoint during the 2004 sampling pH's ranged from 6.2 to 6.6 and no lime was required, from the precision analysis pH's ranged from 6.1-7.0, with an average of 6.5. In 2005 precision data pH's ranged from 5.9-6.8 with an average of 6.3. From the 2004 precision sampling 55.8 acres, which was 73.6% of the sampled area, required 0 lbs. of lime. 8.8 acres, (11.7%), required 525 lbs. per acre. 7.03 acres, (9.32 %), required 1111 lbs. per acre, 2.01 acres, (2.71 %), required 1215 lbs. per acre, .59 acres, (.78%), required 1420 lbs. per acre, .28 acres, (.37%), required 1625 lbs. per acre, and .19 acres, (.25%), required 1804 lbs. per acre. The lime requirement data from 2005 sampling was as following: 39.6 acres, which was 52.5% of the sampled area, required 0 lbs. of lime per acre, 15.4 acres, (20.4%), required 504 lbs. of lime per acre, 19 acres, (25.3%), required 1000 lbs. per acre, while 1.4 acres, (1.82%), required 1204 lbs. per acre. See table below:

2004 Lime Requirement Data

Amount Recommended (Lbs./Ac.)	Total Acres Needing Application	Percentage of Field
0	55.8	73.6
525	8.8	11.7
1111	7.03	9.32
1215	2.01	2.71
1420	0.59	0.78
1625	0.28	0.37
1804	0.19	0.25

2005 Lime Requirement Data

0	39.6	52.5
504	15.4	20.4
1000	19	25.3
1204	1.4	1.82

Lime was not applied due to the field only needing 9.4 tons from the 2004 sampling recommendations. This value increased in 2005 to 14.3 tons required to treat the entire acreage.

When observing the precision P and K levels it is noticed that requirements are quite high in some areas of the field. When viewing the conventional sample recommendations of P and K the data was quite similar in fields 1-4. Fields 1-2 required 85 lbs. and 80 lbs. of P205, while fields 3 and 4 required 90 lbs. and 95 lbs. of P205 per acre. When tabulating the data and making nutrient recommendations and cost analysis these fields were combined (Fields 1 & 2) and (Fields 3 & 4) based on topography and where they lay within the total 75.46 acre boundary. Field 1 and 2 had 41.77 acres, while fields 3 & 4 had 33.69 acres. The P205 recommendation on fields 1 & 2 required that 3.76 ton of 0-46-0 or 18-46-0 was needed to meet nutrient requirements, which was an expense of $1,146.80, with the fertilizer valued at $330.00 per ton. The P205 recommendation on fields 3 & 4 required that 3.42 ton of 0-46-0 or 18-46-0 was needed to meet nutrient requirements, which was an expense of $ 1043.10, with the fertilizer also valued at $330.00 per ton.

When observing K20 requirements of fields 1 and 2 it was required that 5.01 tons of 0-0-60 be applied, at a cost of $220.00 per ton, totaling 1,102.80, while fields 3 and 4 required that 2.5 tons of 0-0-60 be applied, totaling a dollar value of $550.00.

Spreading fees were set at $ 5.50 per acre, costing $ 415.03, while conventional sampling fees were set at $ 3.00 per acre, which was $226.38, for 75.46 acres.
Total expenses for the conventional method of sampling, nutrient application, P205 and K20 fertilization would have been $ 4,484.12.

When examining the precision agriculture data we see a slight to moderate variation of P & K levels throughout the 75.46 acre boundary. From the 2004 sampling P205 recommendations ranged from 130 lbs. per acre to 240 lbs. per acre, with an average of 194 lbs. per acre. A total of 7.31 ton of 18-46-0 was applied to meet the precision nutrient requirements on the 75.46 acres. The 18-46-0 was valued at $305.00 per ton, totaling $2,226.50.

The K20 requirement had a larger variation throughout the field, ranging from a requirement of 0-275 lbs per acre, with an average of 128 lbs. per acre. 4.81 ton of 0-0-60 was required to meet the sample recommendations on the 75.46 acres. The 0-0-60 was valued at $220.00 per ton, bringing the total to $1,058.20.

2004 Data

Precision Ag P205 Recommendations

Lbs. Per Acre	Acres in Field	Percent of Field
130	0.6	0.79
152	5.95	7.88
174	16.41	21.75
195	35.26	46.73
218	10.99	14.65
240	6.22	8.24

Precision Ag K20 Recommendations

0	12.81	16.99
50	9.74	12.9
67	3.49	4.63
84	2.48	3.29
100	1.73	2.29
117	2.85	3.77
133	3.35	4.44
151	9.63	12.76
183	9.46	12.54
200	6.17	8.18
225	6.51	8.62
250	6.3	8.34
275	0.94	1.24

2005 Data

Precision Ag P205 Recommendations

Lbs. Per Acre	Acres in Field	Percent of Field
130	0.59	0.79
152	5.95	7.88
174	16.58	21.75
195	35.26	46.73
218	10.99	14.56
240	6.22	8.24

Precision Ag K20 Recommendations

0	12.82	16.99
50	9.73	12.9
68	3.49	4.63
75	2.48	3.29
100	1.73	2.29
117	2.85	3.77
133	3.35	4.44
151	9.63	12.75
183	9.46	12.54
201	6.17	8.18
226	6.51	8.62
250	6.3	8.34
276	0.91	1.24

The precision agriculture sampling fee was $8.00 per acre, on 68.32 spread-able acres, totaling $546.00, while a variable rate nutrient application fee of $9.00 per acre totaled $612.00. The precision agriculture fees including sampling, fertilizer, and variable rate application totaled, which $4,443.26. The concept of precision agriculture saved the producer $40.86 over the conventional method of soil sampling.

- See Power Point presentation information provided for summary.

Now that the analysis has been compiled the data is much unexpected. There was concern among the participants in the project that producers may not see an economic benefit with a slight to moderate soil fertility variation as sampled by the conventional method of sampling and compared with the precision agriculture method of sampling. When observing the soil fertility maps there are only slight to moderate variations in soil fertility on this particular farm. The participants once felt the there needed to large variations of soil fertility within a field to make the use of this new technology feasible. The analysis has now shown that the use of precision agriculture technology can be a viable economic benefit for producers who have grasslands as their "high-value crop."

As producers we sometimes question the accuracy of soil sampling. When comparing the soil fertility data and the soil fertility maps of 2004 to 2005, they are **very** consistent. The 2004 0-46-0, and 0-0-60 recommendation maps are almost is identical when compared to the 2005 maps. The soil sample results of the project are provided in Excel form on the next page.

Assessment

When viewing the results of the project many of the prior questions were answered. The participants felt that the use of this technology could be an economic benefit when compared to the conventional method of sampling, but the main concern was; if there is a lack of variation in soil fertility, does this still make the use of precision agriculture on pasture a viable option for producers? By sampling this particular 68.32 acre pasture it was discovered that precision agriculture is a viable option over the conventional method of sampling, and even if there were slight to moderate variations in soil fertility. Due to the positive outcomes of this project participants of the study will continue to use and promote the use of this technology in the area. Economic data will continue be analyzed between the two methods of sampling until there is a substantial amount of acreage with enough data to support the continual use of this technology.

Adoption

After completion of the project the producer will continue to use the precision agriculture technology when soil sampling pastures. The use of precision sampling only saved this producer $40.86 on 68.32 acres when compared to the conventional method of sampling, but the use of the soil fertility maps gives the producer a visual perspective of where the nutrients and lime need to be applied. Once producers can visually relate to the soil fertility maps it brings in a new perspective of understanding of a particular farm's soil fertility and how topography affects soil fertility and nutrient requirements.

Report Summary

The use of precision agriculture has been used in the mid-west for several years. The large vast acreage of the Midwestern farm fields makes the use of precision agriculture a valuable economic and environmental tool to producers who use it. In the Northeast, and more specifically, West Virginia, precision agriculture has not been as widely used, mainly due to the lack of economic benefit, which is a result of the lack of soil fertility variation on our small crop farming fields.

As we proceed through a change in agricultural management we are seeing more dependence on grazing of livestock, and less emphasis on confinement and continuously grazed systems. As we change our management systems our agricultural priorities change. Ten years ago our priorities may be to concentrate our fertility on hay and crop fields to increase tonnage, where as today grazing and decreasing our economic inputs through different aspects of grazing has become more of a precedence. As grazing becomes more of a concern for livestock producers increasing pasture fertility, building pasture division fencing, and developing water resources takes priority to planting corn for silage, or making hay for winter feeding, thus making pasture our "high value," crop in Appalachia.

As producers become more concerned with the productivity of pastures, soil fertility becomes more of a priority. The group members involved with this S.A.R.E Farmer Grower Grant saw an opportunity to utilize the precision agriculture technology resources that were available in the area as a potential economic benefit to producers who solely rely on pastures to graze livestock. Precision agriculture had previously been researched on crop fields, but with little economic benefit to the producer. Group members wanted to research the possibility of using the precision technology on pasture by comparing precision economic data to the conventional method of soil sampling.

On April 12, 2004, forty seven samples were pulled, representing 68.32 acres of pasture via using the precision method of soil sampling. On that same day the same 68.32 acres was divided into four boundaries and sampled via the conventional method of sampling. Once the soil sample data was returned from the lab the data was entered into a data base file to build the soil fertility maps for the precision method of application.

When observing the results there was slight variation in soil fertility using both methods of sampling. Sampling fees, nutrient requirements and application fees, were compared when analyzing the economic data of the two sampling methods. The precision agriculture method saved the producer $ 40.86 over the conventional method of sampling.

Now that the analysis has been compiled the data is much unexpected. There was concern among the participants in the project that producers may not see an economic benefit with a slight to moderate soil fertility variation as sampled by the conventional method of sampling and compared with the precision agriculture method of sampling. When observing the soil fertility maps there were only slight to moderate variations in soil fertility on this particular farm. The participants once felt that there needed to be large variations of soil fertility within a field to make the use of this new technology feasible. The analysis has now shown that the use of precision agriculture technology can be a viable economic benefit for producers who have grasslands as their “high-value crop.”