Yield Monitors for On-Farm Research

by:
Roy Button, Soils and Crops Agrologist
Extension Service
Tisdale Rural Service Centre

Yield monitors and GPS units mounted on combines have the potential to be used by farrners to conduct on-farm research. In 1991 producers spent about $500 million dollars on fertilizer, chemicals and seed in the Province of Saskatchewan. By 1996 that had doubled to 1.1 billion dollars. Many new products and varieties are being marketed each year with limited testing under different soil and climatic conditions. Producers are concerned regarding the economic benefits some of these products and varieties can have on their own farms. Yield monitors and GPS units allow farmers to apply different treatments on their fields and measure the benefits of using different inputs or crop varieties.

Precision farming technology also allows producers to determine yields and vary inputs within fields according to crop requirements. The tools required to get into precision farming is yield monitors on combines, GPS systems and variable rate application equipment. Using yield maps, soil testing, field scouting and product testing farmers can start to develop variable rate application of products that may provide economic returns.

Conducting strip trials or on-farm research can assist farmers in determining how to adjust rates within fields. The initial step in looking at precision farming is to have yield maps and monitor fields to determine variations and develop agronomic research projects to determine how to adjust products and rates.

A group of farmers in northeast Saskatchewan have formed the Northeast Agriculture Research Foundation. The major focus of the Foundation is to conduct research on precision farming to determine if it can be economical on fields in northeast Saskatchewan. Farmers in the Foundation have seven combines that have been mounted with yield monitors and GPS units. They have been using these yields monitors for two years and have developed yield maps on a number of fields on their farms.

The Foundation has a precision farming centre of 155 acres that they obtained from the Melfort Research Station. This site will be used to conduct precision farming projects, however, projects will mainly be conducted using yield monitors on fields managed by producers.. Initially, the Foundation has focused on conducting strip trials utilizing different products on producer fields to determine if yield monitors and GPS units are effective in monitoring yield responses. Trials were conducted in 1996 and 1997 with fungicides on canola and cereal crops. Test strips with three treated and three untreated strips were established in each field. In 1997 three fields were treated with Tilt, two on wheat and one on two different barley varieties. Five fields were treated with fungicides for the control of sclerotinia on canola. Small plots were established in some fields to determine if similar data could be obtained from small plot results.

There was excellent crop growth in early July and good potential for disease problems that could affect crop yields. However, dry conditions occurred during the month of July resulting in very low levels of disease and no detectable responses for spraying fungicides on canola.

The yield monitors were reasonably effective in being able to detect yield responses for Tilt on Harrington Barley. On Vince Walker's farm half a field was seeded to Harrington and the other half to Oxbow Barley. Small plots were established in each of the Harrington and Oxbow fields. Vince sprayed Tilt on both the Hanington and Oxbow Barley and left three test strips untreated in each field. The yield results from these plots are outlined in Table 1 and Table II.

Table 1. Yield in bushels per acre on Tilt treated and untreated strips of Harrington Barley on Walker's Farm at Brooksby.

Tilt at 200 ml/acre on Harrington Barley Yield bu/ac			
Site	**Untreated**	**Tilt**	**Difference**
Rep 1	**54.7**	**61.5**	**6.8**
Rep 2	**52.1**	**65.9**	**13.8**
Rep 3	**55.6**	**66.8**	**11.2**

Table 2. Yields and bushel weights from small plots of Harrington and Oxbow Barley treated with Tilt at 200 ml/acre on Walker's Farm at Brooksby.

Tilt at rate of 200 ml/acre on Harrington and Oxbow Barley			
Variety	**Treatment**	**Yield bu/ac**	**Weight lbs/bu**
Harrington	**Check**	**55.5**	**52.5**
	Tilt	**71.9**	**53.8**
	Difference	**16.4**	**1 . 3**
Oxbow	**Check**	**79.8**	**56.3**
	Tilt	**77.0**	**55.7**
	Difference	**-2.8**	**-0.6**

The yield responses utilizing the yield monitor varied from 6.8 to 13.8 bu with an average yield increase of approximately 12 bu per acre on the Harrington Barley There was no evidence of any yield increases on the Oxbow Barley from the yield maps The . Harrington Barley on the small plots had a yield increase of 16.4 bushels and 1.3 lb./bu increase in bushel weight. Oxbow Barley had no significant differences in yield between the treated and untreated plots.

Small plot and field data showed similar results, however the yield monitor probably would give a better average yield increase over the whole field than what would be obtained from small plots. Strip trials were also applied using micronutrients. Soil tests were conducted on three fields and showed deficiencies in copper and boron. Test strips were established on these fields with foliar copper and foliar boron. Two copper trials were established on wheat and flax and one boron strip on canola. There was no evidence of any yield increases from the application of micronutrients on these crops.

Canola strip trials and pea strip trials were combined using a yield monitor and GPS systems. Yields off these sites were also taken with the weigh wagon. Computer analysis of the yield maps still has to be completed in order to show how accurate the two systems were in determining yields. Preliminary data and yield maps show that the monitors, when properly calibrated, measure yields within 2-5% of weigh wagon yields. Accuracy should improve as acreages increase on test strips.

Lorne Christopherson divided a field into three different varieties of Canola seeding Independence, 45A71 Pursuit Tolerant Canola and Invigor. Table 3 outlines the yield results obtained from this field. Grain from the three varieties were weighed separately and the weights compared to the yield monitor. The yield monitor weights were within 1.5 % of the yields that were obtained from the weights taken by the weigh scale.

Table 3. Yields of canola varieties and accuracy of yield monitor on Lorne Christopherson's farm at Weldon.

Yield Monitor Accuracy

	Canola Varieties		
	Independence	**45A71**	**Invigor**
Field Size (ac)	78.1	38.1	21.7
Moisture %	8.2	10.1	8.8
Total Dry Bushels	1735.0	991.3	667.5
Yield (bu/ac)	22.2	26.0	30.8
Yield Monitor (lbs)	86,751.8	49,619.1	33,376.8
Scale (lbs)	87,140.0	48,919.0	33.686.0
% Difference	-0.5	1.4	-0.9

More work is required to evaluate the accuracy of yield monitors to compare yields from different treatments, however a number of the producers are fairly confident that this technology can be used to conduct test strips on their farms and evaluate yield responses. The major problem in conducting trials on producer fields has been the ability to obtain accurate yields with limited cost and inconvenience to harvest operations. Yield monitors and GPS systems allow producers to evaluate crop responses on different landscape positions effectively. Some producers feel there is a major economic benefits to testing products and crops on their own farms.

The Northeast Agriculture Research Foundation plans to establish strip trials on a number of fields in 1998 to evaluate fungicides on canola, Tilt on cereals and determine the accuracy of yield monitors to conduct on-farm research The Foundation also plans to do on-farm research on variable rate fertilization, variable rate application of herbicides for wild oat control and variable rate application of fungicides to look at the economic responses from these inputs.

PFRA has assisted the Foundation in developing contour maps on 3 quarter sections that belong to producers. The potential of utilizing variable rate fertilization on these fields will be evaluated. The farmers have found that yield maps show large

variations of yields within fields. Using these maps over two to three years plus doing some field scouting and soil analysis farmers feel there is potential to vary the level of inputs and provide economic returns. Producers can identify areas on their fields with low returns and develo practise s to increase returns or seed areas to more profitable crops.

The potential of mapping weed populations, especially wild oats, and varying herbicide rates within fields to improve weed control and reduce costs will also be evaluated. Wild oat control is our major herbicide cost Wildoat populations may be related to topography and be monitored and mapped to provide economic returns to variable rate application.

The cost of equipment is a major factor when evaluating the economics of on-farm research or precision farming Table 4 outlines the approximate cost of running a John Deere Greenstar system. It costs $10,000. 00 for the yield monitor and GPS system including the software. There is an annual differential correction signal required of about $500. Add in 50% use of a computer plus some time and the total cost can be about $13,450.00 .Assuming the combine is used over five years and combines 200 acres/yr the total cos t$1.35/a cpr year. It is assumed after five years the equipment will be outdated and will have no salvage value.

Table 4.
Cost in %/acre of developing yield maps on farms

Cost of Yield Monitoring	
John Deere Greenstar	**$10,000.00**
Annual GPS Fee	**$500.00**
Pentium Computer 50%	**$2,200.00**
Time: 50 hrs. @ $15.00/hr.	**$750.00**
Total	**$13,450.00**
Acres Combined in 5 years	**10,000**
Cost per acre/year (% yr. life)	**$1.35**

Depending on the acres combined, salvage value, etc. the costs could be anywhere from $1 .OO to $2.OO/acr e per year for yield maps. There is good potential that this technology could be less in future years so it wouldn't be unrealistic to look at a cost of $1 .OO/acr e to develop a yield map each year. Cash operating costs in northeast Saskatchewan for wheat o $85./acr e and canola of $ 1OO./acr e are common. Any system that could allow farmers to evaluate the yield responses from inputs could have a very significant impact on reducing costs and paying for this technology.

There are immediate benefits of using this technology to conduct on the farm research, however more extensive research is going to be required to determine the benefits of utilizing precision farming techniques for variable rate application of crop inputs. This technology has the potential to be of major benefit in crop production and on-farm research. Producers evaluating yield maps of their fields will be asking many questions on why the large variations occur in fields. Researchers will be asked to conduct research to determine why these large variations in yield occur and are there production practices that can be utilized to improve returns?

The demand from farmers that are using yield monitors to find answers to production problems will increase. Researchers will be requested to conduct detailed research to evaluate problems and develop solutions. Test trials using yield monitors can be used to conduct field scale type research over variable climatic and soil conditions to determine economic benefits to producers.

Producers will be confident in adopting new technology that has been tested on there own or neighbours farm. Precision farming technology and on farm research has the potential to make crop production more economical and is well worthwhile developing programs to evaluate.