Crop Science Investigation Workshop Series Lesson Plans

Subject: On-Farm Research **Grade Level(s):** 4th – 12th grades
Lesson Title: How is on-farm research conducted?
Time period: 1-3 hours (depending on activities conducted)

These lessons can be adapted for youth of any age depending on level of technical content taught. When working with youth of varying ages, it is suggested to have older youth help the younger ones.

MATERIALS NEEDED:

______ Measuring wheel and/or 100’ tape measure

______ Soil probe

______ Field flags

______ Clipboard

______ Calculators

______ Computers with Excel Spreadsheet software

______ GPS (optional)

LEARNING OBJECTIVES:

- Understand the fundamentals of sound on-farm research.
- Learn to design an on-farm research protocol using randomized and replicated treatments.
- Appreciate the power of good experimental design.

LEARNING ACTIVITIES:

- Lecture
- Experiment
- Individual projects/roles
- Team activities
- Partnerships with private industry

ATTENTION FOCUSING ACTIVITY:

- On-farm research design concept may be discussed in the classroom. Begin this lesson by have students brainstorm methods of testing products or practices in agricultural fields. What are their goals? How will they set-up the experiment? What tools will be needed to design, implement and evaluate the experiment? Will they be confident in the results? How could they improve the process and/or end product?

STEPS AND KEY POINTS

Introduction

Everyday you see, read or hear about farming practices that hold promise for increasing the profitability of your farming operation. The question you typically have is, "Will it work on my farm?"

To answer this question you may need to experiment. The experimentation must be conducted in a manner that will produce credible information. Typically, there is much variation in crop performance within a field. Therefore, a side-by-side comparison of two practices does not give reliable information as we cannot know if yield differences or lack of differences are due to the different management practices or to different growing conditions in the two strips or parts of the field. There are some experimental procedures that should be applied to obtain reliable information on alternative practices on your farm. Following these procedures will insure that you, your neighbors, business associates, and others can rely on you will see the value in conducting scientifically based on-farm research. You can easily conduct valid, field-scale on-farm research using your equipment, on your land, employing your operation's management practices.

On-farm research has three basic components: **formulating a hypothesis (question), testing the hypothesis (question)** with experimentation**,** and **drawing a conclusion** based on the data**.**

Forming the hypothesis (question)

Simply develop a well-defined research question that can be answered with data that you can collect from the field. Try to keep the question focused on one practice. Will changing this practice, e.g. decreasing planter speed, affect crop performance and profitability? Formulate this into a hypothesis, which needs to be tested.

Activity – Have students brainstorm questions farmers may have about their cropping system.

Activity – This might be an individual summer SOE project or a class/chapter project..

Examples of hypothesis (questions) for on-farm research could be:

- Strip tilling soil at or before planting field corn increases grain yield.
- Treating Bean Leaf Beetles on early-planted soybeans reduces the incidence of Bean Pod Mottle Virus, and ultimately increases soybean yield.
- Incorporating agricultural lime will increase soil pH and thus enhance corn and soybeans yields faster than non-incorporated lime applications.
- Early April planted soybeans will have increased yields over May planted soybeans.
- No-till corn and soybeans will yield better than conventional tilled crops on Lutton Clay in the Missouri River Bottom.

<u>Testing the hypothesis (question)</u>

Here you decide what treatments to compare, design the field layout of the experiment, and determine what you will measure. Two experimental layouts are typically used in on-farm research. The proper design is determined by the number of treatments necessary to test the hypothesis. Two-treatment experiments use the *paired-comparison* layout. Experiments with additional treatments can be designed using the *randomized complete block* layout.

****Activity – ask students what factors might affect the results of the on-farm research comparison. How do they propose compensating for these factors?***

****Activity – what is found in almost all farm fields? A – variability (slope, drainage, soil type, etc.)***

Using the two layouts described above you can measure differences between treatments at a given level of probability. Randomization and replication are important components of a well-designed on-farm research experiment. ***Randomization*** ensures that favoritism is not given toward a treatment. ***Replication*** reduces the possibility that results are due to chance rather than the treatment. These two factors separate demonstration plots from on-farm research experiments, which can be used to make valid conclusions and ultimately wise business decisions.

****Activity – challenge students to design an on-farm research comparison consisting of 2 and 3 treatments respectively.***

<u>The paired comparison layout (similar to a split-planter approach)</u>

Paired comparison layouts should have six to seven replications. If you lose a pair or two due to pest infestations, weather damage, or other circumstances you will still have sufficient pairs (minimum of five) to analyze the experiment with confidence. Two harvest weights are measured in each treatment area and then compared to the alternative treatments on either side.

Figure1: Paired comparison layout**.** Two treatments: A and B. Seven pairs.

Trt. A	Trt. B	Trt. A	Trt. B	Trt. A	Trt. B	Trt. A	Trt. B

	Pair 1	Pair 2	Pair 3	Pair 4	Pair 5	Pair 6	Pair 7	

Comparison Border/Buffer	**Harvest and Weigh** Buffer	Buffer **Harvest and Weigh**	**Harvest and Weigh** Buffer	Buffer **Harvest and Weigh**	**Harvest and Weigh** Buffer	Buffer **Harvest and Weigh**	**Harvest and Weigh** Buffer	Buffer **Harvest and Weigh**	**Harvest and Weigh** Buffer	Buffer **Harvest and Weigh**	**Harvest and Weigh** Buffer	Buffer **Harvest and Weigh**	**Harvest and Weigh** Buffer	Buffer **Harvest and Weigh**	Comparison Border/Buffer

<u>The randomized complete block layout</u>

The randomized complete block layout is used for on-farm comparisons that require three or more treatments. At least five blocks are recommended (four minimum) to conduct reliable statistical analysis. Treatments are randomized within each block to remove favoritism in the comparison.

Activity – How is the randomization process accomplished?

Figure 2: Randomized complete block design. Three treatments: A, B and C, randomly assigned within each block. Five blocks. One harvest weight is measured in each treatment area.

Block 1			Block 2			Block 3			Block 4			Block 5		
Trt. A	Trt. B	Trt. C	Trt. B	Trt. C	Trt. A	Trt. C	Trt. A	Trt. B	Trt. A	Trt. B	Trt. C	Trt. C	Trt. A	Trt. B
Buffer **Harvest and Weigh** Buffer	Buffer **Harvest and Weigh** Buffer	Buffer **Harvest and Weigh** Buffer	Buffer **Harvest and Weigh** Buffer	Buffer **Harvest and Weigh** Buffer	Buffer **Harvest and Weigh** Buffer	Buffer **Harvest and Weigh** Buffer	Buffer **Harvest and Weigh** Buffer	Buffer **Harvest and Weigh** Buffer	Buffer **Harvest and Weigh** Buffer	Buffer **Harvest and Weigh** Buffer	Buffer **Harvest and Weigh** Buffer	Buffer **Harvest and Weigh** Buffer	Buffer **Harvest and Weigh** Buffer	Buffer **Harvest and Weigh** Buffer

Activity – students need to consider the size of farm equipment used to properly size these field size layouts to make harvest as convenient as possible for farmers.

<u>Measuring and marking comparison area</u>

Information such as row, planter, combine, sprayer and fertilizer rig and other relevant implement widths must be known prior to the comparison design. Incorporating this data into the experimental layout will improve the efficiency of managing the experiment as treatments are applied and harvest is conducted.

Be sure to mark the treatment locations well with field flags, wooden stakes, global positioning system equipment or a combination of these tools. Draw a sketch of the experiment layout for reference at harvest time. Buffer areas between treatments are typically important to ensure that treatments do to not influence each other. Including a field border/buffer is important to eliminate influence from compacted end rows, fence line grasses, field roads, etc.

Activity – if you have a GPS will it work to mark treatment boundaries? Is it accurate enough? What is your backup plan?

<u>Collecting data</u>
Harvest weights may be collected using a properly calibrated weigh-wagon or yield monitor. Moisture and test weights should be collected for each grain yield treatment measured. The worksheet following this article can be used to record harvest data and calculate crop yields.

In addition to crop yield, grain moisture and test weight you may want to collect additional data relevant to your on-farm research experiment hypothesis. Examples of this data include soil fertility, plant height, insect thresholds, weed densities, planting and harvest populations, grain protein analysis, etc. This data can be statistically analyzed if collected using the same procedure used for harvest.

Keeping a diary of crop and weather conditions throughout the growing season is an invaluable resource when the time comes to draw conclusions from the experiment. A photographic record of observed differences during the growing season may also be useful.

Activity – which student(s) will be responsible for each component of the on-farm research process? Each team could focus on one research site.

<u>Drawing Conclusions</u>

Data collected from a scientifically designed on-farm research experiment can be statistically analyzed and interpreted to determine whether or not real differences are present among treatments. It's difficult to draw conclusions by simply looking at the raw data. Statistical analysis determines probabilities that the differences were caused by treatments versus chance (random variation or error).

Various confidence levels are used to analyze agricultural data. University researchers generally select a minimum confidence level of 95%, which means that there is a 95% probability that experimental differences measured are due to the treatments rather than to chance. There is a 5% possibility that the treatment differences are due to chance. Many farmers readily accept a confidence of 90% depending on the nature of the experiment. There is always a 10%, 5%, 1% or even .0001 percent chance of error. However, by following the experimental guidelines suggested here the odds of making a scientifically based decision are in your favor.

****Activity – students could record data as the comparison is harvested and calculate moisture content, yield, etc.***

Activity – students may statistically analyze results. Excel has a program built in to analyze paired comparisons.

Once yield and/or other treatment differences are determined you should focus on economics. What is the cost:benefit ratio? Is the advantage of a given treatment worth the cost difference between the treatments? Non-tangible benefits such as improved soil quality, environmental improvement, and efficiency should also be considered.   Conclusions should generally be drawn from comparisons repeated in more than one location and/or year.

Summary

On-farm research is a powerful decision-making tool for farmers. The time and effort required to design, implement and analyze a sound on-farm research comparison is worth the confidence that you and other agriculturalists will have in the results. Results should be taken a step farther by analyzing the economics of the comparison. A yield difference is important, but perhaps not relevant if the cost of the yield increase is more that than the return on investment. Contact your local University of Nebraska—Lincoln Extension Educator for further assistance.

Activity – students could post on-farm results on chapter website. This type of date is very popular with farmers!

REFLECTION

- Have students/teams present their on-farm research design proposal and ask other class members to constructively critique their plan.
- What are the key components of each on-farm research design? (form a hypothesis (question), test the question (hypothesis), draw conclusions)
- How are true treatment differences measured? (statistical analysis)
- How will student researchers determine which treatment(s) are profitable? (compare treatment costs – all other factors should remain constant)

PERFORMANCE ASSESSMENT

- Students will be able to identify key components of on-farm research design.
- Students will be able to design, implement and evaluate an on-farm research comparison.

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Resources

Penas, E.J., Ferguson, R.B., Herger, G.W., Shapiro, C.A. and G.D. Binford. *Procedures for Field Demonstrations of Nitrogen Management Practices*. 1993. University of Nebraska Cooperative Extension EC 93-126.

Rzewnicki, Phil, *On-farm Trials for Farmers Using the Randomized Complete Block Design*. 1992. University of Nebraska Cooperative Extension EC 92-125.

Sooby, Jane. *On-Farm Research Guide*. Revised April 2001. Organic Farming Research Foundation.

Sundermeier, Alan, *Guidelines For On-farm Research*. Ohio State University Ag and Natural Resources.

FARM RESEARCH DATA WORKSHEET

Date ___________Location ______________________Crop _________________Crop DM,lbs/bu __________Row Width, inches__________

(1) Plot No.	(2) Block No.	(3) Trt.	(4) Rows, No.	(5) Width Trt, ft	(6) Length Row, ft	(7) Grain, Lbs.	(8) Moisture, %	(9) Test wt., lbs/bu	(10) 100-Moisture / 100	(11) Trts/ac (43,560/5*6)	(12) Bu/trt. (7*10/DM)	(13) Yield, bu/ac (11*12)
Example												
Date __*11/1/10*___ **Location** __*Sec 15 T6N R12E*_____ **Crop** ___*Corn*__________ **Crop DM**, lbs/bu __*47.60*___ **Row Width**, inches____*30"*______												
102	1	Limed	8	20	2257	9250	15.2	58	.848	.96	164.8	158.2

DM for corn @ 15.0% moisture = 47.60 lbs/bu; corn @ 15.5% moisture = 47.32 lbs/bu; grain sorghum @ 14% moisture = 48.16 lbs/bu; soybeans and wheat @ 13.0% moisture = 52.20 lbs/bu

Worksheet adapted from UNL Extension EC93-126