Conducting On-Farm Research

Operations Managers Conference 2017

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Why Conduct On-Farm Research

- Fact based answers to farmer driven questions.
- Fact based answers to questions to which there are no answers.
- Fact based answers to questions under “normal” or “real-life” farm management.

Types of Investigations

- Demonstration
- Side by Side Comparisons
- Replicated Research
  - Small plot
  - Large plot

Demonstrations

- Is not the same as research.
- Helps us gain experience or expose others to new practices or technology.
- Yield or other data not collected or analyzed.
- Central to field days and outreach.

Side by Side Comparisons

- Is not the same as research.
- Helps us gain experience or expose others to new practices or technology.
- Yield or other data might be collected.
- Date cannot be analyzed and should not draw conclusions from the information.
- Central to field days and outreach.

Replicated Research

- A systematic investigation
- A meaningful question
- The research project is planned and conducted without bias
- Data are carefully measured and recorded.
- Results are statistically interpreted to answer the research question.

Allows for comparison of treatments –including a control.

The treatments are replicated (repeated) to help remove Background Noise to mathematically separate the TRUE treatment effects from those due to Background Noise.

Small Plot Research

- Targets uniform area to minimize error from surroundings (Background Noise) and helps to detect treatment effects.
- Allows for comparison of many treatments –including a control.
- Generally requires specialized equipment for implementation.
- Typically this research occurs at a "research farm" but can also occur on-farms.

Large Plot Research

- Hosted on "real" fields that tend to be highly variable.
  - Harder to control Background Noise.
- Limits treatments to be evaluated due to large plot size.
- Field scale/commercial equipment is used to implement research.
- Typically this research includes replicated strips of treatments – otherwise known as a "Strip Trial".

What is the goal of research?

- Knowledge through
  - Learning
  - Understanding
  - Systematic Testing
  - Observation and Measurement
  - Communicating

Source: Tom Morris, UConn & Sue Ellen Johnson, NE Small Farm Institute

Goals of Agricultural Research

- Greater Production
- Greater production efficiency
- Greater farm profitability
- Better environmental stewardship
- Provide basis for better recommendations

Source: Tom Morris, UConn & Sue Ellen Johnson, NE Small Farm Institute

Designing an Experiment

- First step is to decide what you want to investigate
- Ask a good question
  - "Just what exactly are you trying to find out"
- Remember- Not all questions are worth the effort to investigate

Agronomy Fact Sheet # 68: On-Farm Research
http://nmsp.cals.cornell.edu/guidelines/factsheets.html

Key steps for conducting on-farm research

- Ask yourself what research has been done in this area already
  - You could end up investigating a question with a well-known answer
- Keep your question simple
  - It is easy to ask a very complex question
  - A simple, straightforward approach is best
- Always have a control treatment
  - Ex. 0 lbs/acre of N in a study on N rates

Data Collection & Record Keeping

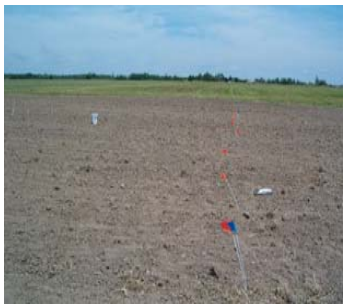
- Trial Description
- Field History
- Soil Test
- Fertility Program
- Soil Moisture at Planting
- Planting Conditions
- Field Operations and Observations
- Weather
  - Rainfall
  - Growing Degree Days
- Insects, Weeds and Diseases
- Crop Growth and Development

Design: Site selection is important

- Variability in conditions greatly affect ability to detect significant differences
  - The greater the variability, the less your chance of detecting treatment differences

What is the best plot size?

- Plot size is determined by
  - Field size
  - Uniformity of the field
  - Equipment used
  - Area needed for a particular treatment



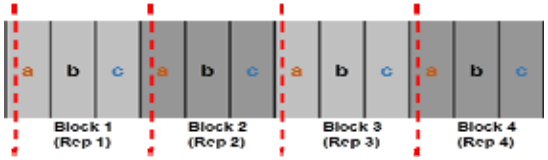
Replication: More is better

- Number of times the treatment is in the field
- Allows you to distinguish between random variation in the system and real affects of the treatments
- Analyzing data without replication is nearly impossible without replicated treatments
- More replications increase chances of detecting treatment differences

Randomization: Mixing up the order of the treatments

- Helps draw conclusions that are representative of the area
- If you don't randomize you can bias your results

Example: Without randomization Treatment "a" could end up situated over tile line in each replication.



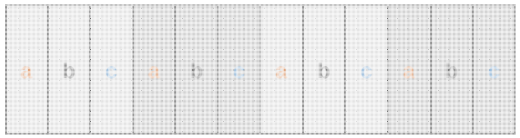
Blocking: Small areas of randomized treatments

- Purpose of blocking is to create smaller, more uniform areas where observed differences will be due to the treatments themselves
- Limits the influence of the treatment's position in the field
- Randomized Complete Block Design is most popular for field research

Plot Layout

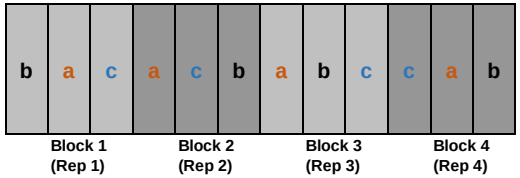
Replicated, Not Randomized

Not Recommended



Randomized Complete Block Design (RCBD)

RCBD groups treatment plots together & randomizes them within replicated blocks.



Spatially Balanced Complete Block Design

# TRTS ↓	# REPLICATIONS 2	3	4	5	6
2	ba ab	ab ba ba	ba ab ab ba	ab ba ab ba ab	ba ab ab ba ba ab
3	bca cab	cba bac acb	bac acb abc cab	bac acb cba bca cba	acb cba bac acb cba bac
4	dcab cbda	cdab dbca dabc	abcd cdab dabc bcda	cbda dcab acbd badc bdca	dcba bcda bdac abcd cadb dabc
5	debac bdcea	cebad eadcb dceba	edacb dbcea acdbe baedc	cdebf dabce aecdb ebdac bcaed	caedb dbaec bcdae becad aebcd edcba
6	cabfed becdaf	facedb cbadef efbacd	bcedfa cafedb efbacd fdcbae	beacdf afbdec fceabd cbdfae dacefb	feadbc baecdf edcbfa cfbead acdfeb dbface

- What's Cropping Up? article
  http://scs.cals.cornell.edu/sites/scs.cals.cornell.edu/files/shared/documents/wcu/Vol15No12005January.pdf

Measuring Results

- Plan ahead and identify what should be measured in the research trial
- If the purpose is to increase yield
  - Measure Yield
- If the purpose is to improve forage quality
  - Collect forage samples
- If the purpose is to increase net profit
  - Analyze cost and returns

Yield Measurements

- Measurements must be taken from comparable areas in each treatment plot
- Measure the size of the harvest area
- Measure plot lengths immediately after harvesting each plot
- Distance is multiplied by width of harvest equipment to determine harvested area
- Harvested area is used to calculate yield

Role of Technology

- Precision Planting
  - Allows planting of randomized replicates without the need to change seed each pass
- Prescription based application rates
  - Implement replicated, randomized treatments by pre-programming prescription
    - Seeding rate
    - Fertilizer
  - Allow space (gaps) between treatments for equipment to change from one rate (treatment) to the next
- Yield Monitors
  - Make sure there is confidences in their calibration

Analyzing your data

- Work with:
  - Local Extension office
  - University
  - Consultant
- Free Online Software
  - internet based statistical analysis software for analyzing on farm test results called AGSTATS02
  - http://pnwsteep.wsu.edu/onfarmtesting

What's in a number?

- Everyone talks about averages
  - Average rainfall
  - Average temperature
  - Average yield
- Averages are meaningless if the data used to calculate it is extreme

Source: Ian McDonald, Applied Research Coordinator, OMAF

Let's look at an example

- Consider three situations which have the same average bu/ac yields

A	90 + 100 + 110 = 300 ÷ 3 = 100
B	50 + 100 + 150 = 300 ÷ 3 = 100
C	0 + 100 + 200 = 300÷ 3 = 100

Which example do you think is more likely to give you more reliable average yield in the future?

Source: Ian McDonald, Applied Research Coordinator, OMAF

Coefficient of Variation (CV)

- Describes the amount of variation in the data
- The lower the CV value, the lower the variation in the data
- CV values of less than 10% are best, numbers of 20-30% are likely acceptable

Source: Ian McDonald, Applied Research Coordinator, OMAF

Least Significant Difference (LSD)

- The amount of difference that has to occur between treatments for them to be assumed to be "statistically' different
- The LSD determines if the differences are a response to a different treatment or due to random chance that result in variations across the trial

Source: Ian McDonald, Applied Research Coordinator, OMAF

Example - LSD

Trefoil	No.Plts/6sq.ft. (9/12/02)	
Variety	Not Inoc.	Inoculated
Bull	29.8	5.2
Exact	30.8	4.2
Lota	17.8	6.0
Norcen	28.3	8.8
Pardee	29.5	12.4
LSD (0.05)	12.7	4.5

M. Smith

Example - Multiple Range Test

Variety	Plant Count
Best	63 a
Okay	59 ab
Less Okay	57 bc
Worst	53 c

M. Smith

Summary

- Keep it simple
- Replicate and Randomize
- Stay uniform
- Harvest individual plots
- Repeat the same project for multiple years

Resources

- Agronomy Fact Sheet # 68: On-Farm Research
  http://nmsp.cals.cornell.edu/guidelines/factsheets.html
- Free Online Software
  - AGSTATS02 http://pnwsteep.wsu.edu/onfarmtesting
- Spatially Balanced Complete Block Design
  - Printout
    https://fieldcrops.cals.cornell.edu/sites/fieldcrops.cals.cornell.edu/files/shared/documents/SBCBD_card_053116.pdf
  - What's Cropping Up? article
    http://scs.cals.cornell.edu/sites/scs.cals.cornell.edu/files/shared/documents/wcu/Vol15No12005January.pdf