Tips and Tools for On-Farm Research

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What is On-Farm Research?
So much information...

- Anecdotal
- Demonstrative
- Scientific
Anecdotal Information

- Experience stories
- Interesting!
- May or may not be true
- Usually no documented proof

Source: Titan Outlet Store
Demonstrative Information

• Visual comparisons
• Learn by seeing
• See the impact of a practice in person

Source: Mississippi State
Scientific Information

• Most reliable
• Experimental design allows us to use statistics
• Statistics tell you how much “stock” you can put in the results

Source: Science Societies, Rick Mascagni
Demonstration Plot Objectives

- Demonstrate scientifically proven practices
- Simple qualitative comparisons
- See visual differences
- Data may be collected to aggregate with other demonstrations
What Demonstration Plots Don’t Do

• Data from plots that were not replicated are not reliable
• Visible differences may not equate yield differences
Research Plot Objectives

• Test validity of new practices
• Quantitative comparisons
• Estimate statistical differences
• Data can stand alone because of replication
What Research Plots Don’t Do

- Not ideal for demonstrations
- Large, randomized
- Usually no side by side comparisons
What is OFR?

- Research conducted on a working farm in partnership with farmers
- Allows assessment of performance of treatments or practices in a real-world setting
- Typically conducted at a field-scale
  - Use standard size farm equipment
  - Less control over variability than in traditional research settings
  - Data collection tends to be more practical than small scale
The Nuts and Bolts of OFR
The Nuts and Bolts

- **Forming good partnerships**
- Forming the research question(s)
- Executing the trial
  - Importance of experimental design
  - Laying out the trial
Benefits of On-Farm Research Collaboration

• Help with data collection and analysis
• Access to funding, techniques, specialists, testing, equipment
• Connections for outreach and future collaborations
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Who is Involved in OFR?

- Industry Partners or Nonprofits
- Extension Specialists
- Educators or Researchers
- Partner Farmers
Keys to Good Partnership

• Work together to form the research question and design
• Be clear on responsibilities, timeline, needs
• Respect each other
The Nuts and Bolts

- Forming good partnerships
- **Forming the research question(s)**
- Executing the trial
  - Importance of experimental design
  - Laying out the trial
A Good Research Question

- Explains what you are trying to do
- Is specific and focused
- Can be answered with facts and data
- Passes the “so what” question
A Good Research Question

Is birdsfoot trefoil good for my pasture?

Does birdsfoot trefoil decrease livestock disease rates when included in pasture?

Does grazing birdsfoot trefoil lower the rate of common parasitic diseases in bison?

- Explains what you are trying to do
- Is specific and focused
- Can be answered with facts and data
- Passes the “so what” question
The Nuts and Bolts

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Predicting the Future

How probable is it that I will get this result again?

- Experimental design and statistics make it possible to isolate “noise” and determine if the yield differences are real
Terms to Know

- Statistical Significance
- Least Significant Difference
- Coefficient of Variance
- Replication
- Randomization
Statistical Significance

- Is the difference real?
- Is the result due to chance or something we don’t know about?
Least Significant Difference

- Means separation technique
- Smallest difference that is real
- Set probability ahead of time
  - 95% is commonly used for most research
  - 90% is accepted for research like OFR where variation is less controlled
- Difference > LSD → Real Difference!
- Difference < LSD → “Noise” or Chance!
Coefficient of Variation (CV)

- Describes the level of variation in an experiment
- Standard deviation ÷ Mean x 100%
- Higher CVs indicate more variation is affecting the results

Std Dev: 26 bu/ac
Avg: 220 bu/ac
CV: 11.8%
Replication

- Important for separating treatment effects from “noise”
- Allows you to see consistency (or not) in treatment performance
Replication
Replication

- Treatment
- No Treatment
- Treatment
- No Treatment
- Treatment
- No Treatment
Replication in OFR

- **Minimum of 3 replications**
  - Required to complete statistical analysis
  - 4 or more are recommended
  - Allows for reps to be dropped due to mistakes or problems like flooding or poor stands
Randomization

- Decreases the odds that spatial variability will influence the results

<table>
<thead>
<tr>
<th>Treatment</th>
<th>No Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 bu/ac</td>
<td>58 bu/ac</td>
</tr>
<tr>
<td>54 bu/ac</td>
<td>52 bu/ac</td>
</tr>
<tr>
<td>48 bu/ac</td>
<td>46 bu/ac</td>
</tr>
</tbody>
</table>
Common OFR Layout Mistakes

• Side by side comparisons
The Nuts and Bolts

- Forming good partnerships
- Forming the research question(s)
- **Executing the trial**
  - Importance of experimental design
- **Laying out the trial**
Selecting the Field

- Field size
  - Will the trial fit?
    - Number of reps and treatments?
    - Minimum plot length – 300 (longer is better for high quality yield data)
- Take note of field variability and plot placement
  - Distribute plots across variability, when possible
Equipment Considerations

• Plot width will be determined by equipment size
  • Planter
  • Combine
    • Especially in soybean
    • Other equipment involved in trial
      • For example: sprayer, fertilizer applicator
  • Quality of correction (WAAS vs. RTK)
Communicating Results from OFR
Sharing Results in Person

• One-on-one sharing between all participants
  • Recap what you learned
  • Discuss what the results mean and might impact on-farm practices
  • Plan for next steps?
Reaching Out Beyond Your Farm

• Meetings, Farm Tours, Conferences
• Farmer and collaborator networks
• Photographs and short summaries
• Written reports and articles
eFields Report

- Annual publication highlighting research projects taking place around the state
- Easy to read report layouts
- Both printed and e-versions available
2017
45 trials
39 partner farms
21 industry partners
20 OSU contributors

2018
95 trials
53 partner farms
39 industry partners
48 OSU contributors

2019
88 trials
45 partner farms
54 industry partners
64 OSU contributors

2020
218 trials
107 partner farms
55 industry partners
65 OSU contributors
**OBJECTIVE**
Compare three different annual forage grasses to see which ones performed best and contained the most crude protein, TDN and NDF.

**STUDY INFORMATION**
- Planting Date: 7/1/2020
- Harvest Date: 9/28/2020
- Variety: 3 costs Treatments
- Population: 10-50 lbs/acre
- Acres: 5
- Treatments: 3
- Rep: 4
- Treatment Width: 60 ft
- Tillage: No-Till
- Management: Fertilizer, Herbicide
- Previous Crop: Wheat
- Row Spacing: 7.5 in
- Soil Type: Centerburg Silt Loam, 74% Nimada Silt Loam, 18% Bennington Silt Loam, 11%

**WEATHER INFORMATION**
Growing Season Weather Summary

<table>
<thead>
<tr>
<th>Month</th>
<th>OCT</th>
<th>NOV-</th>
<th>DEC</th>
<th>JAN</th>
<th>FEB</th>
<th>MAR</th>
<th>APR</th>
<th>MAY</th>
<th>JUN</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precip (in.)</td>
<td>2.99</td>
<td>12.3</td>
<td>4.84</td>
<td>3.58</td>
<td>4.55</td>
<td>1.88</td>
<td>1.80</td>
<td>30.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cumulative ODDs</td>
<td>271</td>
<td>328</td>
<td>397</td>
<td>528</td>
<td>909</td>
<td>1541</td>
<td>1541</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**STUDY DESIGN**
Morrow Soil and Water Conservation District and OSU Extension Morrow County have a 20-acre field donated by the county commissioners that we used for research. The area of the trial was 5 acres. Three species of summer annual forage crops (oats, teff grass and sorghum sudangrass) were planted with a John Deere 1500 no-till drill on July 31st and fertilized with MAP at 80 lbs/acre, potash at 81 lb/acre, and zinc at 480 lb/acre two weeks before planting. The plots were moved on September 30th and tiled on October 3rd. Each bale was weighed and samples for forage tests were taken.

**OBSERVATIONS**
All forage species tested emerged after wheat but the teff grass and sorghum sudangrass performed the best. The teff grass could have been harvested later and given a longer growing period the sorghum sudangrass could have had two cuttings, as well. Both are great options to plant after wheat if needing additional forage for livestock in the winter.

**SUMMARY**
- A significant difference in yield was observed where the wheat and sorghum sudangrass were over 2.5 times the yield of oats.
- Crude protein was higher for the oats by just over 6%.
- Teff grass produced the highest energy or TDN, followed by sorghum sudangrass.
- Based on crude protein, digestible protein nitrogen, relative feed values and dry matter any of these species would be acceptable as forages. The key is to plant what works best for your farm operation.

**RESULTS**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Crude Protein (%)</th>
<th>TDN (%)</th>
<th>NDF (%)</th>
<th>Yield (tons/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oats</td>
<td>17.6</td>
<td>47.2</td>
<td>65.7</td>
<td>0.51 b</td>
</tr>
<tr>
<td>Teff Grass</td>
<td>11.3</td>
<td>64.1</td>
<td>61.1</td>
<td>1.25 a</td>
</tr>
<tr>
<td>Sorghum Sudangrass</td>
<td>11.3</td>
<td>64.0</td>
<td>65.4</td>
<td>1.38 a</td>
</tr>
</tbody>
</table>

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

| LSD: 0.20          |
| CV: 20.52%         |

**TOOLS OF THE TRADE**
Demonstration plots
- Demonstration plots are an effective method for sharing experiences with new crops and management practices. They can be easily installed and placed in a visible location on the farm.

**PROJECT CONTACT**
For inquiries about this project, contact Carr-Jagger (jagger6@osu.edu).
OBJECTIVE
Survey farm fields to better understand how soil health values are influenced by (i) soil type and CEC, (ii) sampling depth, and (iii) past management practices such as rotation and cover cropping.

BACKGROUND INFORMATION
Measuring soil health properties represents a great opportunity to better understand their relationships with soil functions. Soil testing builds on our current methods of soil testing to provide additional information to farmers. Rather than focusing solely on soil chemistry, all elements of soil health are incorporated into a common framework. Building and maintaining high-functioning soils requires that all three key components (chemistry, biology, and physical structure) be considered in a balanced manner.

There are many potential soil health measurements or indicators to choose from. For this study, we selected the following three indicators:

1. **Total organic matter**: This is the most important soil property that is easily recognized as a major variable in soil. It is commonly measured in routine soil testing.
2. **POXC (permanganate oxidizable carbon)**: POXC (aka. Active C) is a biologically active pool that represents a small fraction (<5%) of total organic matter. POXC is a more sensitive indicator of changes in management practices compared to total organic matter, which changes slowly over time. In contrast, POXC represents a more dynamic pool of organic matter and nutrients that are more rapidly used and plant available.

3. **Aggregate stability**: Soil aggregation is the essence of soil structure. Soil aggregates (sand, silt, clay) are bound together by organic matter to form micro-aggregates which, in turn assemble to form macro-aggregates. Aggregate stability is measured as the ability of a soil to hold together and not stack in water. This relates to greater pore space for gas exchange, faster water infiltration, resistance to water and wind erosion, and compaction by traffic.

STUDY DESIGN
Soil cores were sampled from 66 fields across 26 counties in Ohio in May–July 2020. Soil cores (10-15 cores per sample) were taken from 3 different depths:

- 0 – 4 inch
- 0 – 6 inch
- 0 – 8 inch

Soil cores from each depth were pulled from the same locations. Fields represented different soil types and management histories (i.e., long-term no-till vs. recently tilled, history of cover crops vs. no recent cover crops). All soils were mailed to the Ohio State Soil Fertility Lab for analysis. Analysis included:

- Routine nutrient analysis: pH, total organic matter, cation exchange capacity (CEC), Mehlich-3 extractable nutrients
- Permanganate oxidizable carbon (POXC)
- Aggregate stability (only run on a subset of samples)

RESULTS

**Influence of Cation Exchange Capacity**
A primary challenge of quantifying soil health is to know how soil type influences its values and what represents a "good" vs. "bad" value. Cation exchange capacity (CEC) is a reasonable predictor of soil type, with sandy soils having low CECs and clay soils having higher CECs. We examined how CEC was related to total soil organic matter (POXC), a biologically pool of organic matter, and aggregate stability (Figure 1). Overall, three measurements increased as CEC increased. However, the slope (steepness) of the blue line reflects the influence of the CEC on the soil health variable. Both total organic matter and aggregate stability had a stronger relationship with CEC than POXC. This suggests that POXC is less influenced by soil type, and more reflective of soil management history than total organic matter. This agrees with other studies that have shown this same trend.

![Figure 1. The influence of cation exchange capacity (CEC) on total soil organic matter, permanganate oxidizable carbon (POXC) and aggregate stability. Total organic matter is strongly driven by soil type, while CEC and POXC are influenced more by management.](image)

**Influence of Depth**
As expected, most soil properties differ according to the depth the soil was sampled. The shallower depth (0-4") yielded greater values than the deeper sampled soils (0-6" or 0-8"). Nutrients and organic matter are naturally stratified in soil (enriched at the surface) relative to deeper depths. This underscores the importance of keeping sampling depth consistent between samplings and over time to be able to evaluate trends in soil test values.

| Table 1. Soil properties by depth, averaged across all fields. Nutrients and organic matter were enriched in shallower depths (0-4") relative to deeper depths (0-8"). |
|---|---|---|---|---|---|---|
| Depth | pH | Organic Matter (%) | Mehlich-3 P (ppm) | Mehlich-3 K (ppm) | POXC (ppm) | Aggregate Stability (%) |
| 0-4" | 6.4 | 2.7 | 70.2 | 198.4 | 678.1 | 79.1 |
| 0-6" | 6.4 | 2.5 | 61.0 | 181.0 | 621.0 | 79.0 |
| 0-8" | 6.4 | 2.4 | 53.5 | 166.1 | 582.5 | 78.8 |
Tools and Resources for OFR
eFields Program

- Protocols
- Team support
- Continuing ed series
Standardized Protocols

- Field-scale trials
- Randomized and replicated
- Current protocols are available online
  https://digitalag.osu.edu/efields
- Support available to develop new or custom-made protocols.
Seeding Rates

- 4-5 treatments recommended
  - Corn: 4,000 sds/ac
  - Soybeans: 40,000 sds/ac

- Data Collection
  - As-planted spatial files
  - Stand Counts
  - Yield
And more…

- Sulfur
- Phosphorus sources
- Manure timing and placement
- Starter fertilizer
- Weed control techniques
- Soil health and cover crops
OSU PLOTS App

- OSU PLOTS
  - iOS App Store and Google Play
- FREE!
- Easy to use
- Share information from app
  - CSV
  - JPEG of Results Summary page
# OSU PLOTS App

## Trial

### New Note

- **Insects**

Select Plot (optional)

Rating 1-5 (optional)

Favorite: 

Add GPS  Add Photo

---

## Notes

- **Disease Rating**

- **Grain Moisture Content**

- **NDVI**

- **Plant Height**

- **Population**

- **Weed Control**

- **Yield**

Add Custom Item

---

## Results

### Summary Report

- **Population**
- **Average**
  - 120000: 95000.00 b
  - 150000: 126500.00 c
  - 180000: 144125.00 d
  - 90000: 70000.00 a
  - LSD(0.10): 6653.19
  - CV %: 4.71

Treatment means with the same letter are not significantly different according to Fisher’s Protected Least Significant Differences (LSD) test at alpha = 0.10.

<table>
<thead>
<tr>
<th>Yield</th>
<th>Average</th>
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<tbody>
<tr>
<td>120000</td>
<td>64.76</td>
</tr>
<tr>
<td>150000</td>
<td>61.20</td>
</tr>
<tr>
<td>180000</td>
<td>64.48</td>
</tr>
<tr>
<td>90000</td>
<td>66.56</td>
</tr>
</tbody>
</table>

CV %: 5.32 *not significant
Q&A
Ask us anything!