Participatory On-Farm Research: Beyond the Randomized Complete Block Design

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http://www.extension.org/organic_production

What is on-farm research?

Observations, evaluation of a new practice or variety, or a systematic comparison of management systems

Why participatory on-farm research?

- Ensuring Relevance
- Engaged co-learning
- Quantifying G by E

*Genetics by environment = evaluating performance of genetics (or technology) across multiple environments and testing for interactions*

Objectives matter

Objectives – take 1

- Ensuring relevance
  - Research stations historical management ‘legacy’ – so go on farm
  - Systems research often requires real world systems – so go on farm
Research Station vs. Farm

Soil Organic C at Malawi sites

- Southern Malawi
- Central Malawi
- Northern Malawi

Snapp, 1998

Relevance:
Experimental designs for systems research

- Case studies
- Gradients across landscape e.g., chronosequence
- Paired farms
- Group of farms

Ensuring relevance

Paired sites on-farm

Reganold et al., 2010

Paired farms or fields

Natural experiments: "Across fence row" comparison of two management systems, e.g., cover crop vs. manure-based fertility

Relevance: Analytical approaches

1. T-test of paired farms
   - Test how variables respond on paired farms, e.g.: yield comparison between organic and conventional
2. Structural Equation Modeling (develop and test research questions)
3. Multivariate data analyses
   - Multivariate approach allows simultaneous evaluation of relationships among many variables
   - e.g.: soil and plant properties, yield traits, economics

Relevance: Analytical approaches

- SEM model
  - An SEM model is based on a composite hypothesis made up of a series of cause-effect relationships between variables
- Multivariate approach
  - Weighted Averages
  - Principal Component Analysis (PCA)
  - Canonical Correspondence Analysis (CCA)
Characterizing complexity: GIS

Grids were established for monitoring potato fields using a Trimble Pro-XRS GPS receiver unit with real time differential correction. (Po et al. 2010)

Actual vs. predicted potato yield

Actual yield based on GPS yield monitor harvester vs predicted yield from stepwise regression equation. Yield = 59.3 + 0.7(250 m WSA) - 89.3(G/R unadj) + 91.9(ECa) R² = 0.60; Po et al. 2010

Relevance:

Key points for on-farm studies

- Understanding on-farm variation rather than attempting to control all variables
- Choice of experimental sites on-farm is critical, choose representative sites and gradients or paired sites can be used
- EMBRACE COMPLEXITY: Use multivariate analytical approaches and GIS-based monitoring

Objectives - take two

- Engaged learning
  - Learn together: iterative co-learning to improve research
  - Adaptive research: develop improved, relevant technologies
- Educate/enhance farmer capacity for experimentation & technology adoption

Engaged research 4 impact

Iterative Co-learning

Diagnosis & Systems Analysis

Best bets

Better bet options

On-farm research

Farmer Capacity
A few hints

- Do homework: review knowledge, agree on a shared agenda, develop research questions and options to test (some may participate at different levels)
- Invest in partnership building and education
  - Facilitated discussions and brainstorm sessions
  - Build in time for reflection
- Choose appropriate on-farm design and do NOT duplicate a research trial on-farm
  
  Communication is key! First, last and always
Engaged on-farm research: Analytical approaches

- Adoption studies
- Impact assessment
- Farmer and researcher capacity
- Technology improvement (better bet options, improved research questions)
- System analysis
- Radar or amoeba diagrams
- Economic evaluations

Engaging Learning: Key points

- Improved farmer capacity to experiment, innovate and adopt technologies
- Improved technologies and research priorities through documenting farmer assessment
- Systems comparisons

On-farm systems comparison using a ‘radar chart’

Farmer ratings of system benefits

Adoption study:
USA Organic acreage 2005

http://www.sare.org/Grants/Grants_information

Swinton et al., 2011
Objectives - take three

- **G by E**
  - Genetics by environment = quantifying performance of genetics (technology) across multiple sites
  - Environment = biological and socioeconomic context (farms)

**Analytical approaches**

- Spatial analysis
- “Mother and daughter” trials
  - Latin Square design
  - Adaptability analysis
- Non-parametric methods for paired comparisons with checks
  - Wilcoxon’s signed rank test

Spatial Experimental Design Field

- **Treatment design**
  - **N rate:**
    - Zero
    - Optimal
    - High
  - **Management system:**
    - without cover crops
    - with cover crops
  - **Topography:**
    - Summit
    - Slope
    - Depression

- **Experimental design:**
  - RCBD with 3 replications
  - A hillside with three N rates within each replicate block
  - Each N rate plot is split into cover crop present and absent

- **Observational plots with GIS/GIS chambers, soil moisture and temperature sensors, wells for ground water monitoring and sampling.**

Investigating treatment interaction with topography on-farm (Krawchenko et al unpublished, 2011)

‘Mother and daughter’ trial design

- **1. Replicated researcher managed “mother trials” test complete set of genotypes or technologies. Yield performance documented.**

- **Systematic linkage**

- **2. Unreplicated on-farm “daughter trials” that compare a subset (~2 or 3 technologies with a farmer check). Farmer perceptions and rating documented.**

- **Design approaches:**
  1) Latin square design
  2) Replicate one treatment per daughter trial
Farmers ranking ‘pairwise’

Farmer name: _________________________   Location of field experiment: ____________________________
Farmer expert: Yes ____  No_____
Mark: Local ________  Wholesale________
Major crops: __________________

Ranking of technologies

<table>
<thead>
<tr>
<th>Ranking of technologies</th>
<th>Fill in with letter of technology which is better (for example: if the farmer thinks that B. Strip till is better than C. Ridge tillage, fill in B in the square). There should be one letter in each square.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>D. Chisel plow</td>
</tr>
<tr>
<td>B</td>
<td>C. Ridge tillage</td>
</tr>
<tr>
<td>C</td>
<td>B. Strip tillage</td>
</tr>
<tr>
<td>D</td>
<td>A. Farmer tillage</td>
</tr>
</tbody>
</table>

(Snapp et al., 2002)

Adaptability analysis

- Regression approach to evaluate performance of technologies across a range of environments
- Average yield or edaphic factors provide an ‘environmental index’ (Hildebrand and Russell, 1996)
- Calories produced can be used to compare technologies (Snapp, 2002)
G by E

Key Points

- Choose experimental design
- Embrace environmental variability
- Large number of on-farm sites required
  - Keep it simple on-farm
- Document farmer assessment, ranking or rating

Summary

1. researcher managed
2. consultative
3. collaborative
4. farmer managed

Resources

- Participatory Plant Breeding Tool Kit, Zyska, Shelton & Snapp. In review www.seedalliance.org
- SARE On-farm experiments grants & resources www.sare.org

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