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

Sieglinde Snapp, Michigan State University

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http://www.extension.org/organic_production

Dr. Sieg Snapp
Dept. Crop & Soil Sciences, Kellogg Biological Station
Michigan State University

Participatory On-Farm Research

Beyond the Randomized Complete Block Design

What is on-farm research?

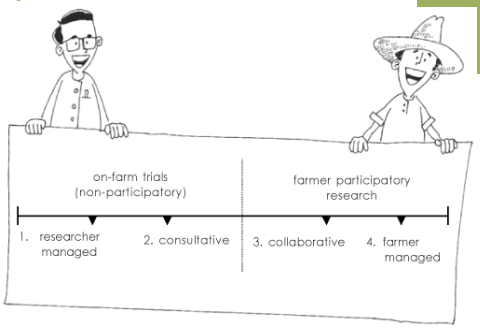
Observations, evaluation of a new practice or variety, or a systematic comparison of management systems

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

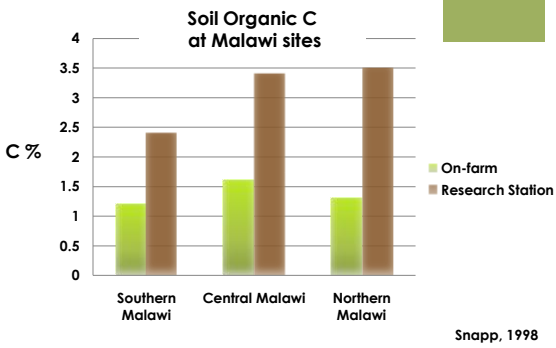


Researcher-Farmer Continuum Gonsolves et al., 2005

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



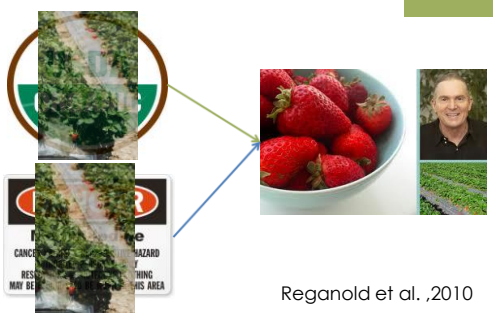
Snapp, 1998

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

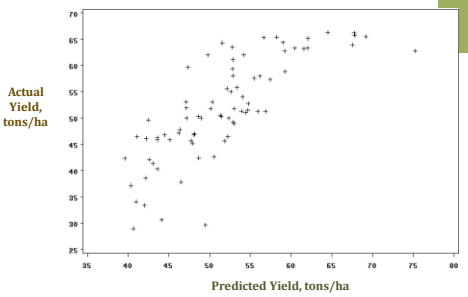
- Multivariate approach

  - Weighted Averages
  - Principal Component Analysis (PCA)
  - Canonical Correspondence Analysis (CCA)

Characterizing complexity: GIS

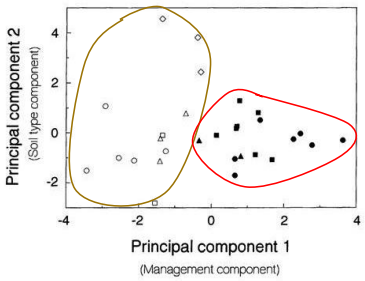
Grids were established for monitoring potato fields using a Trimble Pro-XRS GPS receiver unit with real time differential correction. (Po et al. 2010)

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(EC_a) R^2 = 0.60; Po et al. 2010

Multivariate Example



Group of on-farm studies analyzed by PCA. In this case, PCA distinguished between impact of soil type, and management (organic versus conventional) in tomato fields. Drinkwater et al. (1995)

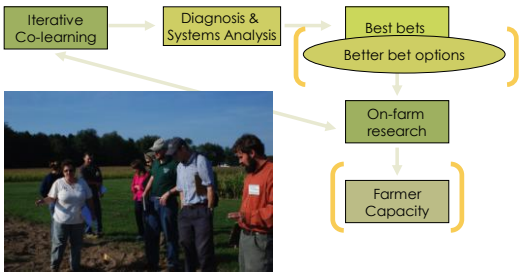
Relevance:
Key points for on-farm studies

- **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

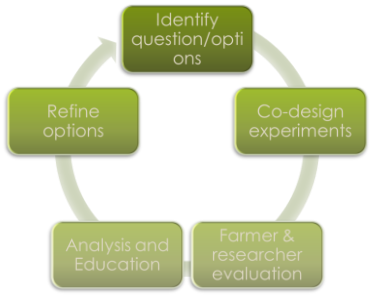
Objectives - take two

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

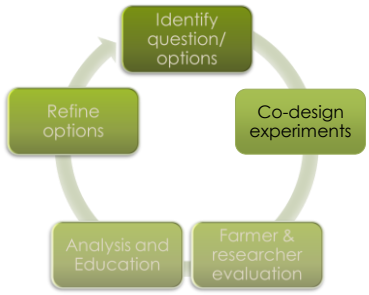
Engaged research 4 impact



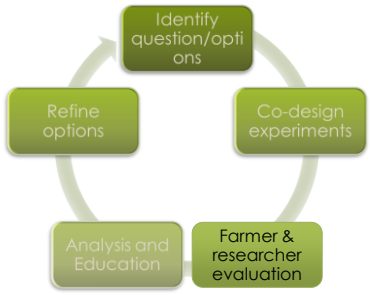
Iterative learning cycle



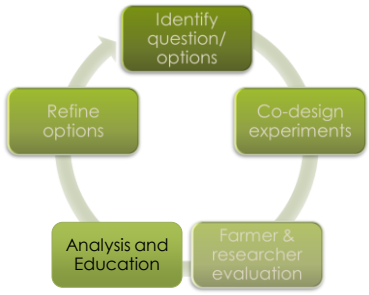
Iterative learning cycle



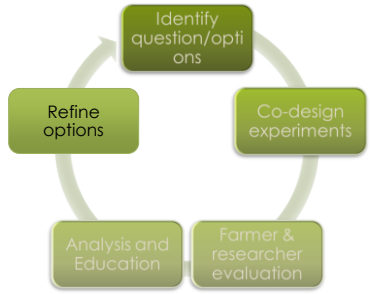
Iterative learning cycle



Iterative learning cycle



Iterative learning cycle



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
- Chose 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

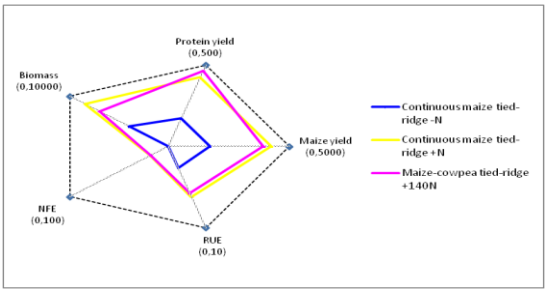
Opportunities

http://www.sare.org/Grants/Grants-Information

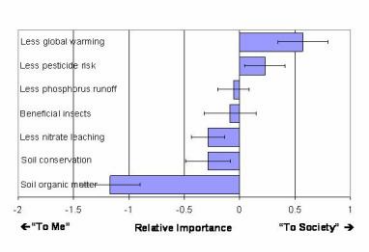
Engaging Learning: Key points

- **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'

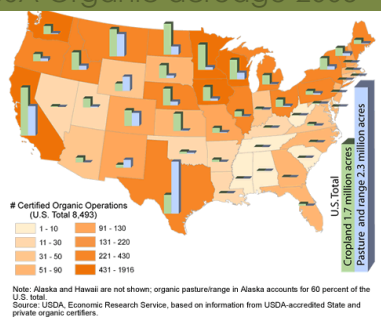


Farmer ratings of system benefits



Swinton et al., 2011

Adoption study: USA Organic acreage 2005



Note: Alaska and Hawaii are not shown; organic pasture/range in Alaska accounts for 60 percent of the U.S. total.
Source: USDA, Economic Research Service, based on information from USDA-accredited State and private organic certifiers.

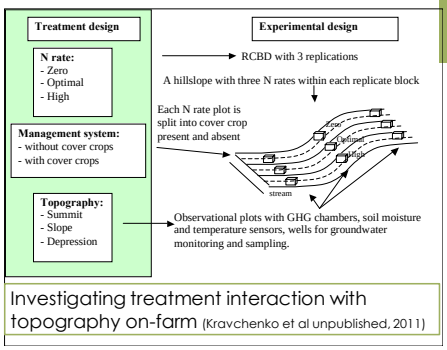
Objectives - take three

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

G by E
Analytical approaches

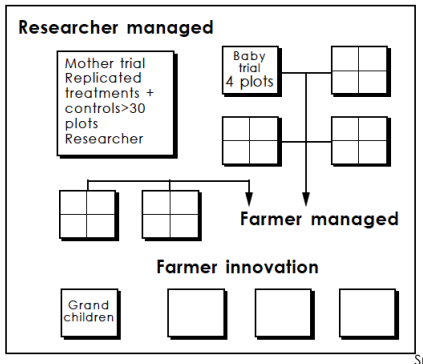
- Spatial analysis
- 'Mother and daughter' trials
  - Latin Square design
  - Adaptability analysis
- Non-parametric methods for paired comparisons with checks
  - Wilcoxon's signed rank test

Spatial Experimental Design Field



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

'Mother and daughter' trial design



Snapp, 1998

'Mother and daughter' trial design

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Systematic linkage

- 2. Unreplicated c
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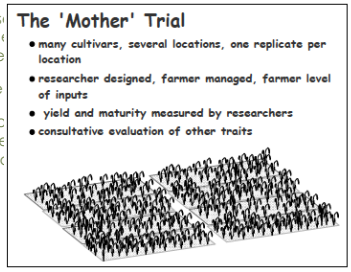
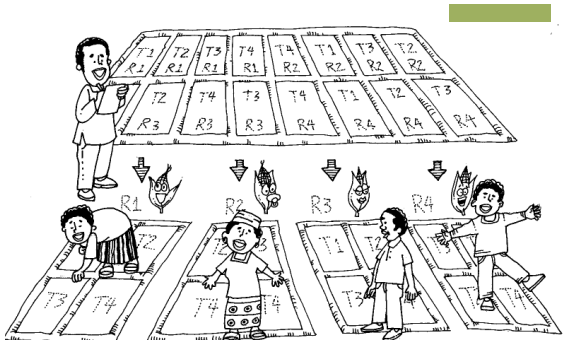




Design approaches: 1) Latin square design
2) Replicate one treatment per daughter trial

On-farm monitoring

Michigan State University Field Trial Recording Form, 2010-2011

ORGANIC DRY BEAN PRODUTION SYSTEMS

Cooperator name: _____

Treatments:

1- _____

2- _____

PHYSICAL DESCRIPTION

County: _____ Township: _____

Nearest crossroads: _____

Taylor et al. , 2011

On-farm monitoring

Michigan State University Field Trial Recording Form, 2010-2011

LEARNING OPPORTUNITY

PRE-TRIAL

What are you expecting to learn from this trial experience?

_____

_____

_____

Taylor et al. , 2011

Farmer ranking 'pairwise'

Farmer name: _____ Location of field experiment:

Farmer expert: Yes ____ No_____ Farm size: _____(acres farmed)

Market: Local _____ Wholesale_____ Major crops:_____

Ranking of technologies		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.			
		A	B	C	D
A	Farmer tillage				
B	Strip tillage				
C	Ridge tillage				
D	Chisel plow				

(Snapp et al., 2002)

Purdue On-Farm Research Trials – Plot Information

Name:							
County:							
Soil series:			Drainage [1]:				
Most recent soil sample results [3]:	OM	pH	P	K	Ca	Mg	CEC
Soil sample date?:			☐ Lbs per acre or ☐ ppm?				
Previous crop:			Tillage [2]:				
Invididual plot length (ft):			Individual plot width (ft):				
Hybrid (Company and brand):							
Planting date:			Seeding rate:				
Harvest date:			Header width (ft):				
Yield monitor?	___ Yes	___ No	If yes, equipped w/ GPS?	___ Yes	___ No		

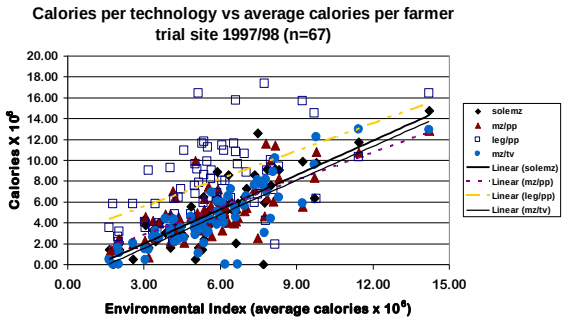
PURDUE UNIVERSITY

t http://www.agry.purdue.edu/ext/ofr

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)

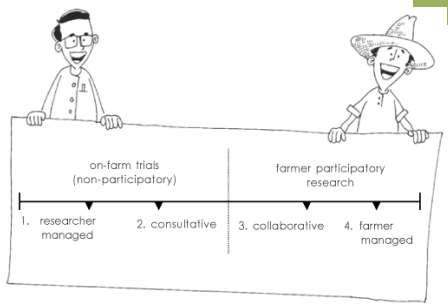
Adaptability analysis



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

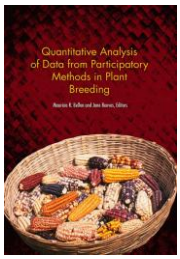
Summary



Gonsolves et al., 2005

Resources

- Participatory Plant Breeding Tool Kit, Zystro, Shelton & Snapp. In review www.seedalliance.org
- Quantifying farmer evaluation of technologies. Snapp, 2002. www.cimmyt.org
- Systems Research Drinkwater In press www.southernsare.org/News-and-Media/Blog/Why-Systems-Research
- Weltzien and Christinck. 2008. Participatory breeding: Developing Improved and relevant crop varieties with farmers. In: Ag Systems, Snapp & Pound, Academic Press
- SARE On-farm experiments grants & resources www.sare.org



Contact: snapp@msu.edu