Designing participatory action research (PAR) for educational, social, and environmental benefits:

A case study of cover crop research with Brooklyn gardeners

Megan M. Gregory & Scott J. Peters
Ecological Society of America • 6 August 2013

Good morning! My name is Megan Gregory.

I work with community gardeners in Brooklyn, NY to research agro-ecological practices for urban gardens, specifically cover cropping.

I also have a strong interest in **using participatory research** as a tool for **community education** and **building more just and sustainable food systems**.

Outline

1. Environmental Justice
   - Definition & implications for ecological research
2. Public Participation in Scientific Research (**PPSR**)
   - Project design framework
3. Case study: Participatory action research (**PAR**) project on cover crops with Brooklyn gardeners
   - Facilitating positive outcomes for science, education, and communities

In keeping with the theme of this session, "Doing Justice Through Your Research," in this presentation I will:

Consider the **meaning of environmental justice**, and how ecological research may contribute to it; and

Introduce a framework from the field of **Public Participation in Scientific Research (or PPSR)** that may help ecologists **enhance environmental justice outcomes of our research.**

Finally (and mostly) I will present a **case study of my own work researching cover crops with Brooklyn gardeners**. I'll focus on what **we're learning about facilitating positive outcomes for science, education, and communities through participatory action research** (PAR), which is one approach to PPSR.

Environmental Justice: Definitions

- "… the ***fair treatment*** and ***meaningful involvement*** of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (US EPA, 2012, emphasis added)

- "… both a field of study and a social movement that seeks to address the unequal distribution of environmental benefits and harms and asks whether the ***procedures*** and ***impacts*** of environmental decision-making are fair to the people they affect" (Bryant and Callewaert, 2003, emphasis added)

Environmental justice is understood in many ways – I've put up just two definitions here. What I'd like to call attention to is that both definitions affirm the importance of:

Just processes that provide **opportunities for people to influence the decisions** that affect their lives, and

Just outcomes that **enhance the environmental and social well-being of communities**, whether that is access to healthy food, opportunities for interaction with the natural world, an environment free of pesticides that threaten human health, and so forth.

Public Participation in Scientific Research (PPSR)

- "Collaborations in which members of the public engage in the process of research to generate new, science-based knowledge" (Shirk et al., 2012)

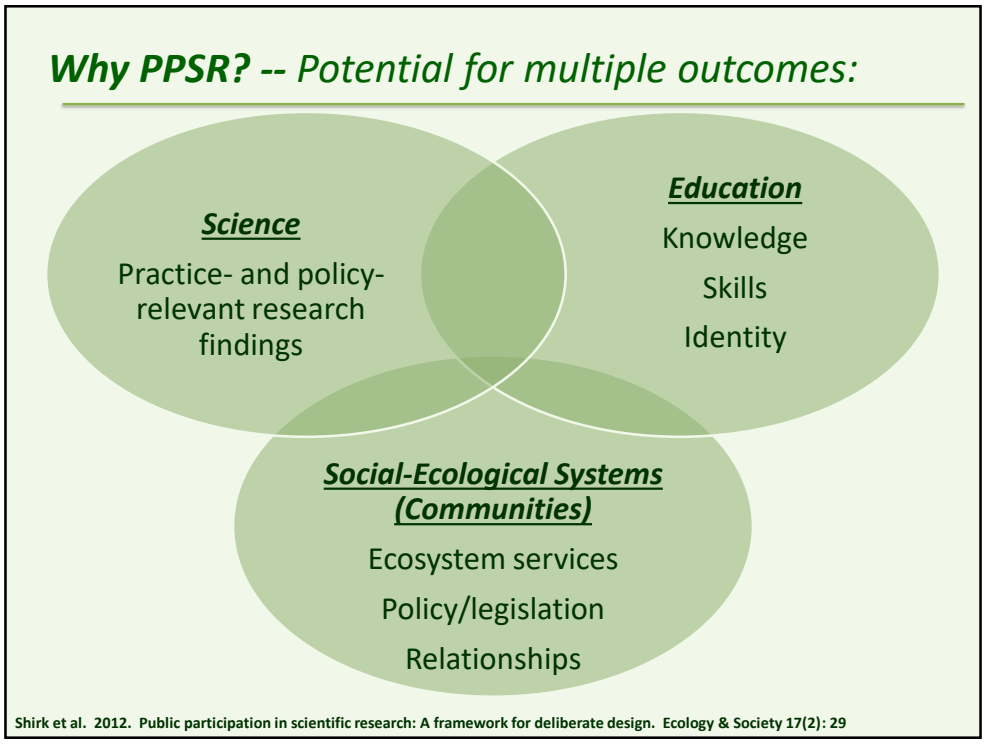


Shirk et al. 2012. Public participation in scientific research: A framework for deliberate design. Ecology & Society 17(2): 29

Photos: Left & Center: http://caise.insci.org/uploads/docs/PPSR%20report%20FINAL.pdf, pp. 30 & 38; Right: M. Gregory

As several of the previous speakers have illustrated, **ecologists can contribute to environmental justice by facilitating public participation in scientific research** (or PPSR) – particularly research to inform environmental stewardship practices that have implications for community health and livelihoods.

However, **"doing justice" through participatory ecological research**, I would suggest, requires intentional efforts to **ensure that the research processes and outcomes contribute to community well-being**.



Scholarship on PPSR offers a helpful framework for considering how ecologists can contribute to EJ by designing projects to produce positive outcomes in (at least) three broad categories:

Outcomes for **science**, for **education**, and for **social-ecological systems**, or communities.

How to facilitate such outcomes is an important question for ecologists and community leaders seeking to advance environmental justice through research.

Case Study Research Question:

How can participatory action research (PAR) be organized & facilitated in an urban gardening context to achieve positive outcomes for science, education, and communities?

← Gardeners monitoring nodules on crimson clover, Spring 2013

PAR: Greenwood & Levin, 2007; Ballard & Belsky, 2010

We are conducting a **case study of a two-year participatory action research, or PAR, project with Brooklyn gardeners** designed to explore essentially that question. We are asking:

> **"How can PAR be organized and facilitated in an urban gardening context to achieve positive outcomes for science, education, and communities?"**

PAR is one form of PPSR, in which **scientists and community groups collaborate** on an inquiry project, with the goal of **informing action for community well-being** – in this case, stewardship practices in the gardens. A **distinctive feature of PAR** is that **community groups are involved in defining the goals and research questions** of the project and sharing results, as well as in data collection.

In the rest of this presentation, I'll provide some background on this project, and share what we're learning about project design choices that may contribute to positive outcomes with environmental justice implications.

← *Urban ag challenges:*

- Building soil quality & fertility with limited access to composts & mulches

Agro-ecological solutions →

- Example: Cover cropping adds organic matter and nutrients

Legume nitrogen fixation

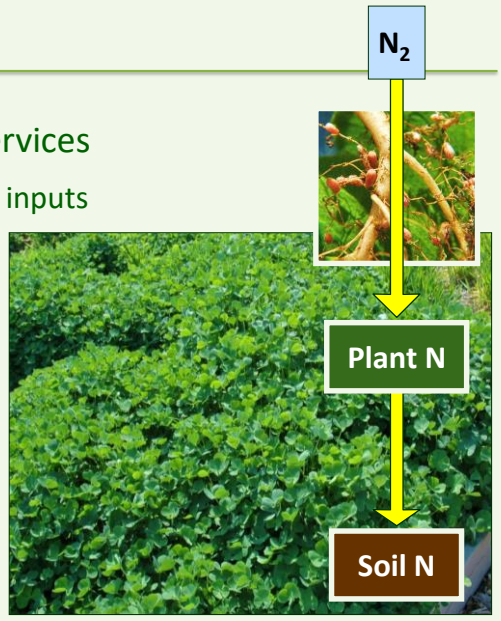
Soil quality challenges in urban gardens: Baker, 2002.

By way of background, we initiated this project largely in response to urban gardeners' concerns about soil quality.

Ecologically-based agricultural practices, like cover cropping, may help address this concern.

Cover Crops

- Garden-level ecosystem services
  - Soil quality (organic matter inputs from cover crop biomass)
  - Nutrient cycling
  - Weed suppression
  - Beneficial insects
- Environmental benefits
  - ↓ chemical fertilizers



Crimson clover cover crop
Inset: nodules on clover roots

Snapp et al., 2005; Drinkwater et al., 2008.

Cover crops are **close-growing crops** – like winter grains, clovers, and vetch -- that are planted in rotation with food crops to **enhance the soil** and provide other **ecosystem services for agriculture**. They are not harvested, but rather cut down and returned to the soil (as a mulch) before planting vegetables again.

Cover crops may enhance productivity and provide other benefits by:

Improving soil quality;

Enhancing nutrient cycling through nitrogen fixation by legume cover crops;

Shading out weeds; and

Attracting beneficial insects.

Cover Crop Research: PAR Activities

Summer:
Workshops to design cover crop research
Gardener priorities:
Soil quality
Weed suppression

Early Fall:
Planted cover crop combinations
Pea & oat/pea
Clover & rye/clover
Vetch & rye/vetch

Fall - Spring:
Monitored & evaluated cover crops
Cover, biomass, N fixation, weed suppression
Gardeners' observations

This PAR project is directed toward helping gardeners **select, manage, and evaluate cover crops** to enhance the productivity and sustainability of their gardens.

In planning meetings, gardeners identified **soil quality and fertility** and **weed suppression** as priority management goals.

For two seasons, we selected **cover crop combinations** to test and under-seeded them to food crops in garden research plots.

Then, we **monitored the different cover crops using indicators linked to gardeners' priority goals**.

I took measurements such as plant biomass, and

We also engaged gardeners in field-based monitoring.

Gardener Monitoring using Agroecosystem Analysis

Soil cover

Cover crop height

Nodules on legume roots

Weed suppression

With the help of community educator partners, gardeners observed their cover crop plots and used simple checklists to record agro-ecological indicators, such as:

Soil cover

Cover crop height

Number and inner color of nodules, or "bumps" with nitrogen-fixing bacteria, on the roots of legume plants (a red or pink color signifies that the bacteria are actively fixing nitrogen), and

Weed suppression.

If you're interested in the cover crop research, please do contact me and I'm happy to share what we're learning about cover crop performance and the effects of background conditions (such as soil and light availability) in these gardens.

Methods: Case Study

1. **Field notes**
2. **Narrative interviews with gardeners**
   - Significance of the PAR experience for gardening practices and broader goals for themselves & their neighborhoods
3. **Group evaluation sessions** (Fall 2011 & 2012)
   - Themes: Cover crops & practices, workshop logistics, gardening knowledge & skills, involving gardeners in research
4. **Surveys on cover crop management and impacts**
5. **Documentation**
   - Workshop outlines & products

Yin, 2008

Today, however, I will focus on the case study addressing our question about project design choices that may facilitate positive outcomes for science, education, and communities.

We are using many sources of data to understand the PAR process and outcomes, including:

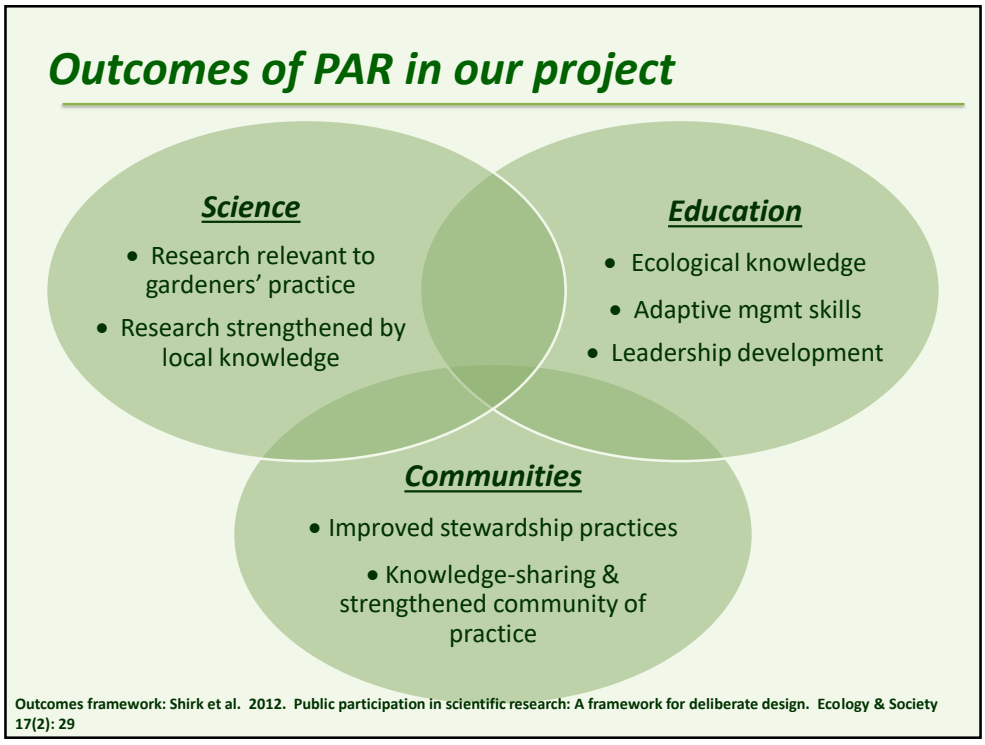
Field notes on the workshops;

Narrative interviews with gardeners;

Group evaluation sessions;

Follow-up surveys with gardeners to gain their perspectives on cover crop management and impacts; and finally,

Documentation, including workshop outlines and workshop products (like gardeners' evaluations of the cover crops and suggestions for management improvements at the last monitoring workshops).



Our initial results suggest that **PAR in urban gardening education can have a number of positive outcomes**, including:

Science that is relevant to gardeners' practice, and **strengthened by local knowledge**;

Educational benefits for participating gardeners, such as **ecological knowledge, adaptive management skills, and leadership development**;

And **broader environmental and social impacts**, including **improved stewardship practices**, and **sharing of knowledge between gardens**.

Although time constraints prevent me from discussing each of these outcomes, I will illustrate a few of the most important ones, along with the practices that contributed to them.

Relevant research

- *"Talking about the crops that gardeners have planted brought out the importance of a fall harvest as something we need to consider when choosing cover crops… I made a mental note to focus on cover crops that … can be underseeded into standing food crops."* (Field notes, 12/July/2011)

- ***"Being able to sow [cover crops] with eggplants that are still in the ground, was really an insight and helpful. It will make me more likely to do it in the future."*** (Bedford-Stuyvesant gardener, Group evaluation session, Fall 2012)

Rye & crimson clover, undersown to eggplant

In outcomes for science,

Engaging gardeners in designing the research made it relevant to their needs and vegetable crop rotations.

For example, **gardener input into cover crop selection and planting practices** led to a **focus on under-seeded cover crops** – cover crops that can be established beneath food crops so that gardeners can harvest vegetables into the fall.

Gardeners later commented on how **this made the research results applicable in their gardens**. In the Fall of 2012, one gardener noted:

> "Being able to sow thing[cover crops] with eggplants that are still in the ground, was really an insight and helpful. It will make me more likely to do it in the future." (Bedford-Stuyvesant gardener, Group evaluation session, Fall 2012).

Relevant research

How? ***Gardener input into research design through a garden diagramming activity followed by group discussion.***

Gardeners discuss priority management goals for cover cropping and cover crop species and practices to test, Summer 2011.

In this case, relevant research resulted from **inviting gardeners' input into research design** through a **garden diagramming activity** to help gardeners identify areas for management improvements, followed by **group discussion** on priority management goals for cover cropping and the most feasible species and practices to test.

Ecological knowledge & adaptive management

- **Ecological knowledge**
  - Nitrogen fixation
  - Weed suppression by cover crops
- **Adaptive management skills**
  - Systematic observation
  - Drawing on observations to suggest improvements in management practices

How? ***Participating in outcomes monitoring using agroecosystem analysis (AEA) and simple checklists***

In outcomes for education…

Participating in collaborative research can **enhance gardeners' ecological knowledge** and **skills for adaptive management** – that is, observing and refining practices based on the results of previous practices.

In our project, **gardeners learned about ecological processes such as nitrogen fixation and weed suppression**, and the potential benefits of these processes in their gardens.

The main activity that facilitated these educational benefits was engaging gardeners in **monitoring the outcomes of their plantings using agroecosystem analysis and simple checklists**.

Outcomes monitoring using AEA

- Nitrogen fixation knowledge:
  - ***"Watching the nodules, pulling them out and looking at them for the color… I thought that was very interesting because I didn't even know that was important, how the dirt needs to have nitrogen in it."*** (Bedford-Stuyvesant gardener, Interview, Spring 2012)
- Weed suppression knowledge:
  - ***"After we planted the crimson clover, when we measure, it was practically no weeds there. But where we didn't have [cover crops] – the control area, you called it – the weeds that it had! So, I see the importance now of the cover crop."*** (Brownsville gardener, Group evaluation session, Fall 2011)

For example, one gardener noted how **looking for nodules on the roots of legumes helped her to understand the importance of nitrogen fixation** in supporting a healthy crop: "Watching the nodules, pulling them out and looking at them for the color… I thought that was very interesting because I didn't even know that was important, how the dirt needs to have nitrogen in it."

Another gardener shared how she **learned about weed suppression by cover crops by comparing weeds in control plots and cover-cropped plots**: "[A]fter we planted the crimson clover, when we measure, it was practically no weeds there. But where we didn't have [cover crops] – the control area, you called it – the weeds that it had! So, I see the importance now of the cover crop."

Leadership development & knowledge-sharing

"The more educated I get on gardening, I could pass it along to the children… and they will pass on, and hopefully, by our next generation, we'll have a healthier generation. We'll have less obesity. We'll have less hypertension…

… "I explain [cover cropping] to the kids, and they're excited because they want to know, 'What was that little stuff growin' up?' So I explained to them what cover crop was. The purpose of the cover crop, which it serve greatly, as eliminating weeds, and the nutrients that it put back in the soil, that you have a healthier and more productive crop for the next year. So they was very interested to see, when you cut open the nodules come the spring time, how inside gonna look."
(Brownsville community gardener, Interview, Fall 2011)

How? ***Gardeners were inspired to share a practice that advances their values (e.g., community health, care for the environment)***

Another important educational outcome for many gardeners was **leadership development**.

For example, one gardener recalled how **she shared her new knowledge of cover cropping with youth in a market gardening program** designed to improve access to fresh foods in the community:

> "I explain [cover cropping] to the kids, and they're excited because they want to know, 'What was that little stuff growin' up?' So I explained to them what cover crop was. The purpose of the cover crop, which it serve *greatly*, as eliminating weeds, and the nutrients that it put back in the soil, that you have a healthier and more productive crop for the next year. So they was very interested to see, when you cut open the nodules come the spring time, how inside gonna look."

For this gardener, and others whose stories I don't have time to share today, **learning about cover cropping connected to broader hopes for their communities** – such as **community health,** and **environmental awareness and concern**. Sharing what they learned with the cover crops provided an opportunity to pass on these values, through a practice that makes at least a small contribution to realizing them.

Opportunities for participants to be educators

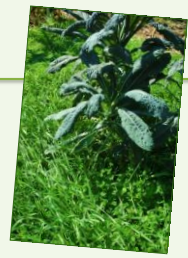
While gardeners shared what they learned with others on their own, it occurred to me that **we could provide opportunities for them to be educators** in their neighborhoods – such as the **field day** pictured here.

Several groups of gardeners have organized events to **show the cover crops to other neighborhood gardeners**, **explain how and why we planted them**, and **introduce kids to soil science and nitrogen fixation with hands-on demonstrations**.

The experience of planning and leading a field day has helped develop gardeners' skills and confidence in sharing their learning with others. Some gardeners who helped plan field days became community educator partners in the project's second year.

Stewardship practices

How? ***Sustained, in-person support in choosing, planting, and managing cover crops***



- ***"[A lesson] that came out of the planting workshops was the importance of… working with gardeners to choose a cover crop that fits their specific vegetable planting schedule, gardening goals, and garden site… 'I got seeds before, but I never planted them because I never fully understood what was what, what to expect, and what to do,' said [gardener]…"*** (Field notes, 25/Sept/2011)
- ***"Sometimes you go to a regular seminar, and you just sit down and you listen! But here, I have to participate. I had to help scatter the seeds, to scratch up the soil. It was not just, you tell me something, and I have to go home and look it up. You were with us, in the field. You work with us, you see? That's the difference with the research."*** (East NY gardener, Fall 2011 evaluation session)

In addition to developing knowledge and skills through PAR, people may also **implement improved stewardship practices** … in our case, planting and managing cover crops, which may improve soil fertility and support good vegetable harvests with little or no fertilizer.

*(*click*)* Having **sustained, in-person support** empowered gardeners to actually implement new practices with environmental and agricultural benefits in the community.

Both of the quotes I've put up here illustrate how this kind of support was important for gardeners planting cover crops for the first time.

The first is from my field notes on our first round of planting workshops in 2011:

> "[A lesson] that came out of the planting workshops was **the importance of… working with gardeners to choose a cover crop that fits their specific vegetable planting schedule, gardening goals, and garden site**… 'I got seeds before, but I never planted them because I never fully understood what was what, what to expect, and what to do,' said [gardener]…"
>
> Participating in a research project provided an opportunity for her (and others) to learn about different cover crop options, and have someone work alongside her to choose, plant, and monitor cover crops for specific vegetable beds.

The second quote is from a gardener during our Fall 2011 evaluation session. As she commented on the experience of participating in research, she said:

> "Sometimes you go to a regular seminar, and you just sit down and you listen! … But here, I have to participate. I had to help scatter the seeds, scratch up the soil… It was not just, you tell me something and I have to go home and look it up. You were with *us*, in the field. You *work* with us, you see? That's the difference with the research."

Outcomes and Effective Practices in PAR

Outcomes ("What?")	Effective Practices ("How?")
• Relevant research informed by local knowledge	• Collaborative research design and interpretation – deliberative processes & frequent, informal conversations
• Ecological knowledge • Adaptive management skills (e.g., systematic observation)	• Outcomes monitoring, using agroecosystem analysis and checklists
• Leadership development	• Opportunities for gardeners to share new knowledge with others (e.g., field days)
• Stewardship practices with environmental & ag benefits	• In-person support applying agroecological management practices
• Enlarged & strengthened communities of practice	• Opportunities for visiting other gardens and exchanging knowledge, practices, & resources

This chart sums up some of the lessons we learned about achieving outcomes for science, education, and communities through participatory action research:

In order to enhance the relevance of research to practice, we found it helpful to design and interpret our research in a collaborative way. This included deliberative processes to define research goals and questions, and choose cover crops to test.

To build ecological knowledge and adaptive management skills, we engaged gardeners in monitoring the outcomes of their plantings using agroecosystem analysis, and simple checklists.

To develop participants' skills as leaders and educators, it seems beneficial to facilitate opportunities for them to share their new knowledge with others, such as field days;

For promoting improved stewardship practices, we found that it's essential to provide in-person support – simply handing out bags of seeds doesn't provide the necessary confidence.

Linking back to the theme of this session, I would suggest that making intentional efforts to foster educational and community outcomes, that enhance participants' capacities and quality of life, can make an important contribution to environmental justice.

Challenges for PAR in our project

1. **Negotiating project design to address community priorities *and* expectations of the academic community**

2. **Time:** Designing a project that is feasible for busy people, but taps the educational potential of engagement in multiple steps of research
   - Trade-off between breadth and depth of participation
   - "Quality time" -- Each workshop a unique contribution to research, stewardship, and/or learning

3. **Providing sufficient research and education support with limited funding for community educator partners**

4. **Designing accessible record-keeping forms and processes**

So I've talked a lot about the potential benefits of PAR.

Yet it also has significant **challenges that make it difficult to put into practice and sustain** in community gardens.

I don't have time today to reflect fully on these challenges and how they might be addressed, but I do want to acknowledge them in order to provide a balanced perspective on facilitating PAR. I will be reflecting and writing more about these challenges in the coming months, and would welcome further discussion with folks doing similar work.

There are too many people and organizations for me to thank in a 15-minute presentation, but I am indebted to our community gardener partners, gardening and greening organizations in Brooklyn, faculty and student mentors and research assistants, and funders.

Thank you for joining us this morning, and please keep in touch to share experiences and best practices doing participatory research that supports sustainable community food systems work!

Extra slides

For use as needed during questions & discussion

PPSR Models by Degree of Participation

Steps in Scientific Process	Contributory	Collaborative	Co-Created
Define questions			
Gather information			
Design data collection methods			
Collect samples / record data	✓		
Analyze samples			
Analyze & interpret data			
Disseminate conclusions, translate results to action	(✓)		
Ask new questions			

Learning outcomes:

- **Process of science**
- **Data interpretation**
- **Communicating results to decision-makers**

Community outcomes:

- **Enhanced resource management**
- **Timely policy decisions**

Citizen science

Farmer Field Schools

PAR

Bonney et al.. 2009. Public participation in scientific research: Defining the field and assessing its potential for informal science education. A CAISE inquiry group report. Center for Advancement of Informal Science Education (CAISE), Washington, D.C.

Scholars of PPSR suggest that the outcomes of such projects – whether for science, stakeholders, or communities -- depend on the **degree and quality of public participation.** In the next two slides, I'll elaborate on what those terms mean in the context of project design.

Degree of participation refers to the **steps in the inquiry process** where the public is engaged. This chart outlines three basic categories of PPSR projects based on degree of participation:

At one end of the spectrum are **Contributory projects**, in which **members of the public collect data** to answer research-defined questions.

Most **citizen science** projects fall into this category.

At the other end of the spectrum are **Co-Created projects**, in which members of the public **identify the questions of interest** and are **involved in all stages of the research** process.

Participatory action research projects fall into this category.

In between are **Collaborative projects**. Scientists may loosely define the questions and protocols, but members of the public help refine the questions and data collection strategies, and are often involved in interpreting data and presenting results.

Depending on the **source of the questions** being explored and the **extent of stakeholder engagement in data collection, interpretation, and dissemination**, Farmer Field Schools and similar Extension approaches range from **collaborative to co-created** project models.

Case studies of different PPSR projects indicate that the **greatest potential for learning lies in collaborative and co-created projects**. Some of the learning outcomes that occur in collaborative and co-created (but not contributory) projects include:

Understanding of the process of science, and

Skills in interpreting data and communicating results to fellow citizens and decision-makers.

Co-created projects are also associated with **enhanced natural resource management** and **timely policy decisions**.

This is not to say that one model is "better" than another, as it is also important to consider public participants' time and interest in engaging in various steps of the research process. However, it is important to be aware of the implications of different project designs for potential outcomes.

Quality of participation in PPSR

- "The extent to which a project's goals and activities align with, respond to, and are relevant to the needs and interests of public participants."

  → "Whose interests are being served?"

← *Gardeners in East New York, Brooklyn discuss & prioritize their management goals for cover cropping, Summer 2011*

Shirk et al. 2012. Public participation in scientific research: A framework for deliberate design. Ecology & Society 17(2): 29

The second design consideration is the **quality of public participation**.

This involves ensuring that the **research focus and process is responsive and relevant to the needs and interests of public participants**.

In other words, high-quality participatory research will:

Address questions of practical importance to participants, and

Include opportunities for participation in research activities that **address participants' goals for themselves and their communities**, while taking into account the time and interest they have to invest in the project.

Cover Crop Research Questions

- Best cover crops & practices for:
  - Soil cover
  - Biomass
  - N fixation
  - Weed suppression
- Effects of background conditions: Soil, light, & intercrops
- Field-based monitoring tools for evaluating cover crop performance

First, we are asking **how species composition and management practices affect cover crop performance** in urban gardens, specifically:

Soil cover

Biomass production

Nitrogen fixation, and

Weed suppression

Second, we are also exploring the **effects of background conditions** – such as **soil properties, light availability, and intercrops** -- on the performance of specific cover crop combinations.

We are also working to develop **field-based observations** that gardeners can use to monitor and evaluate cover crop performance.

Monitoring: Soil protection & cc growth

1. COVER CROP GROWTH

a) Visual % Cover (check one):

☐ 1-10 % ☐ 11-25% ☐ 26-50% ☐ 51-75% ☐ 76-100%

b) **Cover Crop Height:** Take 2 measurements. For mixtures, record legume & grass height.

Height 1: Legume: _____ in (mixtures only →) Grass: _____ in

Height 2: Legume: _____ in (mixtures only →) Grass: _____ in

c) **MIXTURES ONLY: Cover Crop Composition:** % Legume: _____ % Grass: _____

Here are some excerpts from the monitoring checklist:

In the first part, the gardeners used reference charts to place each plot in a percent cover class, based on how much of the ground is covered by the cover crop.

Monitoring: Weed suppression

2. WEED SUPRESSION:

a) **Percent Weeds** (use percent cover charts to estimate): _____ %

b) **Most common weeds** -- List. Indicate weeds producing seed with a star (*)

_____ _____
_____ _____
_____ _____

c) **Compared with the control plot, the *cover crop plot* has** (check one):
☐ More weeds ☹ ☐ Less weeds ☺ ☐ Same amount of weeds 😐

d) **How satisfied are you with weed control by the cover crops?** (check one):
☐ ☹ Not satisfied – weeds in the plot are a major concern; cover crops did not help
☐ 😐 Somewhat satisfied – weeds are not too bad; cover crops helped a little
☐ ☺ Very satisfied – weeds are not a problem; cover crops helped a lot

e) **Are there weeds producing seeds?** ☐ Yes ☐ No



The second part of the checklist was weed suppression. Gardeners:

Estimated total percent weed cover in the plot;

Listed the most common weeds;

Compared the cover crop plot with the control plot; and

Indicated how satisfied they were, or were not, with weed control.

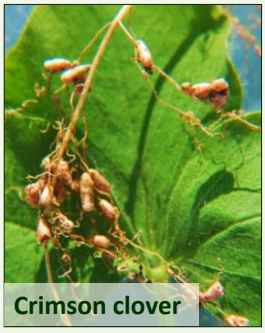
Monitoring: Nodulation

4. NITROGEN FIXATION

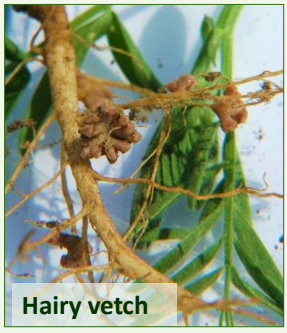
*Pull up two legume plants (**crimson clover** or **hairy vetch**) and examine the roots.*

	Plant 1	Plant 2
a) Count the nodules:	# Nodules: _____	# Nodules: _____
b) Inner Nodule Color:	☐ Mostly pink ☐ Some pink ☐ White or green	☐ Mostly pink ☐ Some pink ☐ White or green

Field peas



Crimson clover



Hairy vetch

This excerpt shows where gardeners record information about nodules on the roots of legume plants.

Gardeners recorded the number of nodules as well as inner color. (A pink or red color inside the nodules indicates that the Rhizobia bacteria are actively fixing nitrogen).

Research strengthened by local knowledge

Wheat under row cover, 3 wks after replanting →

How? ***Gardeners' contributions of local knowledge through informal conversations helped interpret results, and suggested a solution for improving cover cropping practice.***

Gardener participation not only resulted in more relevant research, it also **strengthened our research with their knowledge of local environmental conditions**.

As just one example of how **gardener participation informed our understanding of cover crop performance**, when the wheat was doing poorly in 2011 *(*click*)*, it was the gardeners who noted that they often had problems with pigeons, (for example, eating spring greens that weren't covered with netting). They suggested that if we *(*click*)* covered the seed with row cover to protect it from birds, perhaps it would be able to germinate and grow – *(*click*)* which was, in fact the case.

In this case, **gardeners' contributions of local knowledge occurred through informal conversations** as we observed and puzzled over the results of our plantings. Through these conversations, **gardeners helped interpret the results** of our experiment, and **suggested a solution for improving cover cropping practice** in urban settings.

In 2012 we took care to do this for all of our cover crop plots, which greatly improved establishment of legume-grass mixtures.

Strengthening the gardening CoP?

- **Within the PAR group:** Increased opportunities to gather within and between gardens
  - Sharing gardening knowledge, practices, plants
  - Sharing opportunities & resources (greening organizations, small grant programs)
- **Beyond the PAR group:** Sharing of locally-adapted practices generated through PAR
  - Ex: Other gardens requesting cover crop seeds and row cover from local gardening organization

Barthel, 2010; Wenger, 1998, 2006

Thinking beyond the immediate, tangible stewardship outcomes to more **dynamic community capacities and relationships**… at this point, it's difficult to say what the outcomes of PAR in Brooklyn gardens will be, so I'm getting into speculation about possibilities rather than observed outcomes.

However, I do think there is some **potential for PAR to strengthen and contribute to communities of practice** – groups of practitioners who learn to improve their practice through regular interaction.

Within the PAR group, **gardeners had more opportunities to gather with gardeners from their own garden** (such as during the planting or cover crop monitoring workshops), as well as the chance to **visit other gardens** during large-group workshops.

All of these meetings had some activities related to the cover crop research, but they were also **occasions for sharing general gardening knowledge and practices**, as well as **knowledge of opportunities and resources** for strengthening gardens (like small grant programs).

Beyond the PAR group, I think that **participants were able to contribute their new knowledge of cover cropping practices in the larger gardening community of practice** – for example, the Urban Agriculture coordinator from a local gardening organization noted that gardeners who were not involved in the project requested cover crop seeds and row cover after seeing the practice in other gardens or talking with gardeners who were participating in the research.

Challenges for PAR in our project

1. **Negotiating project design to address community priorities *and* expectations of the academic community**

2. **Time:** Designing a project that is feasible for busy people, but taps the educational potential of engagement in multiple steps of research
   - Trade-off between breadth and depth of participation
   - "Quality time" -- Each workshop a unique contribution to research, stewardship, and/or learning

3. **Providing sufficient research and education support with limited funding for community educator partners**

4. **Designing accessible record-keeping forms and processes**

Some of the challenges we faced include:

First, negotiating project design to address community priorities within the constraints of a discipline-specific dissertation project was difficult, and raises broader questions about how graduate education and research funding might be shaped to better complement public interests.

Second, respecting gardeners' limited time was another challenge – I found that I had to make a real effort to **'feel out' a feasible level of participation, but one that still tapped the educational potential of engaging in multiple steps of the research**.

I began to focus on what I call "quality time" rather than "quantity time" by ensuring that each workshop or activity where I asked for gardeners' participation made a unique contribution to the research, their garden, or their learning.

Third, I found that **maintaining high-quality research and education required a huge degree of one-on-one, garden-by-garden support**. Having very **limited funding for community educator partners** was a major obstacle to providing that support without burning out.

I think it will be difficult for gardening and greening organizations to devote the time to facilitate collaborative research without at least half- or full-time support for community educator partners.

A final difficulty was **designing accessible record-keeping forms and processes**, which is a challenge I actually think we were able to address with the monitoring checklists (complemented, of course, by one-on-one support and guidance).