

## ***The Garden Ecology Project (GEP):***

### ***Enhancing Urban Food Production, Ecosystem Services, & Environmental Education in NYC Community Gardens***

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**Background:** City dwellers, civil-society organizations, and policymakers show growing interest in community gardening for its potential to improve nutrition and public health, enhance urban environmental quality, and provide opportunities for urban residents to experience the natural world.<sup>1-4</sup> Community gardens may play important roles in fostering food access and healthy eating, physical and mental health, environmental stewardship, and community organizing.<sup>5-8</sup> Supporting and expanding community gardens could benefit many urban dwellers in neighborhoods where people lack access to affordable healthy foods and opportunities for interactions with nature.<sup>9, 10</sup>

However, urban community gardeners face a number of challenges and knowledge gaps. Social and institutional challenges for city gardeners are well-characterized and include insecure land tenure,<sup>11-15</sup> recruiting and sustaining volunteers,<sup>4</sup> and securing appropriate materials and technical support to garden successfully.<sup>2, 4, 12, 14</sup> Agricultural production and ecological processes, however, have only recently received attention in the research community.<sup>15</sup> As a result, there has been little research on agricultural practices that address the unique constraints of growing food in urban settings. These include: building soil quality in raised beds with imported substrates, which often have poor structure and low water-holding capacity;<sup>16, 17</sup> unbalanced nutrient sources;<sup>17-19</sup> and decreased arthropod natural enemy (predator and parasitoid) populations and higher densities of insect pests.<sup>20-22</sup> There is also a need for practical educational opportunities in sustainable agriculture in cities. At present we have limited knowledge of the educational, environmental, and social outcomes of community gardening education,<sup>2, 23</sup> making it difficult for organizations to design programming to meet particular goals.

**Goals:** Through my research with community gardeners and educators in New York City (NYC) I hope to contribute to the knowledge base for developing ecologically-based management practices tailored to urban gardens. Specific goals include the following:

- 1) Document and understand the contributions of urban gardens to urban food security, ecosystem services, and community development; the major challenges faced by gardeners; and the knowledge systems that gardeners use to continue learning and improving their practices.
- 2) Develop agricultural management practices that enhance food production and ecosystem services in urban gardens, specifically cover cropping and ecologically-based pest management.
- 3) Understand how participatory action research (**PAR**) projects can be designed to achieve positive outcomes for science, education, and communities (including environmental and social benefits), while enhancing educational opportunities in Brooklyn gardens through such a project.

**Projects:** The GEP includes research and education on four topics (described in detail on the following pages):

- 1) [NYC garden characteristics, challenges, and knowledge systems](#)
- 2) [Cover crops for enhancing soil quality, nutrient cycling, and weed suppression in urban gardens](#)
- 3) [Participatory action research in gardening education](#)
- 4) [Ecological insect management](#)

**Contact Information:** The Garden Ecology Project is coordinated by Megan Gregory, a graduate student in the Department of Horticulture at Cornell University. Please contact me if you are interested in collaborating with this project, or to voice questions and suggestions. Thank you!

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***PROJECT #1: Agroecological & social characteristics of NYC community gardens: Understanding & enhancing contributions to urban food security, ecosystem services, and environmental education***

This work involves basic characterization of NYC community gardens, gardening challenges, and gardener knowledge systems. This will help community educators to provide appropriate support for gardeners, document the benefits of community gardens for policymakers and planners, and identify priorities for further research.

Research Questions:

- 1) What are the agroecological and socioeconomic characteristics of urban community gardens and gardeners in New York City? (e.g., crops grown; contributions to food security; management practices for soil fertility, weeds, and insect pests; land use, & plant species richness)
- 2) What are the key constraints to food production for community gardeners in New York City?
- 3) How do gardeners understand and apply ecological knowledge in their gardening practices? Are gardener knowledge systems adequately developed to overcome production challenges? What information sources do urban gardeners use to inform management decisions?

Approaches & Methods

- Survey interviews with >100 gardeners and garden coordinators from > 60 gardens across NYC
- Ecological and agronomic sampling in a subset of these gardens, including: land-use maps, plant species richness inventories, soil sampling and analysis, and scouting for pest and beneficial insects

***Below: Diverse plantings in NYC community gardens. First row, left to right: Tomatoes, okra, yellow squash & sunflowers. Second row, left to right: Lufsa, border of flowers & woody perennials, bitter melon.***











## ***PROJECT #2: Cover cropping for soil quality, nutrient cycling, and weed suppression in urban vegetable gardens***

The second and third projects are situated in participatory action research (**PAR**) on cover crops with two groups of gardeners and educators in Brooklyn, using the “Farmer Field School” (**FFS**) methodology. This is a discovery-based learning method in which groups of gardeners experiment with environmentally-friendly practices and evaluate them using agroecosystem analysis.<sup>24-26</sup> Our practice of interest is *cover cropping*, in which close-growing crops are planted in rotation with food crops to provide ecosystem services for agriculture, including soil cover, organic matter inputs, biological nitrogen (**N**) fixation, and weed suppression.<sup>27</sup>

During the 2011-12 and 2012-13 field seasons, gardeners participated in defining research questions, designing field experiments, planting and monitoring cover crops, and sharing initial findings through field days. Both groups identified soil quality and fertility and weed suppression as priority management goals for cover cropping. In 2011-12, we planted ~100 research plots to four over-wintering cover crop combinations (crimson clover, wheat/crimson clover, hairy vetch, and wheat/hairy vetch). These cover crops are planted in the fall, survive the winter, and grow through early spring before being cut and mulched at flowering in April or May prior to planting the next crop of vegetables.

In 2012-13, we planted ~150 research plots to six cover crop combinations (Table 1). We continued work on over-wintering cover crops (crimson clover, rye/crimson clover, hairy vetch, and rye/hairy vetch), and also added winter-kill cover crops (field peas and oats/peas). Winter-kill cover crops are planted in late August and grow until the first killing frost, then form a dead mulch. Although winter-kill cover crops often do not produce as much biomass as over-wintering cover crops, gardeners can plant vegetable crops in early spring following a winter-kill cover crop (unlike over-wintering cover crops, which grow through early spring).

**Table 1. Cover crop combinations tested in Brooklyn community gardens, 2012-2013**

<b>LEGUME MONOCULTURES</b>		
Field peas ( <i>Pisum sativum</i> subsp. <i>arvense</i> ) 	Crimson clover ( <i>Trifolium incarnatum</i> ) 	Hairy vetch ( <i>Vicia villosa</i> ) 
<b>GRASS-LEGUME MIXTURES</b>		
Oats ( <i>Avena sativa</i> ) / Field peas 	Winter rye ( <i>Secale cereale</i> ) / Crimson clover 	Winter rye ( <i>Secale cereale</i> ) / Hairy vetch 

Based on cover crop performance results (e.g., soil cover, biomass production, nitrogen fixation, and weed suppression), we will provide recommendations for various rotation plans, management goals, and garden sites to meet the needs of urban gardeners while promoting responsible use of natural resources.

### Research Questions:

- 1) How does cover crop species composition and seasonal niche of legume-based monocultures and mixtures affect soil cover, cover crop biomass, N fixation, and weed suppression?
- 2) How does environmental variability (soil properties, light availability, and intercrops) in urban vegetable gardens influence the performance of specific legume-based monocultures and mixtures?
- 3) How do gardeners adjust their management practices to successfully incorporate cover crops? Are these changes seen as feasible and worthwhile? Why or why not?
- 4) What field-based observations can gardeners use to monitor and evaluate cover crop performance that are both reliable and feasible?

### Approaches & Methods

- We characterized background conditions of research plots in community gardens, including soil properties, light availability, and gardener management (e.g., soil amendments, intercrops).
- In late summer and early fall, gardeners under-sowed cover crops to food crops in community garden research plots using standard seeding rates.
- To characterize cover crop performance, we are using a combination of quantitative sampling methods and field-based observations by gardeners.
  - Quantitative indicators and methods include:
    - Percent cover at 3, 6, and 9 weeks after planting (grid sampling)
    - Cover crop biomass (dry weight) at maturity (quadrat sampling in November for winter-kill cover crops and April-May for over-wintering cover crops)
    - Nitrogen fixation by legumes (15-N natural abundance method<sup>28</sup>)
    - Weed suppression (absolute and percent reduction in dry weed biomass from quadrat samples of cover crop plots compared to control plots)
  - Field-based observations by gardeners include:
    - Visual percent cover estimates
    - Number and inner color of nodules on legume roots
    - Visual weed cover estimates in cover crop plots and comparison with control plots
- In the summers of 2012 and 2013, we surveyed gardeners to gain their perspectives on cover crop management and perceived impacts on soil, weeds, and subsequent vegetable crops.



**Quantitative sampling:** A hairy vetch biomass cut, April 2011. Plant material from each quadrat was separated into cover crops and weeds, dried, and weighed. Legume samples were also processed for nitrogen fixation measurements.



**Field-based observation:** Gardeners record the number and inner color of nodules on crimson clover, May 2012. Closeup: Nodules on crimson clover. Gardeners observe inner color of nodules because a pink color indicates that *Rhizobia* bacteria are actively fixing nitrogen.

***PROJECT #3: Designing participatory action research (PAR) for scientific, educational, and community benefits: A case study of cover crop research with Brooklyn gardeners***

Successfully practicing agroecology requires ecological knowledge, adaptive management skills, and communities of practice that support knowledge sharing and innovation.<sup>26, 29-33</sup> In recent years, scholars and practitioners of agriculture and natural resource management have shown growing interest in participatory action research (PAR) for its potential to generate new knowledge that supports ecologically sustainable practices and nurture participants' capacities to implement, refine, and share such practices.<sup>29, 34-39</sup>

This study explores the experiences of urban gardeners, educators, and researchers in the PAR project on cover crops (described above) in order to gain a better understanding of how PAR can be designed to generate ecological knowledge that is relevant to gardeners' practice; provide learning opportunities that build knowledge, skills, and CoPs for sustainable agriculture; and foster improvements in stewardship practices that benefit gardeners and their communities.

Research Questions:

- 1) How can participatory action research (PAR) be organized and facilitated in an urban community gardening context to achieve positive outcomes for science, education, and communities?
- 2) What are some of the challenges of doing PAR with urban community gardeners? How might facilitators address these challenges?

***Below: Photos from the Farmer Field School workshop series, 2011-2013.***



*Gardeners decide on priority management goals and cover crop species to test, Summer 2011.*



*Planting crimson clover, Fall 2012.*



*Gardeners check for nodules on field peas, Fall 2012.*

Approaches and methods: I am conducting a case study<sup>40</sup> of the PAR project on cover crops with Brooklyn gardeners. Sources of data include:

- Field notes covering program design, implementation, and facilitation;
- Transcripts of semi-structured interviews with gardeners about their learning experiences in the FFS;
- Transcripts of group evaluation sessions focused on feedback in four areas: cover crops and practices, workshop scheduling and logistics, gardening knowledge, and involving gardeners in research;
- Documentation, including (a) workshop preparation; (b) workshop products (agroecosystem concept maps, gardeners' completed datasheets); (c) resources for urban gardens and educators informed by the FFS workshop series and PAR project on cover crops; and (d) grant proposals and reports.

Data analysis will include: thematic (content) analysis,<sup>41</sup> development of a case description,<sup>40, 41</sup> explanation-building<sup>40, 42</sup> to understand how program design choices contributed to particular outcomes, addressing of rival explanations,<sup>40, 43</sup> and a synthesis of lessons for educational practice.



***PROJECT # 4: Ecological insect management in urban gardens: Effects of garden land use, management, and landscape context on pest and beneficial insect populations***

This work involves exploring relationships between insect dynamics and garden land use, management practices, and landscape context for 22 gardens across Brooklyn, Harlem, and the Bronx in the summer of 2011. Upon completing data analysis, we will provide recommendations for gardeners on land-use patterns and management practices for attracting beneficial insects and reducing insect damage on crops. We will also suggest directions for further research to develop effective local- and landscape-level practices to conserve natural enemy populations and achieve conservation biological control of insect pests in urban gardens.

Research Questions

- 1) What are the temporal dynamics of key pest and beneficial insects in NYC community gardens?
- 2) How do garden-level land use & management practices, and landscape context, affect pest and beneficial insect populations and pest damage on crops in urban vegetable gardens?

Approaches and Methods

- From June through September 2011, we monitored insect populations on Brassicas, cucurbits, and tomatoes using biweekly scouting and sticky cards.
  - Pests monitored include: aphids, flea beetles, Lepidopteron larvae, whiteflies, cucumber beetles, squash vine borer, squash bugs, thrips, and two-spotted spider mites.
  - Beneficial arthropods monitored include: adults and larvae of ladybird beetles, larvae of syrphid flies and lacewings, minute pirate bugs, spiders, and parasitic wasps.
- We collected information on local garden characteristics, including land use, plant diversity, light availability, and management practices (e.g., winter sanitation, pest control practices).
- To characterize landscape context, we conducted GIS analysis of green space in 200-m buffers.
- Data analysis will involve elucidating relationships between garden- and landscape-level ecological and management characteristics and pest and beneficial insect populations using multivariate statistical methods, including multiple regression and path analysis.



*Scouting for insects on collard greens, June 2011*

***Below : Photos of two of the most widespread pest problems in NYC community gardens:***



*Whitefly nymph circles, pupae, and adults on a collard leaf in a community garden.*



*Tomato leaf damaged by the two-spotted spider mite. Inset: Two-spotted spider mites on underside of a tomato leaf*

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