**DRAFT White Paper and Research Plan v 1.0 28JAN2018**
**Collaborative Evaluation of Ecosystem Services Provided by Urban Agricultural Best Management Practices in the Twin Cities Metropolitan Area**
NCR-SARE Research and Education Grant Project 00067679 01NOV2017-30OCT2020

**1. Purpose.** Nic Jelinski and Jennifer Nicklay met with all community and academic partners to discuss and update the needs, questions, resources, and capacities of each collaborator. Based on your feedback in this listening process, we were able to clarify and update the goals and methods initially proposed in the grant application. We've captured these updates in this document, which proposes a plan for the first year of this study. The most important purpose of this document and out "All-Hands Meeting" on February 6 is to allow all partners an opportunity to provide feedback and participate in collaborative decision-making. After the meeting, we will make any necessary revisions to the 1st year plan and initial draft of this white paper.

**2. Background**. Urban agriculture in the Twin Cities includes agricultural operations, community gardens, aquaponics/hydroponics facilities, and backyard gardens under for-profit, non-profit, community, and individual management. While urban agriculture has expanded in the Twin Cities Metropolitan Area (TCMA), urban growers remain challenged by issues related to land access, environmental justice, high public visibility, and the perceived trade-offs between agricultural land use and other, more traditional forms of urban land use. Furthermore, the management practices and challenges of urban growers often go overlooked by traditional agricultural research and extension activities.

To address these challenges, this three year collaborative study seeks to collaboratively evaluate the ecosystem services provided by urban agriculture. Our group of farmers, community partners, and researchers will be holistically exploring the ability of urban agriculture to provide high-quality food, regulate water quality and soil health, support biodiversity, and fulfill the social and cultural needs of communities.

**3. Who are we?**
*Community Partners*. The community organizations participating in this project - Frogtown Farm, Urban Farm and Garden Alliance, Growing Lots, and Mashkiikii Gitigan - are highly diverse. Each was formed in response to different historical and contemporary challenges/opportunities; have different operation models; are embedded in different locations and communities in the Twin Cities; and utilize a diverse array of agricultural practices.

Community Partners

| Name | Location | Description | Capacity | Contact |
|---|---|---|---|---|
| Urban Farm and Garden Alliance | St. Paul - Aurora, St. Anthony, and Frogtown | Alliance of 6 community gardens | Able to support observational studies. In progress: site-specific determination of capacity for replicated studies. | Melvin Giles, Megan Phinney |
| Frogtown Farm | St. Paul - Frogtown | Nonprofit, urban demonstration farm. One site. | Able to support replicated and observational studies | Iman Mefleh |

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| Growing Lots | Minneapolis - Seward | For-profit, CSA farm. 2 possible sites. | Able to support replicated and observational studies | Taya Schultz |
| Mashkiikii Gitigan | Minneapolis - Phillips | Non-profit, 3 possible sites | Able to support replicated and observational studies | Michelle Manske |
| Caroline Devany | NA | Former manager of Stone's Throw | Caroline will be helping plan outreach events | Caroline Devany |

*Academic Partners*. The academic team is a multi-disciplinary, multi-institutional group that is committed to approaching urban agriculture from a systems perspective. This project leverages the existing connections/relationships that each of these individuals has with the urban agriculture community and their areas of expertise in order to holistically measure ecosystem services.

Academic Partners

| Name | Institution | Research Focus | Responsibilities |
|---|---|---|---|
| Nic Jelinski<br>Asst. Prof | University of Minnesota | Soil science, including: contamination, formation and distribution,<br>urban systems | ● Project Coordinator<br>● Lead and direct data collection for soil and earthworm measurements<br>● Co-advise graduate and undergraduate students |
| Mary Rogers<br>Asst. Prof | University of Minnesota | Entomology<br>Plant Science<br>Horticulture | ● Lead and direct data collection for crop/biomass yields, plant quality, and biodiversity<br>● Co-advise graduate and undergraduate students |
| Chip Small<br>Asst. Prof | University of St. Thomas | Nutrient Cycling<br>Hydrology | ● Conduct off-farm studies<br>● Consult on installation of lysimeters, conduct analysis for leachate tests, and assist with nutrient budget construction for on-farm plots<br>● Co-advise graduate and undergraduate students |
| Valentine Cadieux<br>Asst. Prof | Hamline University | Environmental Studies<br>Sustainability Studies<br>Collaborative knowledge in food, agriculture, & land | ● Assist Chip with continued survey refinement<br>● Coordinate integration of this project with UFGA sign development and farm tour<br>● Co-advise graduate and undergraduate students |
| Pam Rice<br>Asst. Prof, Research Chemist | University of Minnesota<br>USDA-ARS | Contaminant Hydrology and Water Quality<br>Environmental Chemistry | ● Lead and direct organic contaminant measurements<br>● Compare sites' land use history with current conditions |
| Paliza Shrestha<br>Post-Doctoral Researcher | University of St. Thomas | Plant and Soil Science | ● Post-Doc in Chip Small's lab working with leachate analysis and off-farm studies |

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| Kat LaBine<br>Research Technician | University of Minnesota | Soil science | • Initial project set-up and on-farm trial establishment<br>• 1st season data collection<br>• Assist in training graduate student (Jennifer) |
| Jennifer Nicklay<br>Ph.D. Student | University of Minnesota | Soil science<br>Agroecology | • Assist with project set-up, on-farm trial establishment, data collection and analysis<br>• Mentor undergraduates |

**4. On-Farm Ecosystem Services Research Plan.** The primary aim of this project is to conduct an evaluation of the ecosystem services provided by urban agricultural land use. Ecosystem services to be evaluated include crop yield, biodiversity, water filtration, carbon storage, soil fertility, supporting community building activities, and much more; in other words, we are attempting to quantify the ways in which urban agriculture impacts biological, physical and cultural environments.

***Objectives.*** Quantify and evaluate the ecosystem services provided by urban agriculture in order to develop urban best management practices for varied conditions so that farmers and community organizations can improve, protect, and conserve the environment and resources in their communities.

***Methods***. We'll be conducting on- and off-farm measurements of crop/yield biomass; plant, soil, and water quality; biodiversity; nutrient cycling; and cultural services. Off-farm measurements will conducted by Chip Small at the University of St. Thomas. On-farm measurements (described in greater detail later) will be conducted at our community partner locations using replicated plots and observational studies.

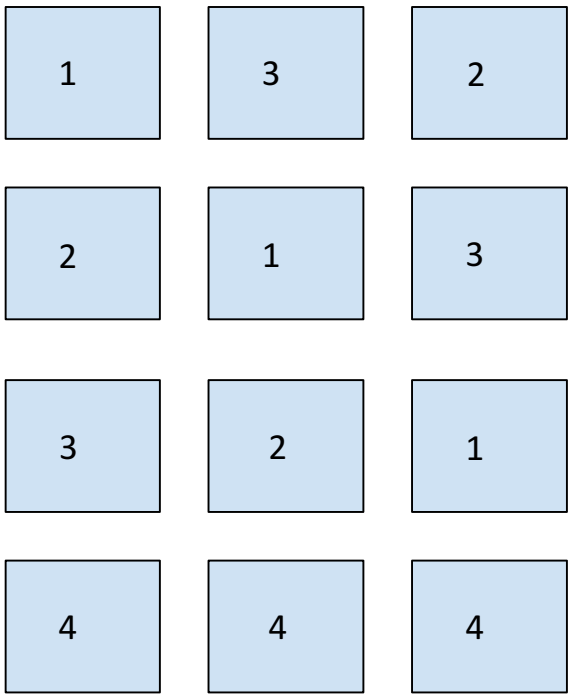
***Outcomes***. Produce scientific information regarding the impact of urban agriculture on the biophysical and social environment to enhance data-driven decisions regarding policies which impact the urban agricultural land base, regulations, and incentive programs. Identify economically efficient and socially grounded environmental practices for growers and community organizations to utilize in their urban agriculture programs.

**5. On-Farm Replicated Experimental Design.**
*Confirmed Sites*: Frogtown Farm, Mashkiikii Gitigan, and Growing Lots
*TBD*: Urban Farm and Garden Alliance

The purpose of the on-farm replicated studies is to determine whether different management practices result in different ecosystem services - and how that compares to the services provided by unmanaged or mown turfgrass. In the treatment descriptions below, the third category is 'Grower's Choice'; for this option, the community partners choose what they want to study. We'll brainstorm around this more at the February 6th meeting, but some ideas that have already been discussed include:

- Intercropped and/or overwintered cover crops (Frogtown Farm)
- Mulching with composted comfrey (Growing Lots)
- Amending with brewer's mash, coffee grounds, or other free materials available in the Twin Cities (Mashkiikii Gitigan)

Below is a simple diagram of what a replicated plot set-up might look like, but this will vary by site. We'll work with each community partner to make sure the plots work within their growing plan.




**Treatment descriptions**
1: Control - no amendment
2: Municipal compost added based on crop nitrogen demand
3: Grower's Choice
4: Turfgrass

Each plot is 1 $m^2$

**Total area required**
Including turfgrass: ~20 $m^2$
Excluding turfgrass: ~16 $m^2$

**Crop Choice**
Lacinato kale in 3 rows (12" spacing)
- Remaining questions:
  - Would collard greens be preferable?
  - How many plantings per year?

**Overwintering**
Mulch with compost, straw, and leaves

**6. On-Farm Observational Design.**
*Confirmed Sites*: Frogtown Farm, Mashkiikii Gitigan, Growing Lots, and Urban Farm and Garden Alliance

Conducting on-farm replicated studies are an exciting opportunity to compare how results from on- and off-farm research. However, urban agriculture is also complex and varied, so we'll be doing observational studies at all community partner sites to better capture the effects of urban agriculture under the management strategies currently used at each site.

Because Mashkiikii Gitigan, Growing Lots, and UFGA have multiple sites, we would ideally have observational plots at each individual site. To set up observational studies, we'll identify 2-3 locations at each site. Grower's would manage these plots as usual, and we would conduct many of the same measurements on them as for the replicated plots.

## 7. Measurements.

| Parameter | Description | Frequency |
|---|---|---|
| **Yield/Biomass** | | |
| Crop Yield (wet mass) | Conducted on-site | Measured for each plot at harvest |
| Total aboveground biomass | Leaf area index - conducted on-site | Measured every week |
| | Biomass samples (dried and weighed) - Mary's lab | At harvest |
| **Plant Quality** | | |
| Foliar Nitrate | 3 samples per plot using 0.1 M CaSO4 extraction - Mary's lab | Twice per year: mid-July and September. |
| Chlorophyll | 3 samples per plot using SPAD 502 chlorophyll meter - Mary's lab | Twice per year: mid-July and September. |
| **Soil Quality** | | |
| Organic Matter<br>Phosphate<br>Exchangeable K<br>pH | Measured at three depths (0-4", 4-8", 8-12")<br><br>Nic's lab or private lab, depending on cost analysis | Once per year: prior to plot establishment in Y1, repeated spring Y2 and Y3 for every plot. |
| Nitrate<br>Ammonium | Measured at two depths (0-4", 4-8") - Nic's lab | Twice per year: prior to planting (after amendment) and post- fall harvest for every plot |
| Bulk Density<br>Aggregate Stability | Measured at two depths (0-4", 4-8") - Nic's lab | Once per year: prior to plot establishment in Y1, repeated spring Y2 and Y3 for every plot |
| Hydraulic Conductivity | Measured with Amoozemeters - Nic's lab | Once per year: prior to plot establishment in Y1, repeated spring Y2 and Y3 for every plot. spring |
| Soil temperature and moisture | Data logger type TBD - Nic's lab | Measured continuously - data download frequency TBD |
| Contaminants | Heavy metals - Nic's lab. Measured on-site with PXRF.<br><br>Organic - Pam's lab | Heavy metals - Conducted before plot establishment, which will guide future measurement plans. Full site screened with subset of samples further analyzed in lab. |
| Microbial Biomass | Jessica Gutknecht's lab - Jennifer | Schedule TBD |
| Microbial Community | PLFA and enzyme substrate Jessica Gutknecht's lab - Jennifer | Schedule TBD |

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| **Biodiversity** | | |
| Insect Biodiversity | Pitfall traps (3 per site)<br>Sticky cards (3 per site)<br>Aerial net sweeps<br>Insects pinned or stored in 70% ethyl alcohol for identification - Mary's lab | Performed twice monthly June-September at all sites, including the St. Thomas plots |
| Earthworms | TBD - possibly liquid mustard extraction | Once per site prior to plot establishment and at the end of September in Y3 |
| **Water Quality** | | |
| Leachate volume | Lysimeters (funnel, 1 L collection bottle, tubing to surface) installed 12" below surface for each plot | Total volume extracted from each plot once per week |
| Leachate nitrate | Collection - Nic's lab<br>Analysis - Chip's lab | Once per week for one replicate from each treatment, once every 2 weeks for all others |
| Leachate ammonium | Collection - Nic's lab<br>Analysis - Chip's lab | Once per week for one replicate from each treatment, once every 2 weeks for all others |
| Leachate phosphate | Collection - Nic's lab<br>Analysis - Chip's lab | Once per week for one replicate from each treatment, once every 2 weeks for all others |
| **Other** | | |
| Ambient temperature | On-site with mounted temperature pendant | Measured continuously, data download bi-weekly |
| Soil Gas Respiration | Gasmet 4040X - carbon dioxide, methane, nitrous oxide, and ammonia - Jessica Gutknecht's lab (Jennifer) | Measured biweekly upon plot establishment until snow coverage, with additional measurements conducted after amendment |

**8. Timeline – Year 1.**

We have attached a tentative calendar schedule for the year. All dates are approximate as we will adjust as needed - especially based on weather. However, this should hopefully give all participants a better idea of the pacing for the first season.

**9. Next Steps.** Ecosystem service evaluation for urban agriculture remains an emerging field; this project is unique in its holistic and collaborative approach to exploring this topic. Thus, we have taken care to address several concerns identified during our fall meetings:

- Frogtown Farm noted that many projects have taken measurements but that the measurements and results are often not shared with them (and thus do not benefit the community). We acknowledge that this experience is not unique to Frogtown Farm, and

we plan to address this by transparently planning the study, sharing data in accessible locations (such as Google Drive which can be accessed by all partners), and ultimately providing results in a form that is easy to parse and digest in order to facilitate inclusion in our community partners' communications, farm plans, and grant applications.

- Growing Lots is unique among our community partners due to underlying asphalt, and they are particularly interested in how this may cause results to differ. Frogtown Farm also has soil sourced from off-farm, while other partners have relied on amending the existing soil. These histories and practices will be considered during data analysis.

- UFGA and Mashkiikii Gitigan both articulated their view that their ecosystem can't be healthy without healthy soil. Thus, one approach both organizations are taking to build healthy communities is to focus on building healthy soil. As a result, we added additional soil tests (heavy metal and organic contamination, microbial community, and soil greenhouse gas respiration).

This document is largely focused on the environmental ecosystem service evaluation planning. This project, though, has two additional goals:

1. **Assessment of urban agriculture land base in Minneapolis/St. Paul**
   Methods: Collaborate with the Sustainable Cities research group in the Hubert Humphrey School of Public Policy to map the land used for farming, community gardening, and backyard gardening
   Outcomes: Types of urban agriculture practiced as well as where and how sites are located within Minneapolis/St. Paul will be analyzed in conjunction with ecosystem service information from objective 1 so that future land use decisions could be made to optimize environmental and socio-cultural benefits.

2. **Develop long-term collaborative and information sharing networks between academic, farmer, and community organization partners**
   Methods: Researcher attendance at and participation in community partner events and meetings. Continued development of TC Urban Ag Connect website. Yearly urban agriculture workshops.
   Outcomes: Deepen relationships between academic and community partners, share information and learning with wider community, generate ideas for future research and collaboration.

The planning for these two aspects is still underway and, like the ecosystem service measurements, can be adjusted as necessary to fit the needs of the academic and community partners involved. Thanks to all involved for their time, effort, and participation!