An Agroecological Survey of Urban Agriculture Sites in the East Bay, California

A report to the Berkeley Food Institute

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Executive Summary

This report summarizes a participatory community-based project carried out over the summer and fall of 2014 in 21 farms and gardens in the East Bay (Alameda and Contra Costa Counties) . We assessed urban farms to determine main agronomic problems limiting production, including soil quality and pest, weed and disease problems. Farms were assessed for productivity, and farmers were surveyed to determine main agronomic challenges and effectiveness of practices used to overcome constraints. Although results indicate that most farms have high soil fertility, and many farmers follow soil building practices and use techniques that emphasize high biodiversity, farmers face a number of issues related to insect and weed pressure, as well as problems linked to soil contamination and water use efficiency. Outreach should be targeted towards methods for increasing functional biodiversity, productivity with lower inputs and resiliency of farms.

I. OBJECTIVES AND MOTIVATIONS

The purpose of this survey was to assess through an agroecological lens the main agronomic problems (soils, pests, weeds, diseases) limiting productivity affecting urban agriculture (UA) in East Bay Area. Our objective was two-fold: first, to determine cultural practices currently used by urban farmers and their effectiveness to overcome identified limiting factors; and second, to quantify actual yields reached in various urban farms subjected to varied soil and pest management practices under different spatial and temporal combinations of crops species and varieties. This information will provide a baseline that can be used to plan a series of on farm-research trials to explore urban agriculture best practices and management designs to overcome production constraints and optimize yields.

Farm managers were surveyed for soil and pest constraints and practices used, soil was sampled in various farms for nutrient and contaminant levels and two types of **yield analysis** were completed:
  - Productivity quadrats: A $1m^2$ quadrat count was randomly placed on sampled beds in each farms (the number of quadrats was dependent on the size of the farm) in the early and late growing season. Number of crop species, plants/species, and vigor was assessed to estimate productivity for a given quadrat.
  - Yield quadrats: Farmers were instructed to weigh all produce grown in designated $6m^2$ plots.

## II. SURVEY DISTRIBUTION AND RESPONSE

This survey included 21 urban farms and gardens in Contra Costa and Alameda counties (Fig. 1.1). The survey captured three different categories of   UA

including school gardens, community gardens and personal gardens that had been opened to the community. Participation in the surveys was varied due to limitations on farm managers' availability.

- Sixteen sites completed the paper survey
- Soil testing was conducted in 10 farms (as per cost constraints)
- Fifteen farms had productivity measured via quadrat method
- Six farmers reported total yields

Community Access:

Sixty-two percent of the farms surveyed were affiliated with a school or educational institution. School affiliation limited community access to only students, family or staff of that school. Fifty-eight percent of gardens were open to the general public.
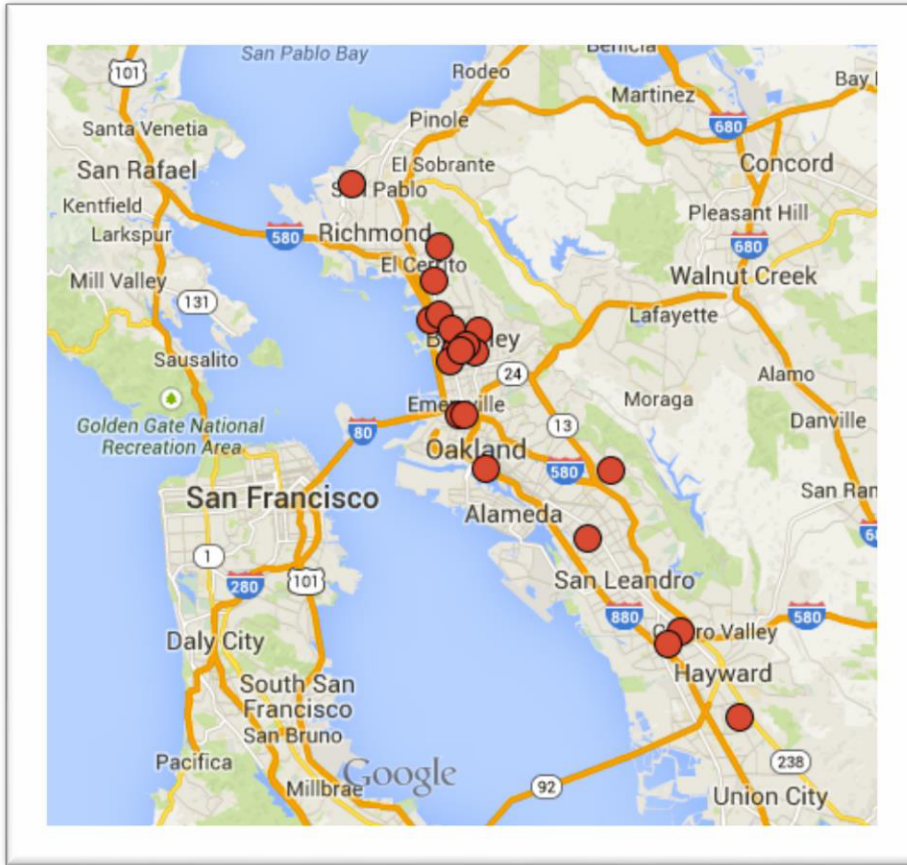
Access

Other,19%

Backyard (open),10%

Community (open),38%

Community & School,10%

School only,24%
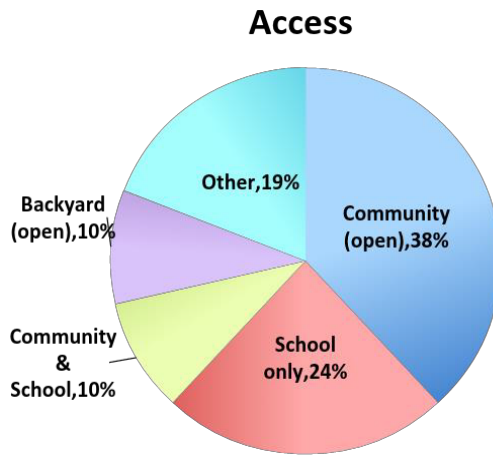
Fig 1.1 Map of the 21 sites surveyed in the East Bay, Alameda and Contra Costa counties, CA

III.   METHODS

Each farm manager was interviewed and completed a four page survey (27 questions). The survey gathered information on the organization, participating farmers, production challenges and farming practices used to overcome limiting factors.

Our survey included 18 data categories:

- **History of the land:** What is the history of the space? What is the general story of the garden/farm?
- **Mission of the farm/garden:** What is the mission of the farm? What are the organizational goals?
- **Legal land status:** Does the farm have secure tenure in this space?
- **Labor:** Who comprises the labor force? Is there paid farm labor or a paid farm manager?
- **Experience of farmers:** How experienced are the farmers and the farm manager?
- **Access for community:** Can the community access this land? Can they rent plots or use the harvest from this space?
- How does the farm acquire implements/tools, seeds and inputs?

- **Crop plans:** What crops are grown? Are they intercropping and does the farm have natural space or space that is not in production?
- Does the farm incorporate animals**?**
- **Pest, disease and weeds:** What are the main pest problems and what methods are they using to prevent or deal with them?
- **Soil Practices:** How do they manage soil fertility? Are they recycling nutrients on-farm?
- Has the soil been tested for nutrients and contaminants?
- Are they utilizing practices or infrastructure to conserve water**?**
- How is the **harvest** distributed?
- What is the size of the farm and the **size (m²)** of the production space?

Soil Samples:

In conjunction with UCANR, we sampled soil at ten farms. Each farm was sampled in three different areas and samples were tested for soil fertility and quality parameters and trace metal content, as described in Table 1.1. For each area, composite samples were taken in triplicate by combining four subsamples into one sample.

Fertility analysis was completed by UMASS Soil and Plant Tissue Testing Laboratory (Amherst, MA). Quality measurements were begun in the field and completed in the Pallud Lab. Trace metal analysis was completed by Curtis and Tompkins Laboratory (Berkeley, CA).

Table 1. Analyses completed on soil samples from different areas

Area sampled	Analysis
Vegetable bed: An area currently in production, planted with tomatoes (or leafy greens, if no tomatoes were planted)	Fertility: pH, extractable macro and micronutrients, nitrate, percent organic matter, cation exchange capacity, extractable lead and aluminum, percent base saturation Quality: texture, bulk density, infiltration rate Trace metal content: arsenic, barium, cadmium, chromium, mercury, nickel, lead
High risk area: An area of concern that the farm manager would like to put into production	Trace metal content: arsenic, barium, cadmium, chromium, mercury, nickel, lead
Native soil: A pathway or open space in the farm, representing unamended soil conditions	Trace metal content: arsenic, barium, cadmium, chromium, mercury, nickel, lead

Productivity Quadrats:
Quadrat sampling was used to estimate possible productivity yields for 19 farms in the study. The methodology used to estimate the average potential yields per square-meter are based on prior work by Altieri et al. and Colasanti and Hamm (2010). At two sampling intervals (May/June and August/September), data from 5 to 20, 1m² quadrats was gathered depending on the size of the farm. The number of samples per farm was proportional to the overall size of each farm. Sampling locations were randomly selected throughout each farm. For each 1 m² quadrat, the following data was collected: the number of species, number of plants per species, number of varieties per species, plant vigor, percent cover of weeds, weed community composition (broadleaf weeds, grass weeds, or mixed), the presence of any edible weed species, % of crop biomass affected by insect pests or diseases (% crop damage) and % soil cover (presence of mulch).

Estimated yields on a per plant basis for each crop species were calculated based on John Jeavons (2012) estimates for yields potentially attained by an intermediate-good gardener using intensive, agroecological practices. If yield estimates were not available for a particular crop, additional sources were used (see appendix for crop yield estimates). Productivity estimates for each m² sampled were calculated by multiplying the number of each species by its estimated yield. Estimated yields were reduced by 50 to 75% if the plant was in poor health or otherwise compromised, based on assessments of plant vigor or pest incidence.

Self-Reported Yield:
Ten farms had 6m² quadrats installed and were given scales and notebooks for recording purposes. Farmers were supposed to weigh the harvest from these areas. This technique did not have successful results, resulting in lower yield reporting. However, six of the participating farms weighed their harvest annually. We used this data and divided it by the total production area measured by our research teams to develop a per m² result.

IV. RESULTS

Soil Results Summary:
Nine out of ten sites had high soil fertility and exhibited good soil quality indicators. No samples contained elevated levels of total trace metals. Most gardeners surveyed followed agroecological practices to maintain soil fertility and quality. These finding were contrary to our expectations; we anticipated observing more farms with poor soil quality and some sites with trace metal contamination.

Fertility and Soil Quality:
While certain macro- and micro-nutrient levels were high across all sites (Appendix 3), representing typical conditions in East Bay soils, some trends emerged that allowed us to classify sites by percent organic matter, cation

exchange capacity, and bulk density (Appendix 4). Cation exchange capacity (CEC) is a measure of the soil's ability to retain nutrients. Bulk density is the weight of soil per unit volume, an indication of soil components and compaction.

Percent organic matter and bulk density were inversely correlated (Figure 1.2.). Infiltration data had a high margin of error and is not reported here. Our fertility and quality results were bookended by Acta non Verba on the high end, with high organic matter, cation exchange capacity (CEC), nutrient contents, and low bulk density. On the low end, the poor soil quality (low organic matter, high bulk density) at Sunnyside could be detrimental to yields. Sites fell into two middle groups defined by moderate-high percent organic matter (City Slickers, Madera Elementary, and Berkeley Youth Alternatives), and moderate-low percent organic matter (San Lorenzo, Tennyson, New Roots, Dig Deep, Peoples' Grocery).

We suspect that these groupings indicate different practices regarding compost amendment. Seventy-five percent of farms are composting on-site, with the remaining 25% citing labor restrictions for not composting. Farms also relied on municipal compost. While all sites added compost, the amount added is related to both cultural decisions and labor, and the effect of the compost is a function of amount added and quality of the compost. Some sites in the moderate-low grouping are school gardens that rely on student labor and serve an educational purpose that is equally important as food production (e.g., San Lorenzo). Future research would consider the degree to which community garden yields depend on compost amendment, with the goal of identifying lower and upper threshold levels of compost amending. Could some sites spend less energy applying compost, while achieving the same yields?
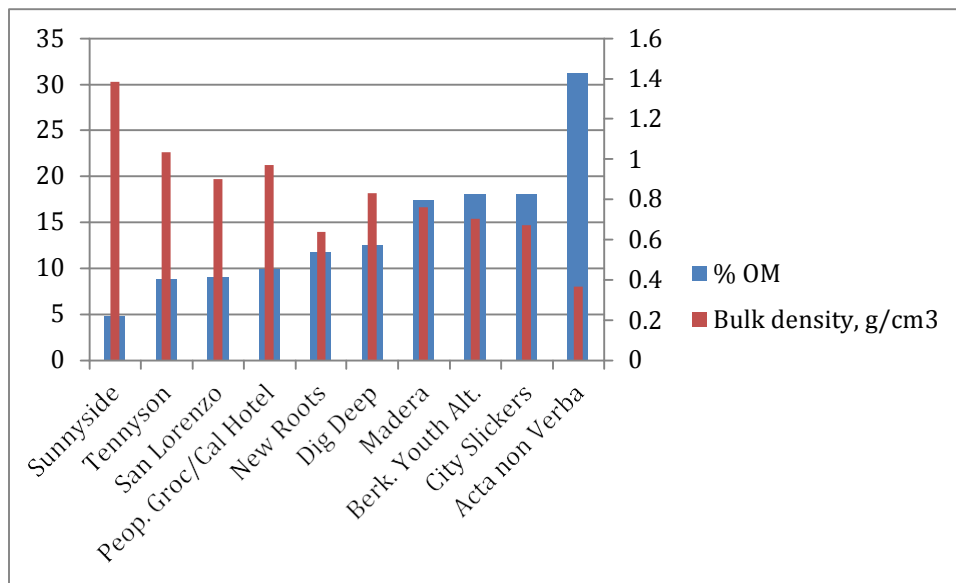

Figure 1.2 Soil organic matter and bulk density at various UA farms

All sites exhibited high soil levels of phosphorus, potassium, calcium, magnesium, and manganese. East Bay soils are generally high in calcium and magnesium. High phosphorus can be associated with watershed pollution, and

could be associated with high compost application rates. More research is needed to determine if the high phosphorus observed in these systems is lost via runoff and contributing to water pollution, or is utilized by plants to ensure high biomass production.

Soil texture analysis, a time-consuming process, is on-going. Results for 4 sites indicate loams (City Slickers, Berkeley Youth Alternatives, San Lorenzo) and silt loam (Acta non Verba). Loams are ideal agricultural soils. It will be interesting to see if any soils are high in clay, a hallmark of East Bay soils, which can lead to poor drainage and poor structure.

Trace Metal Contamination:
Thorough analysis of the trace metal concentration data is challenging because there are no federal guidelines for trace metal concentrations in agricultural soils (US EPA, 2011). However, no samples exceed the levels for total arsenic, cadmium, lead, or zinc recommended by the EPA Region 5 Technical Remediation for Brownfields program, which advises community groups seeking to redevelop brownfields into urban agricultural sites (Leven, 2014) (Appendix e 5). One sample out of 30, one of the three replicate samples taken from Dig Deep Farm, had elevated extractable lead. The wide range of concentrations measured in the Dig Deep Farm samples indicates hotspots of high lead, but not elevated levels overall. Compost amending is recommended for tying up lead and thus making it less bioaccessible, and also diluting existing lead in soil. Dig Deep was in the group of sites with moderate-low organic matters, so we would recommend that they add more compost to both stabilize contaminants and increase fertility overall.

Water:
The obvious need for irrigation is often complicated by urban water prices and access. All but two respondents related that if the farm itself was responsible for irrigation costs they would not be able to operate the farm. Fifty-two percent of surveyed farms had an organization or partner that covered the costs of irrigation. Many farms are on city property and have MOU's with the related city that provides that the city itself pays for irrigation needs. Only 10% of the farms (2) had wells that were used for irrigation and both related that they were worried about the quality of the water and also the possibility of the well running dry. One respondent was able to acquire agricultural rates from East Bay Municipal Utilities District (EBMUD).

On-farm animals:
Less than half of the farms surveyed had on-farm animals (chicken, goats, ducks, worms or bees). Raising chickens was the most popular (42%) animal activity; chicken ate ,uch of the crop residues and also provided manure. Keeping animals showed a positive correlation with on-farm soil building. Ducks and sheep were represented at 5% with worms and bees at 18% and 29% respectively.

Insect Pests:

Most respondents felt that pest problems were not as much of a pressing issue as we expected. Many farmers were following best practices to promote beneficial insects for biological control such as having habitat strips, intercropping or planting flowers and facilitating a more heterogeneous crop plan. Despite these measures, some pests were prevalent such as cabbage aphids often tended by argentine ants, snails, slugs and leaf miners which under certain conditions could inflict high levels of damage (Figure 1.3). Common practices to control aphids are hand-washing the plants or spraying aphids off with a hose. Symphylans, an often-unknown pest related to millipedes that eats roots, was often mentioned. Interestingly, the Peoples Grocery Hotel California location believes that planting fava beans seem to have helped reduce symphylan levels in their garden.
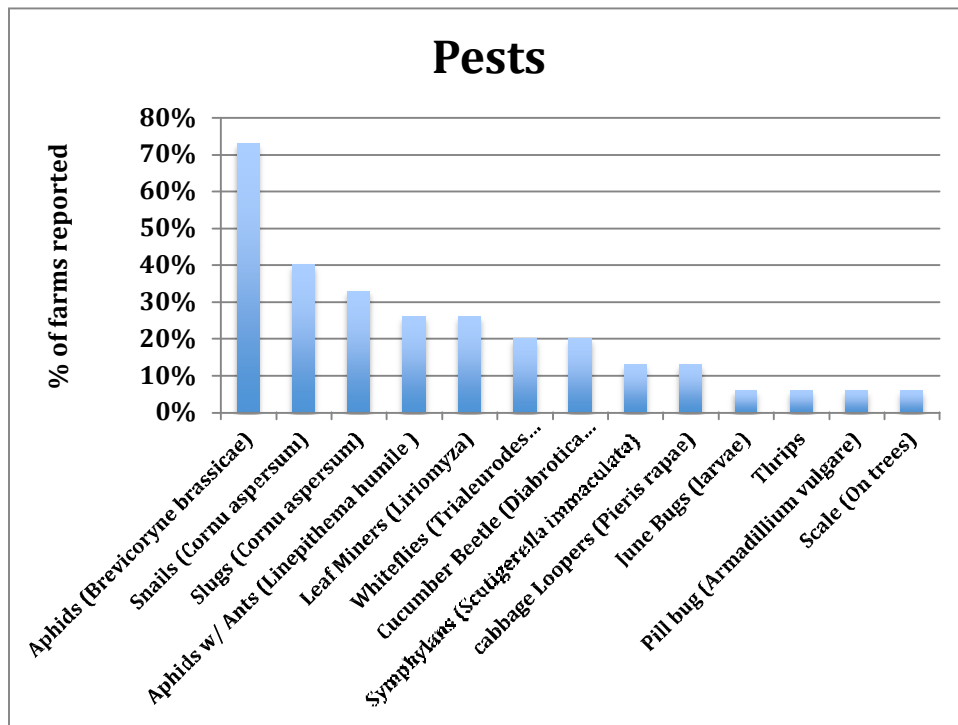
Fig 1.3 Prevalent pests observed and reported in UA surveys

The majority of respondents believe that measures they are using to prevent pests are effective (Figure 1.4). Using homemade sprays or organic approved pesticide sprays was common but most respondents said these techniques were not very effective. Generally, most farms recognized that soil health, on-farm biodiversity and plant vigor helped repel pests most effectively. Effectiveness of various pest control practices are anecdotal and warrant further research.

Methods of Pest Control
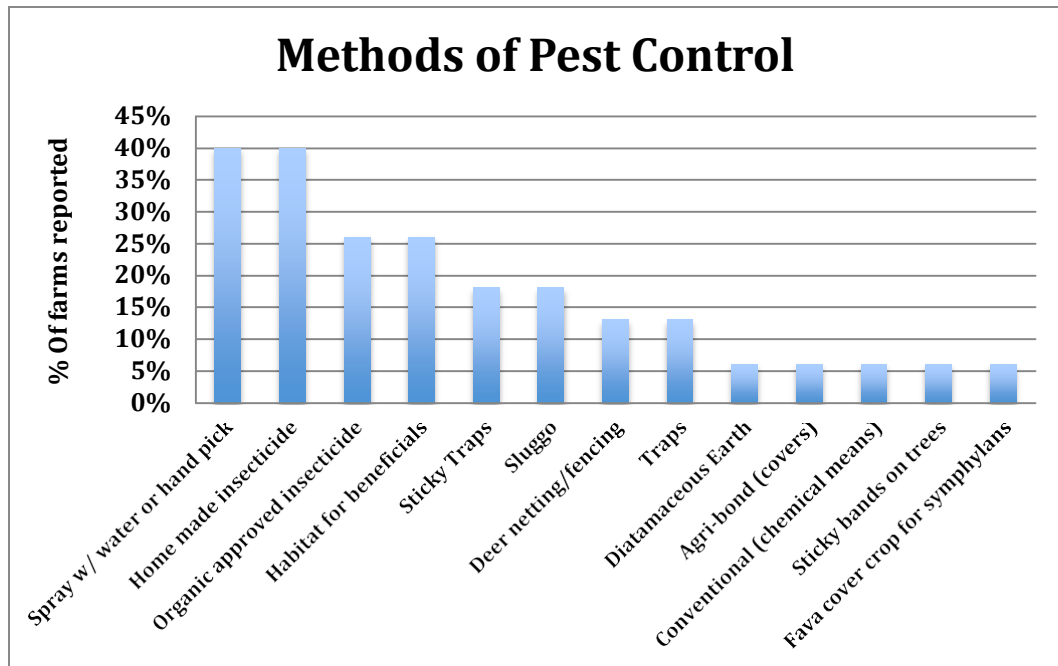
Fig 1.4 Most common methods of pest control

Weeds:

Many farmers struggled with weeds. However, the majority of farmers mentioned that methods used to control or prevent are "effective" to "generally effective". Some farmers take advantage of "weed" cover after plants get past their period of critical competition, but most allow presence and growth of aggressive weeds (amaranth, grasses) to levels that reduce crop yields. Joseph, the farm manager at Union Plaza, said weeds like wild radish are "okay" because they provide ground cover. A few of the gardens (SOGA, Tennyson and Union Plaza) suggested that using a hoe to weed can be counter-productive because you create a better habitat for weed growth.

Weed Community Data:

Percent cover of weeds in each quadrat also varied by farm. Some farms had very low weed densities (or no weeds), but in others, weeds reached high presence. However, average weed cover in quadrats sampled was 7.13 %/ m² (Table 2) Over half of the quadrats sampled were in raised beds, our observations suggest that raised beds typically exhibited lower weed densities. Broadleaf weeds were prevalent in the quadrats, while most weed communities consisted of broadleaf weeds only, many quadrats exhibited combinations of broadleaf weeds mixed with grasses (Figure 1.6 and 1.7). Dominance of grass weeds signaled low yields in many plots. Many of the weed species identified in this study were edible such as purslane, lambsquarters, malva , and amaranth. (Figure 1.5).
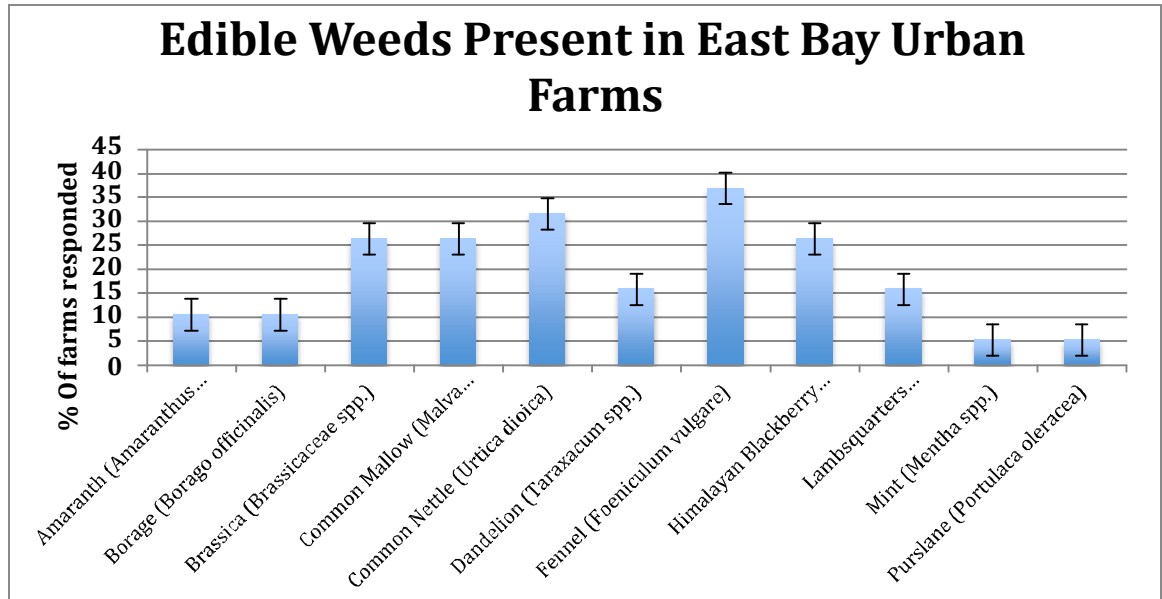
Fig 1.5 Edible weeds present in East Bay urban farms

Table 2. Weed % cover in raised beds and plots with mulch

Overall Weed Data Summary			
	Percent weed cover/ m^2	Percent of quadrats sampled in raised beds	Percent of quadrats sampled with mulch*
Mean	7.13	53.26	30.15
Standard deviation	8.08	------	------

*Not all mulch cover was adequate to be effective; most was sparse (Fig 4.4)

Weed Community Compostion
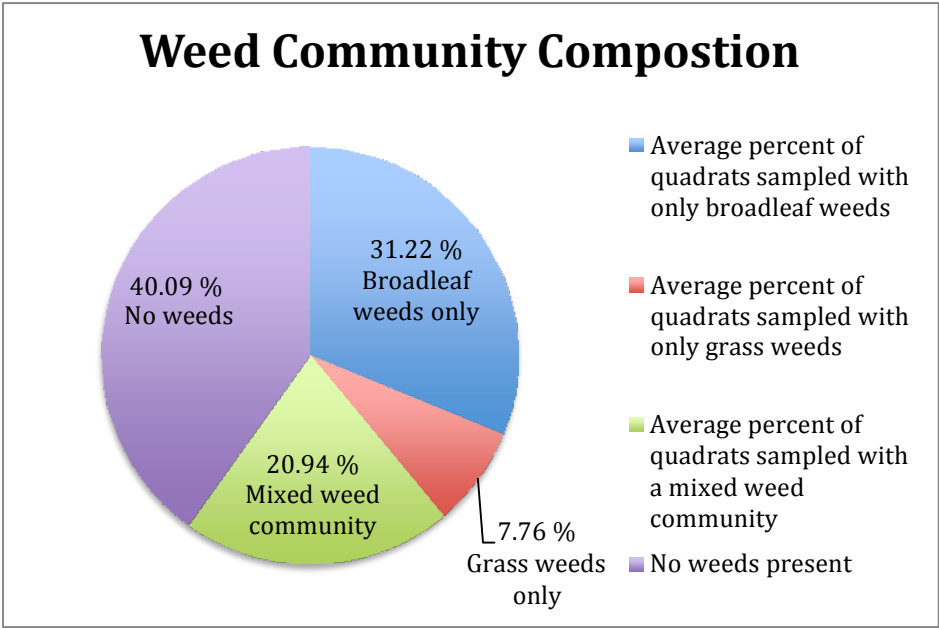
Fig 1.6 Weed community composition
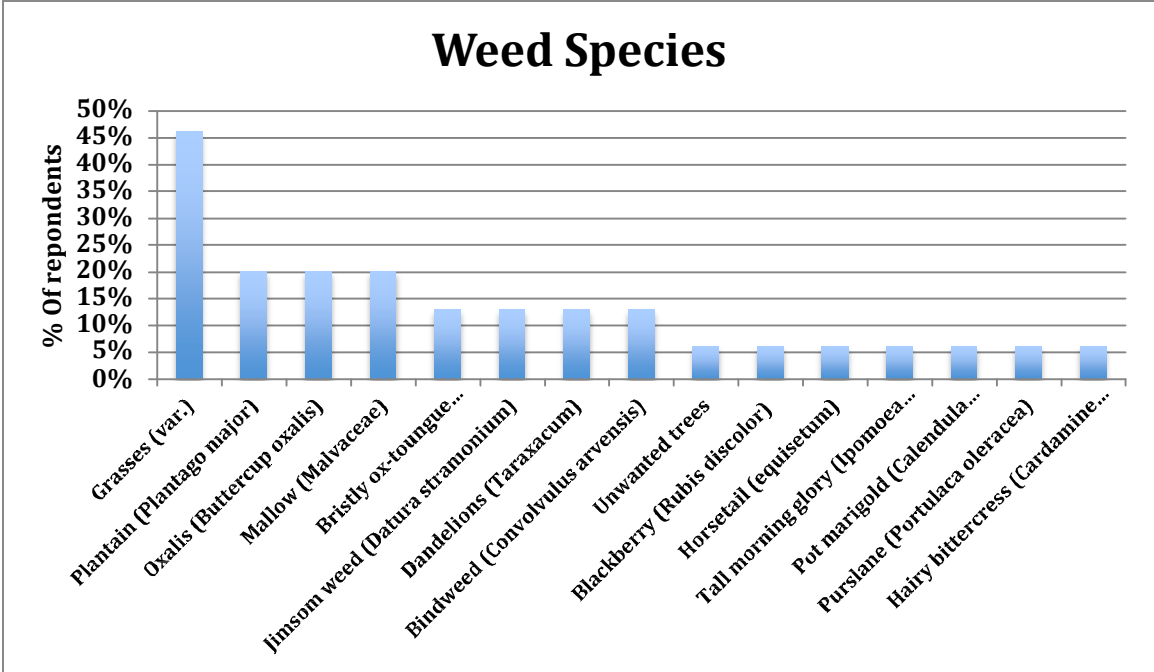
Weed Species

Fig 1.7 Weed species
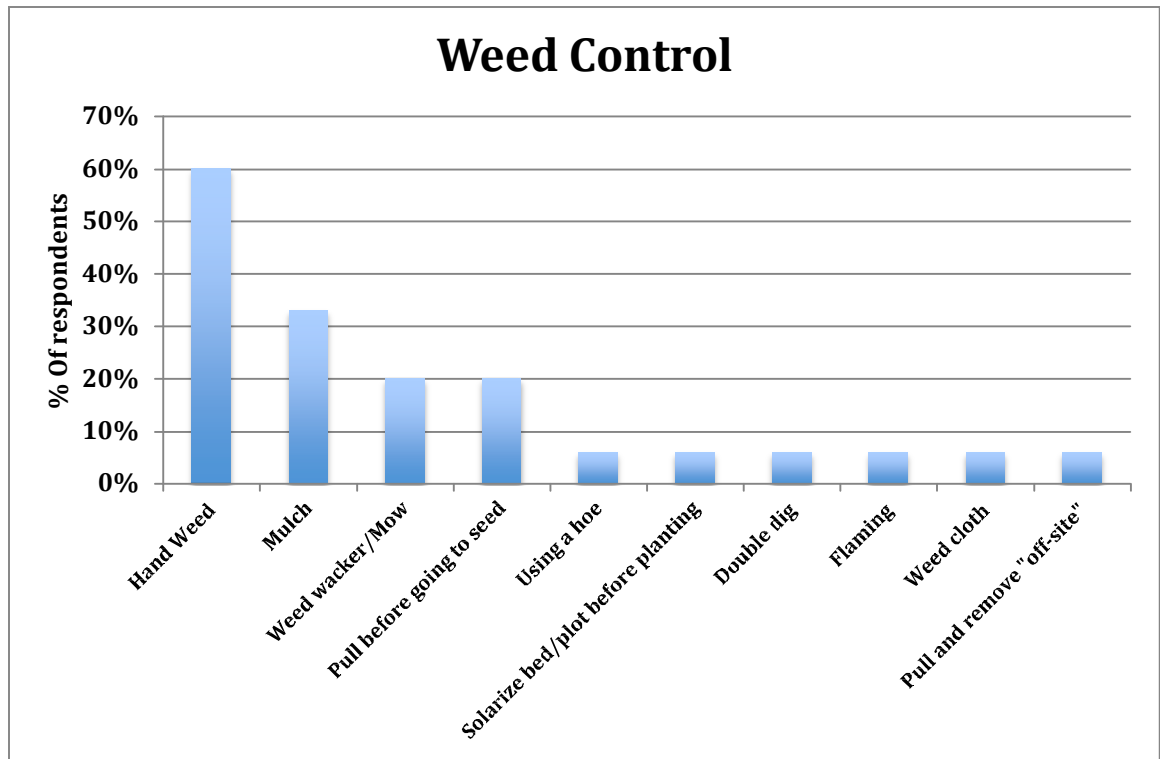
Fig 1.8. Weed control cultural practices

Weed control:
There was a wide range of weed control methods used by surveyed farmers (Figure 1.8). Hand weeding was effective only if done timely in relation to the weed critical period of competition. Thirty percent of the quadrats sampled had some form of mulch. However, in many of these cases, the mulch cover was very light and was not effective in blocking weeds, but in plots with a thick mulch weed suppression was high.

Productivity:
Estimated productivity results varied among farms (Appendix 1), most likely due, in part, to the diversity of goals, labor support, and organizational characteristics of each farm, as recognized by the interview results. Average estimated seasonal yield ranged from 3.43 kg/m^2 to 17.16 kg/m^2 , with a mean productivity of 7.09 kg/m^2 for all farms included in the study (Table 3). This estimate is less than the targeted 10 kg/m^2 of productivity (established by our team based on production levels reached by intermediate Cuban urban farms) and demonstrates the potential for increased yields in Bay Area urban agriculture with additional research, outreach, and institutional support. Low yields seemed associated with poor choice of crops, bad management and low levels of crop diversity. A large number of heavy, high producing crops (tomato, squash, and strawberry) resulted in high estimated productivity and are hypothesized to be a large factor in the variation seen in the data. Additionally, weight is not the only way of measuring productivity, in farms using intercropping systems a more appropriate method is the use of the Land Equivalent Ratio.

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Table 3. Overall farm productivity summary

	Overall Productivity				
	Farm level species diversity	Garden-bed level species diversity	Garden-bed level genetic diversity	Productivity	
	Total # crops grown (normalized by size)	Average # spp/m^2	Average # varieties/spp/m^2	Average estimated yield lbs/ft^2	Average estimated yield kg/m^2
Mean	1.63	2.84	1.37	1.45	7.09
Standard deviation	0.54	1.08	0.66	0.67	3.25

V.   RATINGS

Each farm was "graded" using a metric created for this survey (see Appendix 2) using ten indicator criteria . Each indicator was given a rating (based on a score of 0-3) or based on the yield scale previously discussed. Ratings were put into an "amoeba" type information graphic (Figure 1.9) and included in a final agroecological report to be issued to each farm to help farmers identify their weak pints (indicators with low scores), adopt social and management practices to improve score of low indicators and thus improve overall performance of each farm. We will use this methodology in future farmer-to-farmer trainings.
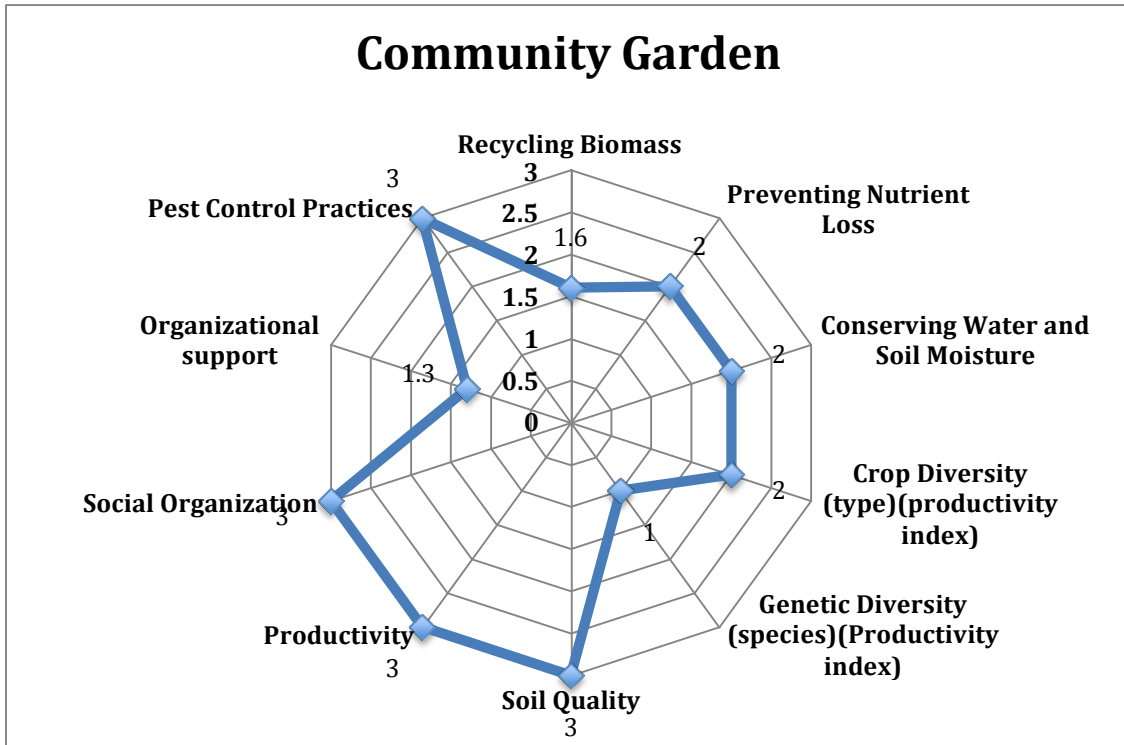
Community Garden

Fig 1.9 Community garden "amoeba" rating system

VI.   Conclusions

During 2014 and with support from the Berkeley Food Institute (BFI) we conducted a research project to assess actual yields and the main agronomic problems (soil constraints, pest, disease and weed pressure) affecting urban farms in Alameda County. By surveying 21 farms we evaluated the cultural practices used to overcome such problems and their effectiveness, as well as yield levels in farms undergoing different crop combinations and management practices . Such diagnosis has provided us with key information to start a series of on farm-research trials to define and scale-up via farmer field schools best agroecological soil and pest management practices to overcome identified constraints and enhance yields. Expanding the production potential of UA can significantly contribute to food security where it is most needed.

VII.   REFERENCES

Leven, B. 2014. What We Tell Cities and Community Gardeners: Approaches to Safe, Productive Gardens, July 2, 2014, Soils in the City Conference. Chicago, Illinois

US EPA. 2011. Brownfields and urban agriculture: Interim guidelines for safe gardening practices. Available at www.epa.gov/brownfields

Appendix 1. Average species diversity and yields, by farm

Farm #	Total area of beds under production (m²)*	Average (by farm)					Notes
		Farm level species diversity	Garden-bed level species diversity	Garden-bed level genetic diversity	Productivity		
		Total # crops grown (normalized by size)	Average # spp/m²	Average # varieties /spp/m²	Average estimated yield lbs/ft²	Average estimated yield kg/m²	
1	101.7	1.13	1.50	1.25	3.52	17.16	Lots of strawberry plants
2	138.6	1.83	2.93	1.05	1.15	5.60	Total area only includes garden beds in production, not permaculture hillside
3	299.7	2.33	2.21	2.76	1.09	5.30	
4	440.1	0.70	1.68	1.15	2.42	11.80	Lots of strawberry, squash, tomato plants
5	56.0	1.50	2.88	1.05	1.10	5.37	
6	136.3	1.41	2.24	1.00	1.51	7.38	Lots of strawberry plants
7	36.8	1.58	3.17	1.00	2.03	9.92	Lots of strawberry, tomato plants
8	96.5	1.95	2.88	1.13	1.22	5.94	Due to lead and summer, sample #2 estimated yeild was very low
9	10.6	2.40	5.10	1.16	1.63	7.97	Lots of tomato plants
10	8016.0	1.61	3.12	1.01	1.19	5.78	Total UC village (from ArcMap) 8,438 m² assuming ~5% for paths = 8016 m²
11	31.3	2.50	5.30	1.13	1.31	6.40	
12	123.1	1.67	2.43	1.42	0.91	4.43	
13	24.1	1.80	4.30	1.02	1.64	8.00	Lots of tomato plants
14	178.8	1.30	1.93	2.05	0.99	4.84	Lots of strawberry, squash plants in sample #2
15	495.3	0.98	2.27	1.13	1.18	5.77	
16		1.03	2.44	1.21	1.12	5.47	Lots of tomato, squash plants
17		2.60	3.66	3.40	2.00	9.75	
18	179.4	1.08	2.00	1.08	0.89	4.34	
19	565.5	1.57	2.00	1.00	0.70	3.43	

Appendix 2. Survey grading matrix

UC Berkeley Urban Agroecology Survey Grading Martrix (Summer 2014)

Name of Farm:					**Survey Date:**			
Category	**Practice 1**	score (0-3)*	**Practice 2**	score (0-3)*	**Practice 3**	score (0-3)*	**Avg. Score**	**Notes:**
Recycling Biomass	Does the farm / garden compost on-site green waste?		Use mulch or Green Mulch?		Utilize on-farm waste from animals? (Vermiculture, chickens manure, etc.)			
Preventing Nutrient Loss	Mulch - Does the farm have continous soil coverage?		Does the farm contol irrigation? (watering in right amount, for right time) Use drip irrigation?		Use cover crops for biological N fixation?			
Conserving Water and Soil Moisture	Use mulch to decrease water evaporation?		Add organic matter - managing soil organic matter (SOM) to increse water holding capacity?		Harvest rainfall? (catchement system)			
Soil Quality	Add amendments - compost, manure, etc.		Has soil been tested? (Yes = 3, No = 0)		Testing results? Practices to remediate or farm on contaminated soil ((Example: raised, lined beds) N/A if prior answer was NO			
Social Organization	Does the farm have active community partners? (Churches, schools, etc.) (Yes = 3, No = 0)		Is the farm open to the public? (open hours)		Does the farm have volunteer Labor from the community?			
Organizational support	Satifactory infrastructure support? (tools, implements)		Security of tenure? (Yes = 3, No = 0)		Paid Labor/manager?			
Pest Control Practices	Use organic - non-input based methods?		Have natural habitat for beneficial insects?		Are these methods effective?			

For the three categories below, score farm 1-3 based on how it is indexed on the productivity quadrats								
Category	Low	Score: 1	Medium	Score: 2	High	Score: 3		
Productivity	3.0 kg - 7.5 kg / m^2		7.5 kg - 11.5 kg/ m^2		> 11.5 kg/m^2			
Crop Diversity (type) (productivity index)	1.00 - 2.50 (crop type / m^2)		2.50 - 5.00 (crop type / m^2)		>5 (crop type / m^2)			
Genetic Diversity (species) (Productivity index)	1.00 - 2.00 (Crop spp./m^2)		2.00 - 3.00 (Crop spp./m^2)		>3 (Crop spp./m^2)			
* A score of zero indicates that practice is not in place (or, NO)								
* Scores of 1 - 3 Range from: Sometimes, Often, Frequently								

Appendix 3. Extractable macro and micronutrient and metal content

Concentrations reported in mg/kg; values are averages of three replicates
Analyzed by UMASS

	pH	SD	P	SD	K	SD	Ca	SD
Optimum Range			4.0-14.0		100-160		1000-1500	
San Lorenzo	6.77	0.12	100.46	17.85	393.86	34.06	3445.86	102.63
Tennyson	7.44	0.12	158.32	19.71	454.02	100.92	6573.30	96.19
City Slickers	6.85	0.11	317.68	28.80	517.92	80.41	5536.43	75.13
Acta non Verba	7.31	0.12	622.50	39.55	2034.90	186.26	8098.91	240.83
Madera	7.27	0.04	395.58	31.11	1546.27	78.73	4758.96	199.05
Sunnyside	7.30	0.04	223.85	57.74	776.59	75.26	2837.90	277.02
Berk. Youth Alt.	6.79	0.08	260.04	15.54	509.70	51.53	5577.42	23.06
New Roots	6.67	0.10	146.54	29.49	518.76	29.69	3767.92	310.67
Peop. Groc/Cal H.	7.16	0.06	312.81	17.26	536.74	19.45	5762.48	68.01
Dig Deep	7.20	0.00	199.27	33.38	318.67	40.20	4809.00	335.45
	Mg	SD	S	SD	Mn	SD	Cu	SD
Optimum Range	50-120		>10		1.1-6.3		0.3-0.6	
San Lorenzo	605.20	24.18	13.25	2.08	8.79	0.85	0.46	0.03
Tennyson	1002.23	57.18	17.89	1.88	16.28	1.58	0.21	0.00
City Slickers	930.29	36.76	56.28	16.24	11.85	2.10	0.29	0.02
Acta non Verba	2105.55	78.53	67.39	8.34	29.90	1.47	0.30	0.01
Madera	1295.00	94.42	38.28	3.04	16.78	4.70	0.78	0.32
Sunnyside	659.16	42.16	19.08	6.24	9.06	1.19	0.24	0.04
Berk. Youth Alt.	716.94	15.08	27.52	2.64	8.53	1.70	0.29	0.02
New Roots	557.85	48.78	15.37	0.90	8.18	0.30	0.28	0.01
Peop. Groc/Cal H.	677.81	18.27	30.85	3.06	12.34	3.58	0.34	0.05
Dig Deep	723.33	69.87	18.73	2.38	13.43	0.72	0.27	0.06
	Zn	SD	B	SD	Fe	SD	Pb	SD
Optimum Range	1.0-7.6		0.1-0.5		2.7-9.4		<22	
San Lorenzo	6.41	0.49	1.36	0.21	4.94	0.58	4.09	0.01
Tennyson	3.61	0.26	3.73	0.29	3.27	0.32	3.78	0.07
City Slickers	14.57	1.64	3.42	0.37	7.47	0.60	4.40	0.24
Acta non Verba	10.96	0.37	9.99	0.38	10.94	0.57	7.44	0.59
Madera	8.87	1.72	5.54	0.51	8.32	0.66	5.27	0.41
Sunnyside	18.80	3.31	2.65	0.84	3.02	0.71	2.73	0.46
Berk. Youth Alt.	11.07	0.47	3.68	0.22	9.85	0.63	4.96	0.62
New Roots	8.68	0.75	2.42	0.39	7.93	0.64	5.74	0.49
Peop. Groc/Cal H.	8.22	1.29	3.28	0.07	4.05	0.47	3.76	0.71
Dig Deep	12.13	1.17	4.63	0.84	3.60	0.44	**15.60**	**14.99**

Table 3, con't.

	NO$_3^-$	SD	Al	SD
Optimum Range			<75	
San Lorenzo	15.18	3.26	5.50	0.36
Tennyson	20.26	4.24	6.99	0.18
City Slickers	62.62	9.89	5.39	0.12
Acta non Verba	42.77	3.22	11.04	0.74
Madera	54.79	13.31	5.46	0.37
Sunnyside	5.30	1.91	8.23	1.02
Berk. Youth Alt.	82.04	14.86	5.80	0.27
New Roots	41.76	21.94	6.15	0.41
Peop. Groc/Cal H.	53.53	4.00	4.36	0.56
Dig Deep	20.67	4.73	3.67	0.58

Appendix 4. Exchangeable acidity, CEC, percent base saturation, and organic matter

	Ex. Acidity	SD	CEC	SD	Ca BS, %	SD	Mg BS, %	SD
Optimum Range					50-80		10.0-30.0	
San Lorenzo	0.96	0.13	24.16	0.70	71.31	0.36	20.53	0.25
Tennyson	0.00	0.00	42.24	1.03	77.82	1.24	19.44	0.70
City Slickers	0.26	0.23	36.89	0.67	75.05	0.90	20.67	0.45
Acta non Verba	0.00	0.00	62.96	2.22	64.33	0.64	27.41	0.11
Madera	0.00	0.00	38.36	1.51	62.04	1.69	27.65	1.32
Sunnyside	0.00	0.00	21.58	1.86	65.72	1.13	25.08	1.00
Berk. Youth Alt.	1.26	0.07	36.33	0.26	76.76	0.51	16.17	0.23
New Roots	2.50	1.00	27.24	0.99	69.08	3.27	16.76	0.90
Peop. Groc/Cal Hotel	0.00	0.00	35.75	0.55	80.53	0.50	15.54	0.50
Dig Deep	0.00	0.00	30.80	2.26	78.00	1.00	19.33	0.58

	K BS, %	SD	Scp Dens, g/cc	SD	OM, %	SD
Optimum Range	2.0-7.0					
San Lorenzo	4.17	0.26	0.99	0.06	9.05	1.99
Tennyson	2.74	0.54	0.98	0.07	8.84	1.26
City Slickers	3.58	0.50	0.78	0.04	18.09	0.44
Acta non Verba	8.26	0.53	0.60	0.01	31.24	1.77
Madera	10.31	0.44	0.86	0.00	17.36	2.76
Sunnyside	9.20	0.25	1.05	0.04	4.73	0.70
Berk. Youth Alt.	3.59	0.36	0.77	0.05	17.99	0.22
New Roots	4.87	0.17	0.92	0.03	11.72	0.59
Peop. Groc/Cal Hotel	3.93	0.13	0.93	0.08	9.85	0.51
Dig Deep	2.67	0.58	0.90	0.01	12.50	1.67

Appendix 5. Trace metal analysis for selected sites

Site Name		Vegetable bed		Area of concern		Path/native soil	
		Avg mg/kg	SD	Avg mg/kg	SD	Avg mg/kg	SD
San Lorenzo High School	**Arsenic**	13.3	1.2	3.9	0.3	13.7	0.9
	Barium	113.3	4.7	203.3	18.9	136.7	4.7
	Cadmium	0.5	0.0	0.5	0.1	0.5	0.0
	Chromium	29.0	2.2	47.0	12.8	30.0	0.8
	Mercury	0.1	0.0	0.2	0.0	0.1	0.0
	Nickel	27.3	0.9	35.3	1.2	29.0	0.8
	Lead	44.0	0.8	78.0	22.9	75.3	31.6
Tennyson High School	**Arsenic**	5.3	0.8	7.3	0.3	7.4	0.8
	Barium	140.0	0.0	170.0	0.0	180.0	0.0
	Cadmium	0.7	0.2	0.7	0.0	0.8	0.0
	Chromium	47.7	2.9	38.7	1.2	35.7	0.5
	Mercury	0.1	0.0	0.1	0.0	0.1	0.0
	Nickel	53.0	2.2	33.0	0.8	30.3	0.5
	Lead	17.7	2.9	22.7	2.1	56.0	8.8
Acta Non Verba	**Arsenic**	2.9	0.3	6.7	0.9	5.8	0.4
	Barium	99.7	7.4	173.3	4.7	183.3	12.5
	Cadmium	0.5	0.0	0.7	0.0	0.9	0.1
	Chromium	19.0	1.6	37.0	0.8	42.3	0.9
	Mercury	0.1	0.0	0.1	0.0	0.2	0.0
	Nickel	20.7	1.2	35.7	0.9	43.0	1.4
	Lead	25.3	1.2	56.0	0.8	70.0	1.4
Dig Deep Firehouse	**Arsenic**	6.2	1.1	7.6	0.3	6.4	0.4
	Barium	130.0	0.0	130.0	0.0	150.0	8.2
	Cadmium	0.8	0.0	1.1	0.2	0.8	0.1
	Chromium	27.0	0.8	28.3	2.6	32.7	2.1
	Mercury	0.1	0.0	0.1	0.0	0.1	0.0
	Nickel	30.0	1.6	28.0	1.4	35.0	2.2
	Lead	87.0	12.6	140.0	29.4	117.7	30.0
People's Grocery	**Arsenic**	4.9	0.9	2.2	0.3	4.4	0.4
	Barium	113.3	4.7	60.3	4.1	143.3	12.5
	Cadmium	0.6	0.0	0.5	0.1	0.8	0.0
	Chromium	37.7	1.7	21.0	0.0	52.0	2.9
	Mercury	0.1	0.0	0.0	0.0	0.1	0.0
	Nickel	47.3	1.2	31.7	2.1	82.0	2.2
	Lead	19.0	1.4	24.0	2.9	50.3	16.7
IRC New Roots	**Arsenic**	3.4	0.5	2.7	0.2	3.2	0.3
	Barium	77.0	0.8	60.7	0.9	54.3	2.1
	Cadmium	0.4	0.0	0.3	0.0	0.3	0.0
	Chromium	34.3	1.2	34.0	0.8	45.0	1.6
	Mercury	0.2	0.0	0.2	0.0	0.6	0.7
	Nickel	29.0	0.8	26.7	1.7	38.3	0.9
	Lead	80.0	4.5	69.7	8.3	18.0	0.8
City Slickers Union Plaza	**Arsenic**	2.6	0.1	5.0	0.0	4.5	0.1
	Barium	95.0	3.7	163.3	4.7	150.0	8.2
	Cadmium	0.4	0.1	0.9	0.0	0.7	0.1
	Chromium	23.0	3.6	31.3	0.5	33.0	0.8
	Mercury	0.1	0.0	0.6	0.1	4.8	6.5
	Nickel	21.7	3.8	27.0	2.9	25.3	0.9
	Lead	34.3	0.5	213.3	12.5	130.0	14.1

Berkeley Alternative Youth Productio n Garden	**Arsenic**	5.5	0.6	5.8	0.4	6.0	0.3
	Barium	106.7	4.7	150.0	8.2	58.7	13.4
	Cadmium	0.7	0.0	1.3	0.0	1.0	0.1
	Chromium	29.7	1.2	38.7	3.1	19.3	3.9
	Mercury	0.1	0.0	0.2	0.0	0.5	0.1
	Nickel	22.7	0.5	33.3	1.7	18.0	2.8
	Lead	62.0	3.6	140.0	16.3	20.7	5.4

Metals analysis completed by UC ANR in collaboration with Altieri and Pallud BFI Urban Agricultural Survey

Samples analyzed by Curtis and Tompkins Laboratory, Berkeley, CA

Due to regulatory constraints, UC ANR was not able to fund metals testing for some sites surveyed by Altieri and Pallud.

Average and standard deviation of three composite samples composed of 4 subsamples each