Closing the Food Cycle Loop: Part 2

Food Residue Composting and Worm Composting

Project Participants
Operations and Academics Working Together

Residential and Hospitality Services (RHS):

Diane Barker, Carla Iansiti, Robbia Pipper,

Student Organic Farm (SOF):

John Biernbaum, Laurie Thorp, Brendan Sinclair

Students: Kirk Green, Thom Mcalvey, Karri Tomich-Baylis, Charles Defever, John Dindia, Allison Stawara

Environmental Studies (RISE): Laurie Thorp and Students

University Office of Sustainability: Jennifer Battle

Land Management & Univ. Farms: Ben Darling, Ted Simon

Recycling Center and Surplus Store: Kris Jolley

Background Time Line

- 2001: Compost production and use research begins at Student Organic Farm.
- 2004: Compost course taught for first time.
- 2005: Campus food waste evaluation and initial data collection.
- 2005: Worm composting horse manure at Pear Tree Farm begins
- 2006: Start of the current phase of evolution of the campus food system.

Project Time Line

- 2010: Plans developed to manage food waste including anaerobic digester and worm composting.
- Fall 2010: WORMhouse constructed at SOF and worm composting begins with 6000 lbs collected.
- Spring 2011: 14,000 lbs collected.
- Fall 2011: over 60,000 lbs of Brody pulper collected and composted for Bailey GREENhouse.
- 2012: Over 100,000 lbs of primarily kitchen preparation residue composted; about 15-20% by worm composting and rest hot composted.
- 2012: Sale of worm compost begins at Recycling Center and Surplus Store.
- 2012: Worm composting expanded to 500 square feet of bed surface area in four types of systems.

Kitchen residue composting continued in 2012 with new methods

- Continued preparation of compost growing medium for Bailey GREENhouse
- Recycling Center transporting material to SOF.
- Hot composting at South Campus Compost facility during spring semester.
- Bioassay of composts for Bailey GREENhouse container plant production.
- Additional worm composting beds at SOF.
- Processing of worm compost for sale.
- Analysis of finished worm compost.
- Establish a new worm bed with purchased worms in an above ground wooden box.

March 2011 – shift from SOF picking up food residue to Recycling Center transporting kitchen preparation residue to the SOF

March 14, 2012 Brody Square

Kitchen Residue on Bed of Horse Manure and Newspaper Bedding at SCCF

April 13 Food Residue Composting

June 12 – 3 months
~30,000 lbs over 3 months

South Campus Compost Facility

July and August at SOF

Compost was moved from South Campus Compost Facility to the Student Organic Farm at the end of June. It was maintained and turned several times and heated to over 130^{o}F.

August 15 – hot phase finished

A significantly smaller pile was ready for curing. Some of the compost was used to feed the worms.

Food residue hot composting methods

Range of delivery size was 200 to 2000 pounds with an average of 3 deliveries per week for 32 weeks at just over 1000 pounds. Estimated landfill savings at over $3000.

Additional kitchen preparation residue came to the SOF several times per week . Straw, hay, leaves mixed with food residue. Later piles were made using wood chips provided by Landscape Services.

Herb Production for Bailey GREENhouse

Herbs growing in flats and pots on top of worm composting beds at the WORMhouse at the Student Organic Farm. Herbs were ready to plant by June 26 (picture date) but maintained until August 8.

Sage, Oregano, Rosemary, Thyme, Chives, Mints

Organic herbs grown in compost and with worm compost as fertilizer. Initial harvesting and sampling by chefs occurred at this point in time.

Six new beds constructed and filled with bedding and worms during May, June & July.

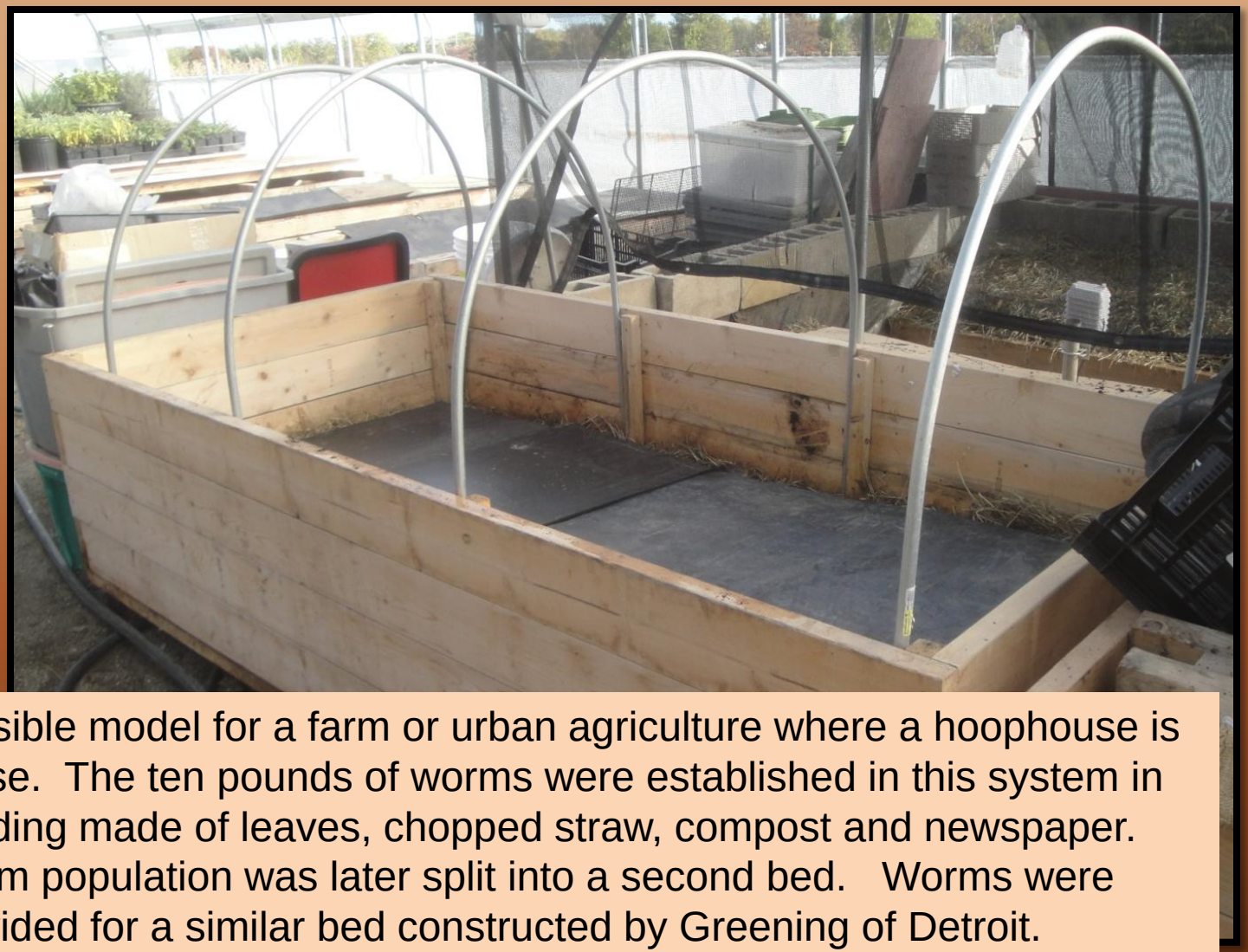
Worm Purchase Experiment

10 lbs ($22/lb+$50 shipping = $270)

Worms were purchased from Morgan Composting to simulate how a farm might start worm composting. Worms arrived in June.

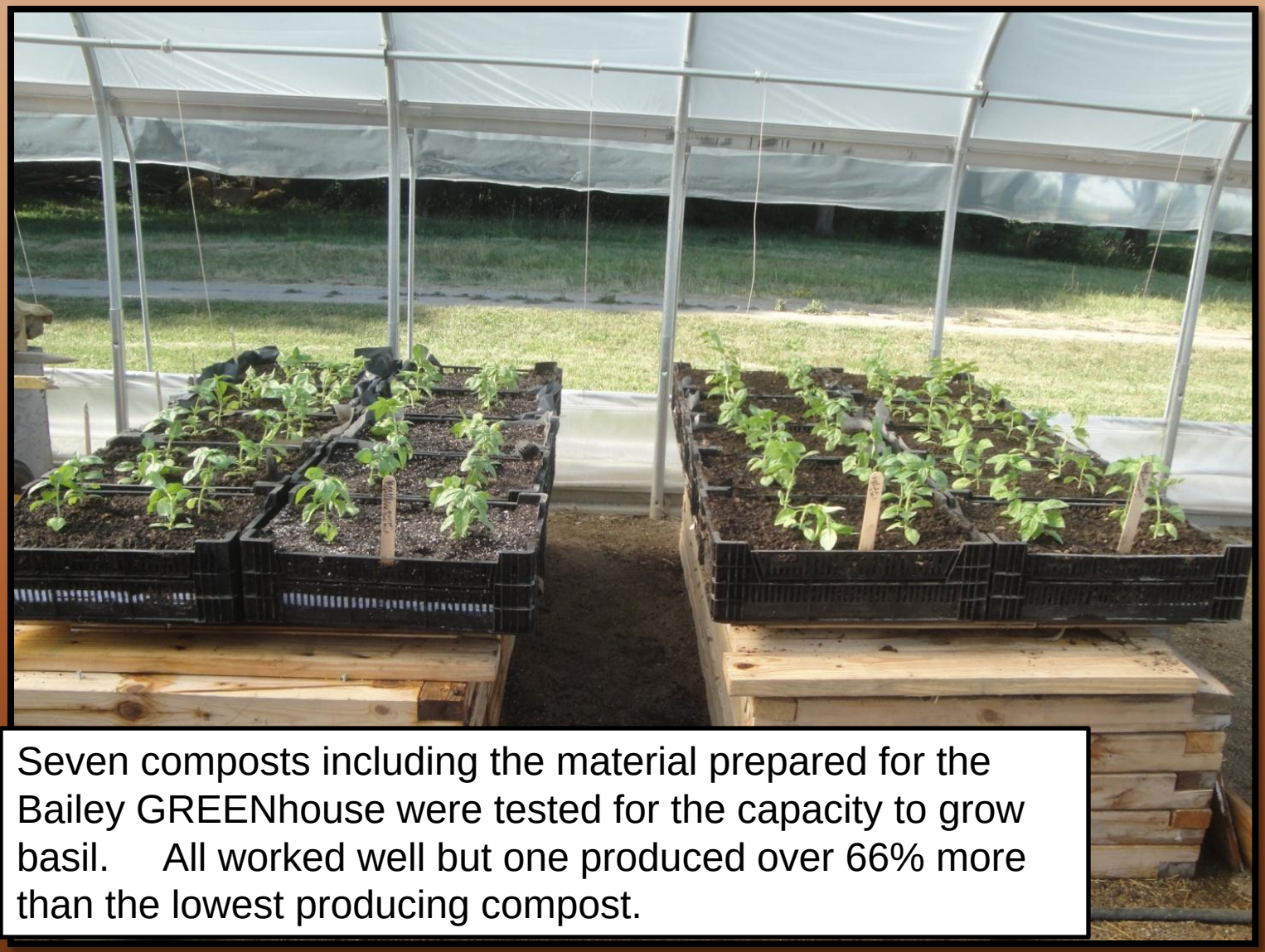
4’ x 8’ Wooden Worm Box/Bed

$100 for wood – standard pine 2”x6”x8’



Possible model for a farm or urban agriculture where a hoophouse is in use. The ten pounds of worms were established in this system in bedding made of leaves, chopped straw, compost and newspaper. Worm population was later split into a second bed. Worms were provided for a similar bed constructed by Greening of Detroit.

Compost Bioassay with Basil in Containers



Seven composts including the material prepared for the Bailey GREENhouse were tested for the capacity to grow basil. All worked well but one produced over 66% more than the lowest producing compost.

Compost Bioassay with Basil in Containers

Basil still producing on August 15 after several harvests.

Basil Yield for each Compost

Description	Compost	Pounds per Crate	Percent over Compost 1
Mixed food waste compost (3 & 4 below)	1	1.72	0.0
Morgan Composting Box Mix	2	1.95	13.6
Food Waste Compost with no soil added	3	1.77	3.0
Food Waste Compost with Soil Added	4	2.11	22.6
Plant Based Compost made with water Fall 2011	5	1.76	2.1
Plant Based Compost made with AD Effluent	6	2.89	67.8
Plant Based Compost made Summer 2011	7	1.72	0.0
	average	1.99	

Yield of 2 pounds in under 2 square feet in about 10 weeks at $16/pound is very high income.

Method of Lining the Crate to Conserve water and nutrients.

Crate Liner Method	Liner	Pounds per Crate	Percent over Liner 1
Newspaper	1	1.76	0.0
Black Woven Landscape Fabric	2	1.86	5.9
Grey Pressed Landscape Fabric	3	1.79	2.0
Black Polyethylene Film	4	2.03	15.2
Black Polyethylene Film with air holes	5	2.01	14.2
	average	1.89	7.5

Lining the crate with plastic film had no negative effect and had some positive effect on yield.

Vermiwash System

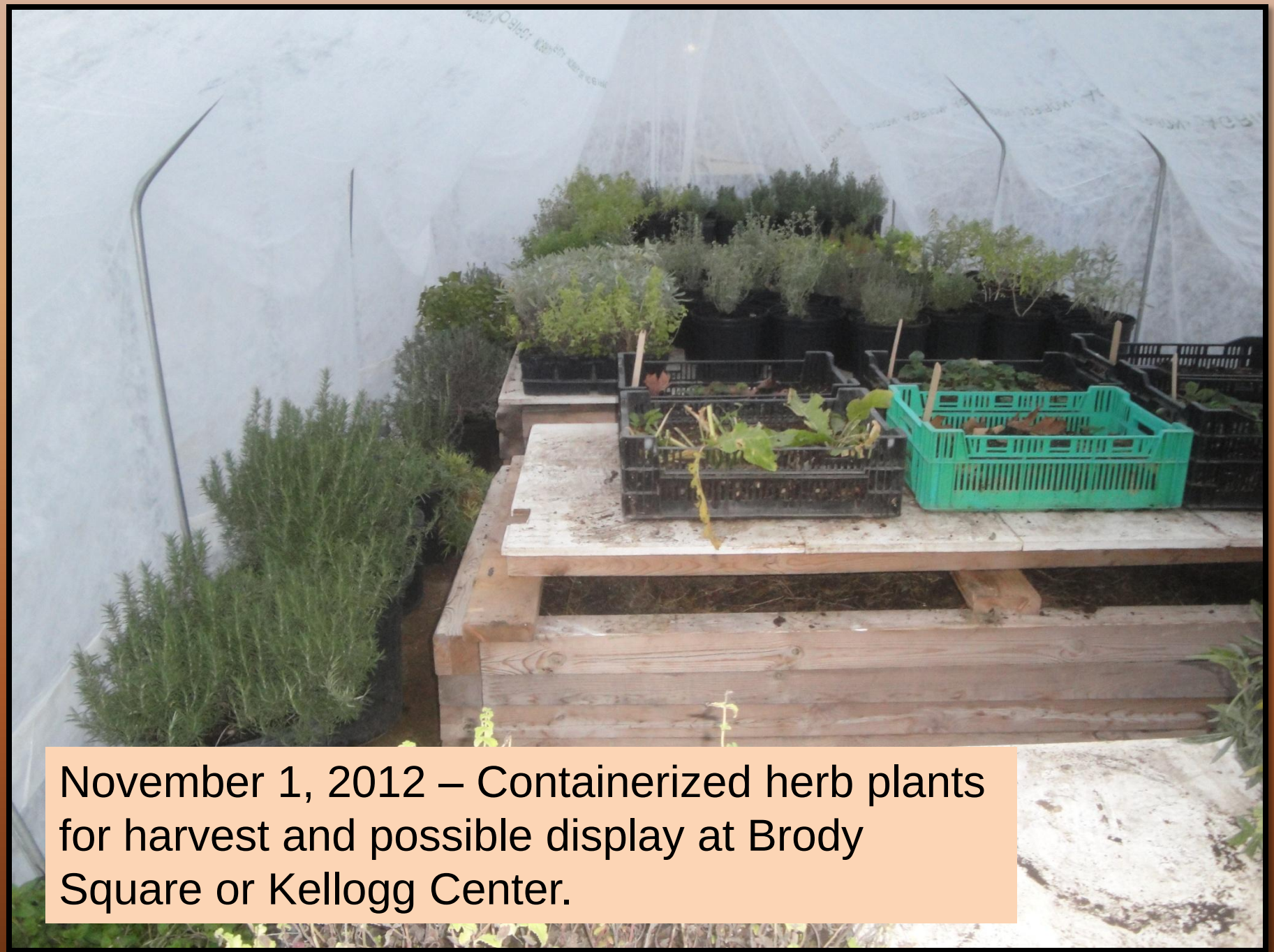
For Collection of Worm Compost Leachate
Wash out soluble nutrients and humates.
Risk of pathogen contaminants if present

Bedding and 5 pounds worms on Top

Drain Line and Valve

Gravel Drainage and Sand Filter Layers in Bottom

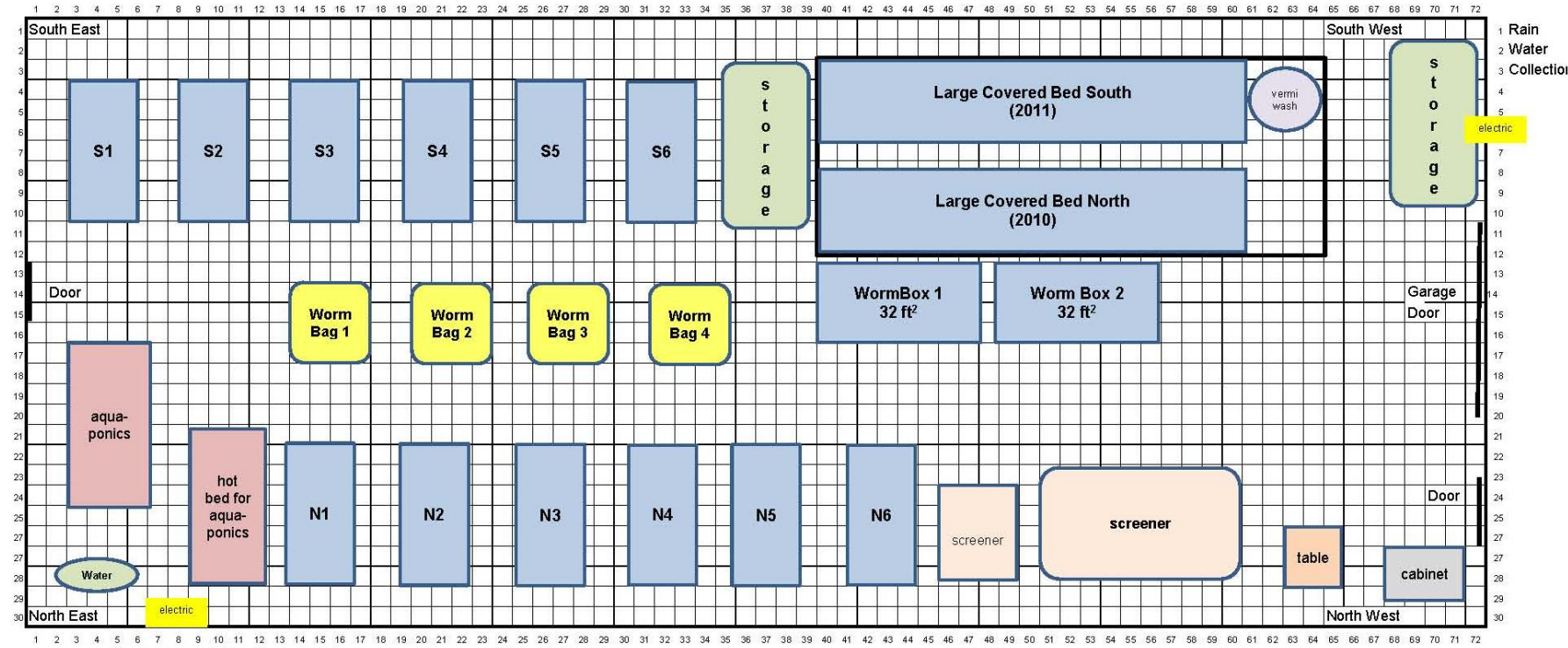
November 1, 2012 – 6 small beds from 2011covered under a single tent to maintain moisture, protect plants and simplify access to worms.



November 1, 2012 – Containerized herb plants for harvest and possible display at Brody Square or Kellogg Center.

2012 Expansion of Worm Bed Area

6 new beds on north side of the worm house



Greenhouse (Atlas Snow Arch)
30' x 72' = 2160 ft²
Thermostatic end wall peak vents
Manual drop down sides

Worm Beds
12 @ 20 ft² = 240 ft²
2 @ 60 ft² = 120 ft²
2 @ 32 ft² = 64 ft²
4 @ 16 ft² = 64 ft²
Total = 488 ft²

2010 - 60 ft²
2011 - 240 ft²
2012 - 424 ft²
2013 - 488 sq ft2

Arrangement is based on research and teaching mission more than optimizing production.
Surface of worm beds are also used for plant production.

Vermicompost processing for sale

- Goal is to remove as many worms as possible prior to screening using bulb crates and light method.
- Then provide an opportunity for the cocoons to hatch and collect small worms.
- Finally, screen to remove cucurbit seeds, clumps & stones and to increase uniformity.
- Final product was collected through a 1/8 inch screen with about 60 to 70% collected.

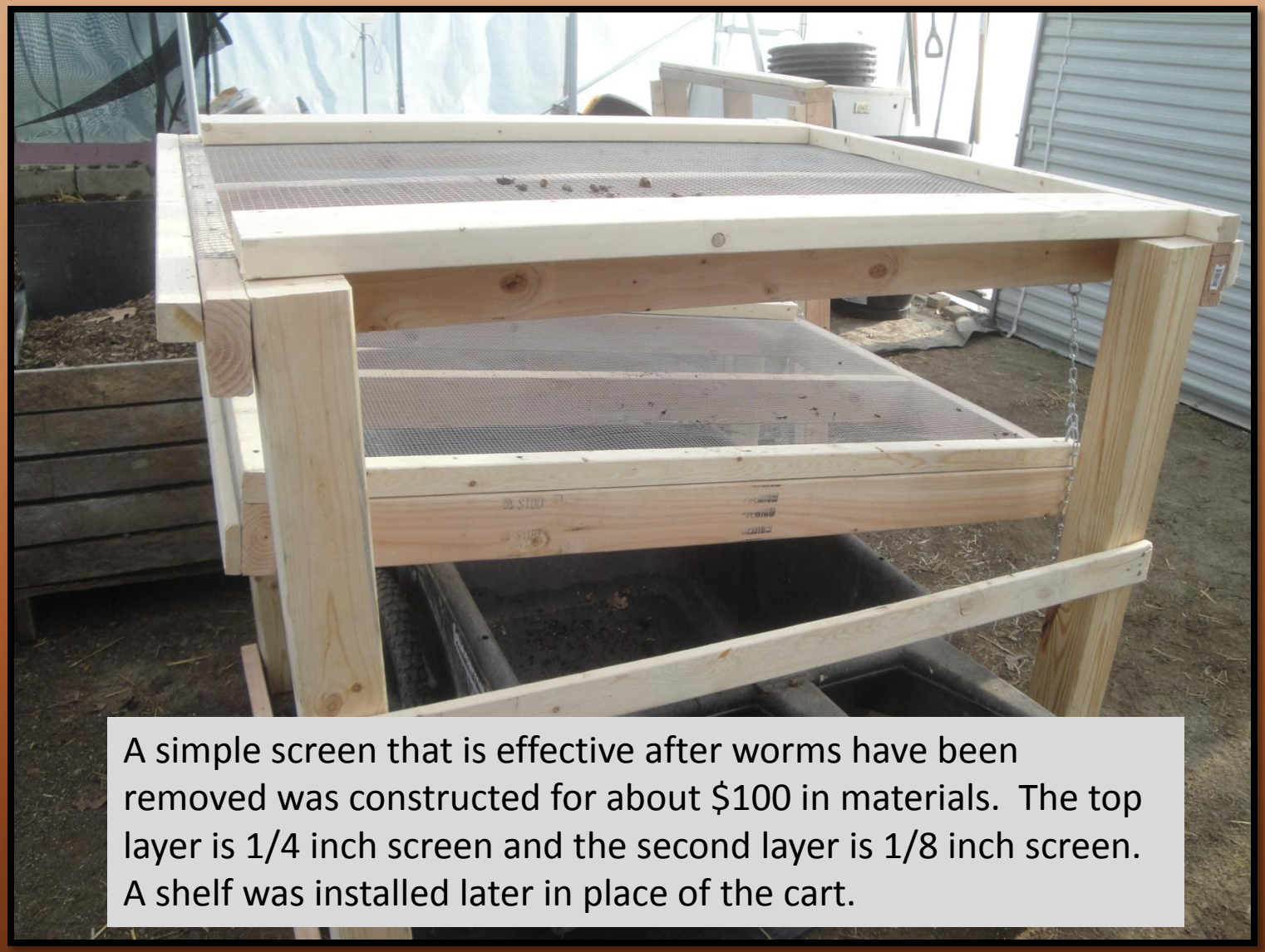
Primary Worm Extraction

Worms were easily extracted using the crate method and top collection. Fresh bedding in crates was placed on the surface of active worm beds and worms moved up and were removed.

Secondary Worm Extraction

Remaining worms were also extracted using the light method and bottom collection. “Finished” worm compost is piled and allowed to dry in bright light conditions. Worms move down and compost is collected from the surface at regular intervals. Worms are collected at the bottom, preferably without exposure to bright light at the end.

Swing Sifter for Screening Compost



A simple screen that is effective after worms have been removed was constructed for about $100 in materials. The top layer is 1/4 inch screen and the second layer is 1/8 inch screen. A shelf was installed later in place of the cart.

Jet Worm Harvester (model 3620)

3 screen sizes – 1/8, 1/4, 1/2 inch size

Can screen out worms from compost

A commercial trammel screen and worm harvester was purchased for a cost of about $3300 plus $300 for crating and $600 for shipping

http://www.jetcompost.com/harvesters/index.html

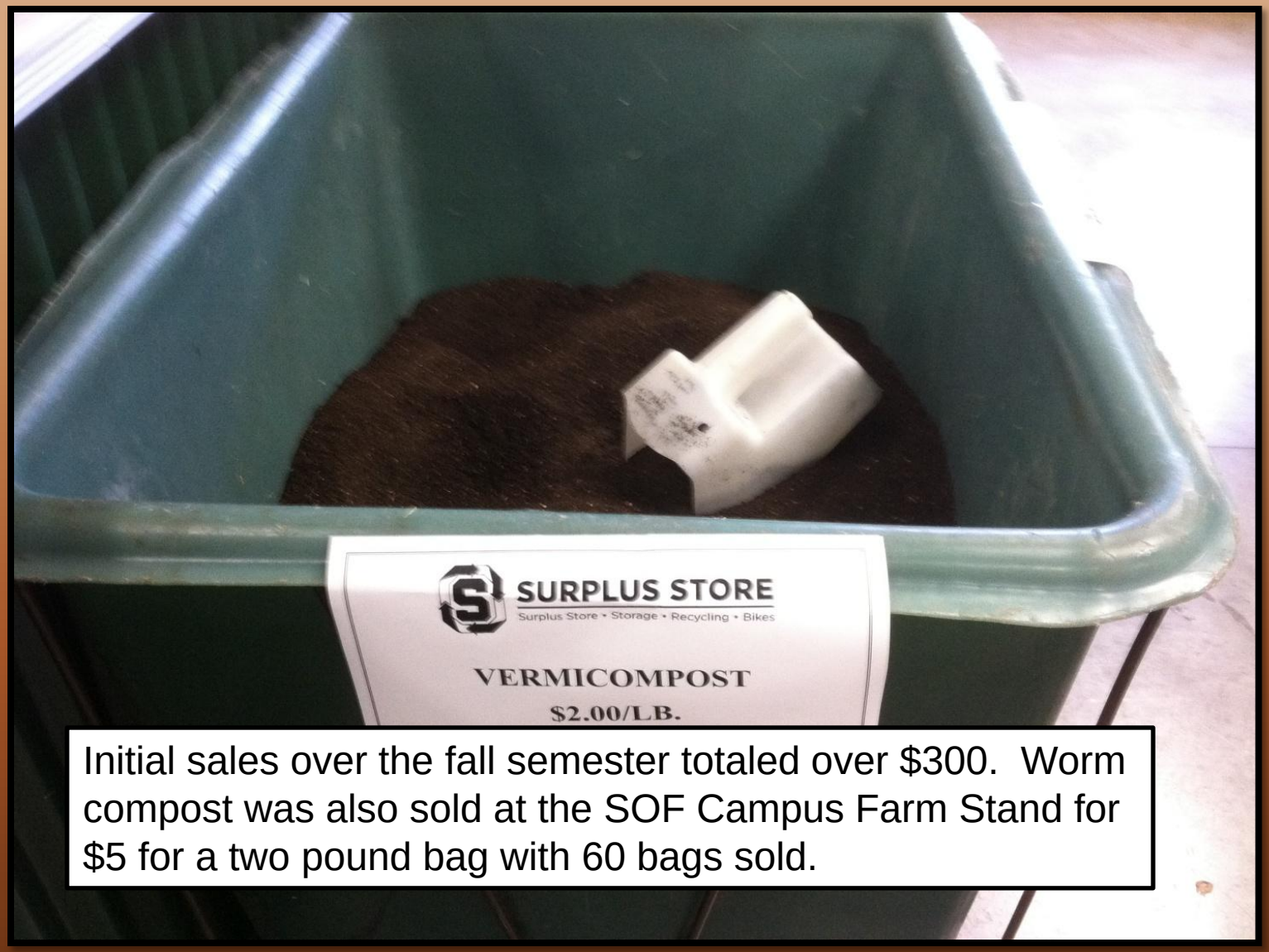
25 pounds in a 5 gallon bucket

33 buckets = 825 lbs or $825

The student organization “Into the Streets” sieved 40 more buckets on Saturday, October 27 as a service project.

Into the Streets RSO also built a work table for use at Bailey GREENhouse

Vermicompost Sales at MSU Surplus Store



Initial sales over the fall semester totaled over $300. Worm compost was also sold at the SOF Campus Farm Stand for $5 for a two pound bag with 60 bags sold.

Analysis of Worm Composts
Organic Matter, Carbon, C:N

Worm Compost	ID	% OM	% C	C:N	% N
Compost+Horse Man (Sum 2010)	W1	30.1	17.4	13.2	1.32
Horse+pulper in Bins (Win 2011)	W2	31.1	18.0	10.5	1.71
Horse in Bins (Win 2011)	W3	28.4	16.5	11.4	1.44
KitchenPrepResidue (Win 2011)	W4	38.0	22.0	10.5	2.10
Plant/leaf Compost (Sum 2011)	W5	47.6	27.6	17.2	1.60
Cow Manure (Sum 2011)	W6	41.5	24.1	16.6	1.45
Mix of W1 & W4 (for SOF)	W7	37.6	21.8	14.1	1.55
Horse manure PTF 2010	W8	18.9	11.0	11.7	0.94
Sieved from Win 2012	W9	33.4	19.4	13.1	1.48
Sieved from Beds 4-6 (Win 2011-12)	W10	20.9	12.1	10.4	1.16
Sieved from Beds 1-3 (Win 2011-12)	W11	33.5	19.4	9.5	2.05
Average of all	Mean	32.8	19.0	12.6	1.53

Analysis of Worm Composts
Total Mineral Content - Macronutrients

Worm Compost	ID	N	P	K	Ca	Mg	Na	S
Compost+ Horse Man (Sum 2010)	W1	1.32	0.30	0.76	2.12	0.51	0.03	0.19
Horse+pulper in Bins (Win 2011)	W2	1.71	0.49	0.75	2.34	0.73	0.07	0.26
Horse in Bins (Win 2011)	W3	1.44	0.44	0.63	2.05	0.55	0.05	0.20
KitchenPrepResidue (Win 2011)	W4	2.10	0.38	1.60	2.45	0.64	0.12	0.24
Plant/leaf Compost (Sum 2011)	W5	1.60	0.36	0.72	2.15	0.47	0.05	0.24
Cow Manure (Sum 2011)	W6	1.45	0.60	1.49	3.49	0.88	0.14	0.35
Mix of W1 & W4 (for SOF)	W7	1.55	0.30	0.96	2.04	0.71	0.06	0.19
Horse manure PTF 2010	W8	0.94	0.29	0.57	1.94	0.49	0.01	0.13
Sieved from Win 2012	W9	1.48	0.24	0.78	3.23	0.85	0.10	0.18
Sieved from Beds 4-6 (Win 2011-12)	W10	1.16	0.34	0.55	2.27	0.83	0.05	0.15
Sieved from Beds 1-3 (Win 2011-12)	W11	2.05	0.26	0.94	3.39	0.95	0.12	0.23
Average or Mean of all	Mean	1.53	0.36	0.89	2.50	0.69	0.07	0.21

Analysis of Worm Composts
Total Mineral Content – Micronutrients

Worm Compost	ID	Fe	Zn	Mn	Cu	B	Al
Compost+ Horse Man (Sum 2010)	W1	3849	81	240	29	16	2328
Horse+pulper in Bins (Win 2011)	W2	4093	104	289	31	19	2108
Horse in Bins (Win 2011)	W3	4053	81	225	28	16	2104
KitchenPrepResidue (Win 2011)	W4	3920	61	210	18	21	1839
Plant/leaf Compost (Sum 2011)	W5	3851	94	234	31	21	2116
Cow Manure (Sum 2011)	W6	4325	140	342	58	20	1759
Mix of W1 & W4 (for SOF)	W7	4467	69	197	26	16	2265
Horse manure PTF 2010	W8	3399	58	197	14	10	1864
Sieved from Win 2012	W9	4449	58	195	21	13	1817
Sieved from Beds 4-6 (Win 2011-12)	W10	3979	62	215	19	12	1871
Sieved from Beds 1-3 (Win 2011-12)	W11	4336	56	224	24	17	1737
Average or Mean of all	Mean	4066	79	233	27	16	1983

Analysis of Worm Composts

Water Extractable Minerals (SME)

Worm Compost	ID	pH	EC	NO3-N ppm	NH4-N ppm	P (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)
Compost+ Horse Man (Sum 2010)	W1	6.5	8.92	850	7.5	93	2106	900	177
Horse+pulper in Bins (Win 2011)	W2	7.2	4.67	272	4.1	147	985	420	126
Horse in Bins (Win 2011)	W3	7.1	5.15	371	1.5	182	1080	420	149
KitchenPrepResidue (Win 2011)	W4	7.6	11.8	834	1.7	90	3498	1260	93
Plant/leaf Compost (Sum 2011)	W5	6.5	5.15	410	1	100	1061	480	120
Cow Manure (Sum 2011)	W6	8.7	7.51	294	4.4	138	2052	900	113
Mix of W1 & W4 (for SOF)	W7	7.0	9.39	694	1	122	2388	960	137
Horse manure PTF 2010	W8	8.0	4.67	280	0.8	35	1251	420	67
Sieved from Win 2012	W9	6.5	12.89	904	6.5	124	2357	1500	247
Sieved from Beds 4-6 (Win 2011-12)	W10	6.9	6.99	450	5.3	124	1326	750	176
Sieved from Beds 1-3 (Win 2011-12)	W11	6.4	11.69	748	5.3	124	1971	1200	194
Average of all	Mean	7.1	8.07	555	3.6	116	1825	837	145

Dilute 1 part compost to 10 parts water and make a good fertilizer solution.

Compost was protected for the winter in 2 structures – one built in November

December 26 – Fall Piles Covered and Leaves Collected for Next Year

Final two kitchen residue and wood chip piles of season.

Leaves were delivered by Landscape Services.

December 26 – WORMhouse Ready for Winter

An Aquaponic (fish and plants) system was also constructed during fall semester.

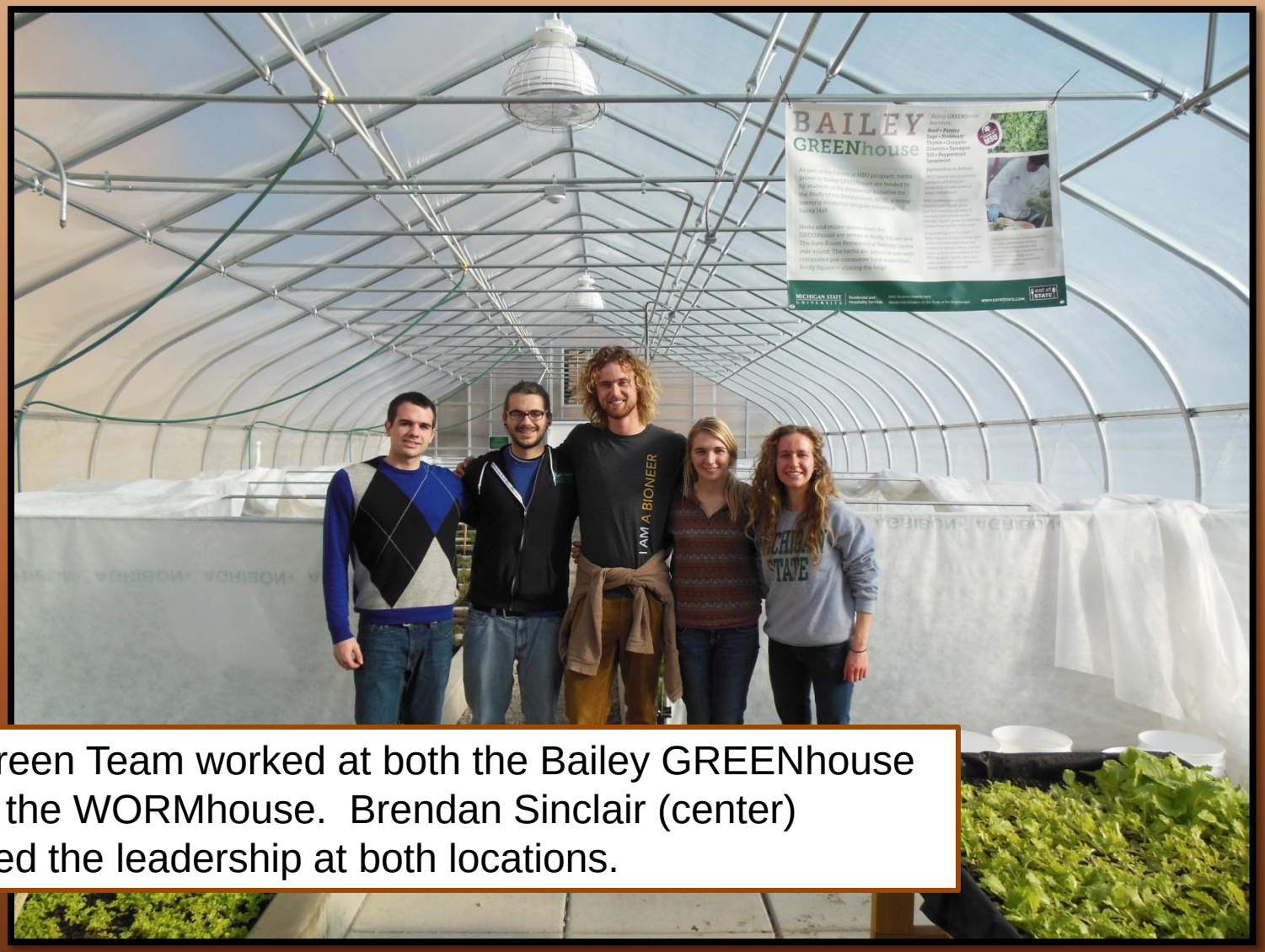
Project was funded separately with a Be Spartan Green grant but required a significant investment of development time, thinking and construction instruction.

Aquaponics plumbing- System Ready for Plants First, Fish Later

2012 Summary

- Recycling Center delivery of kitchen residue to SOF in place. A total of over 100,000 lbs or 50 tons of material was composted in 2012.
- An estimated 10 to 15% was fed to worms.
- Potted herb transplants were prepared for the Bailey GREENhouse.
- Wormhouse composting area increased from 300 sq ft to 488 sq ft with more worms and four systems in place for winter testing.
- Compost screening methods developed for finished compost.
- Worm compost available for sale at SOF Farm Stand and Recycling Center. Over 100 5 gallon (25lbs each) buckets processed and ready for sale. An additional 3 to 4 cubic yards ready for screening over the winter. Working on marketing plan with Surplus Store.
- Eleven samples of worm compost made at the SOF were analyzed for organic matter, total nutrients and water soluble nutrients and compared t previous hot composted samples.
- Several batches of hot composted material are ready for plant production in raised beds at the Bailey Urban Farm in 2013.
- External Research proposal submitted to CERES Trust for 3 year study but was not funded.

The GREEN Team



The Green Team worked at both the Bailey GREENhouse and at the WORMhouse. Brendan Sinclair (center) provided the leadership at both locations.

A Local Food Cycle

The path to prosperity, peace, parity and partnership
is the passionate perennial progression from
planting,
producing,
protecting,
processing,
preserving,
purchasing,
preparing,
partaking
and passing pooh to
renew the soil and begin anew.

Promote positive personal, public and planetary perspectives and programs with your food practices and purchasing power.

John Biernbaum

A Vision and A Task

A vision without a task is a dream.
A task without a vision is drudgery.
A vision and a task
Are the hope of the world.

Integral Agriculture

Farmers, friends and families
using facts and feelings to
physically, faithfully and fearlessly
farm
front yards, forests and fields
for food, feed, fodder, fiber, fuel, flowers,
fertility, fun, freedom, fairness

and the future.

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