Closing the Food Cycle Loop: Food Scrap Composting and Compostponics

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What are Characteristics of Sustainable and Organic Systems?

- Resourceful
  - Reduce, Reuse, Recycle
- Resilient
  - Resistant, Responsive, Redundant
- Regenerative
  - Renewing, Reproductive, Reorganizing
- Must be Healthy, Living Systems
- Participation requires rethinking, redesigning and reorganization through collaborative learning, active participation and a deep sense of truly belonging to a place.

Food Waste and Farming

- Waste at farm, retail and home levels.
- Estimates of 25 to 40% of food wasted.
- An estimated 98% ends up in landfills and contributes methane as a greenhouse gas.
- At the same time the cost of fossil fuel derived fertilizer and mined minerals are increasing.
- Farm soil is often being mined of minerals and soil organic matter.
- Composting food scraps seems about as obvious as having distributed animal husbandry to facilitate ease of putting animal manure back on the land.
- Collection and composting takes an investment.

Closing the Food Cycle Loop I

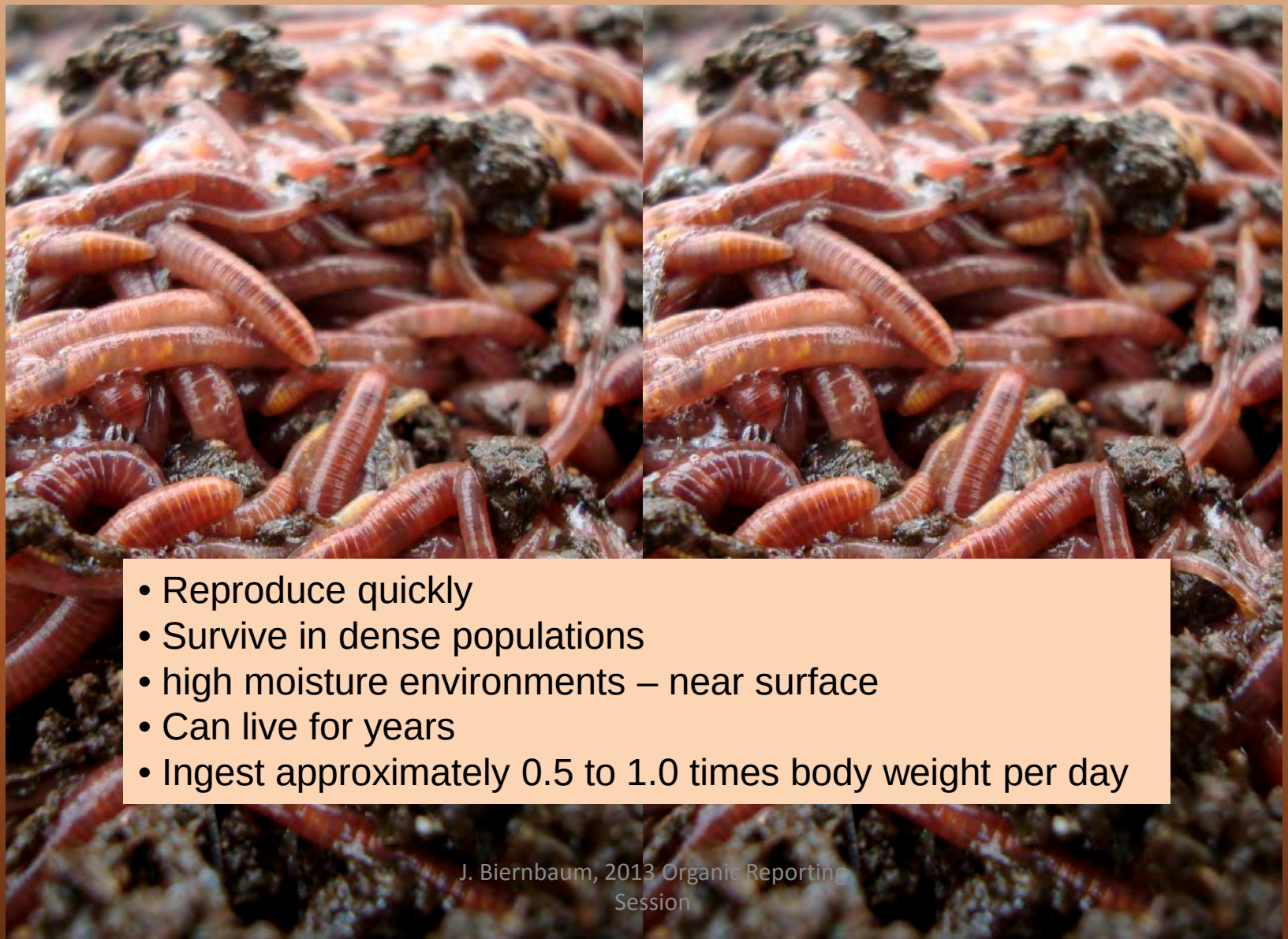
Food Residue Composting and Worm Composting

J. Biernbaum, 2013 Organic Reporting Session

Compost and Transplant or Crop Growth.

Top dressed worm compost
Starting rate of ~ 1 cup per flat

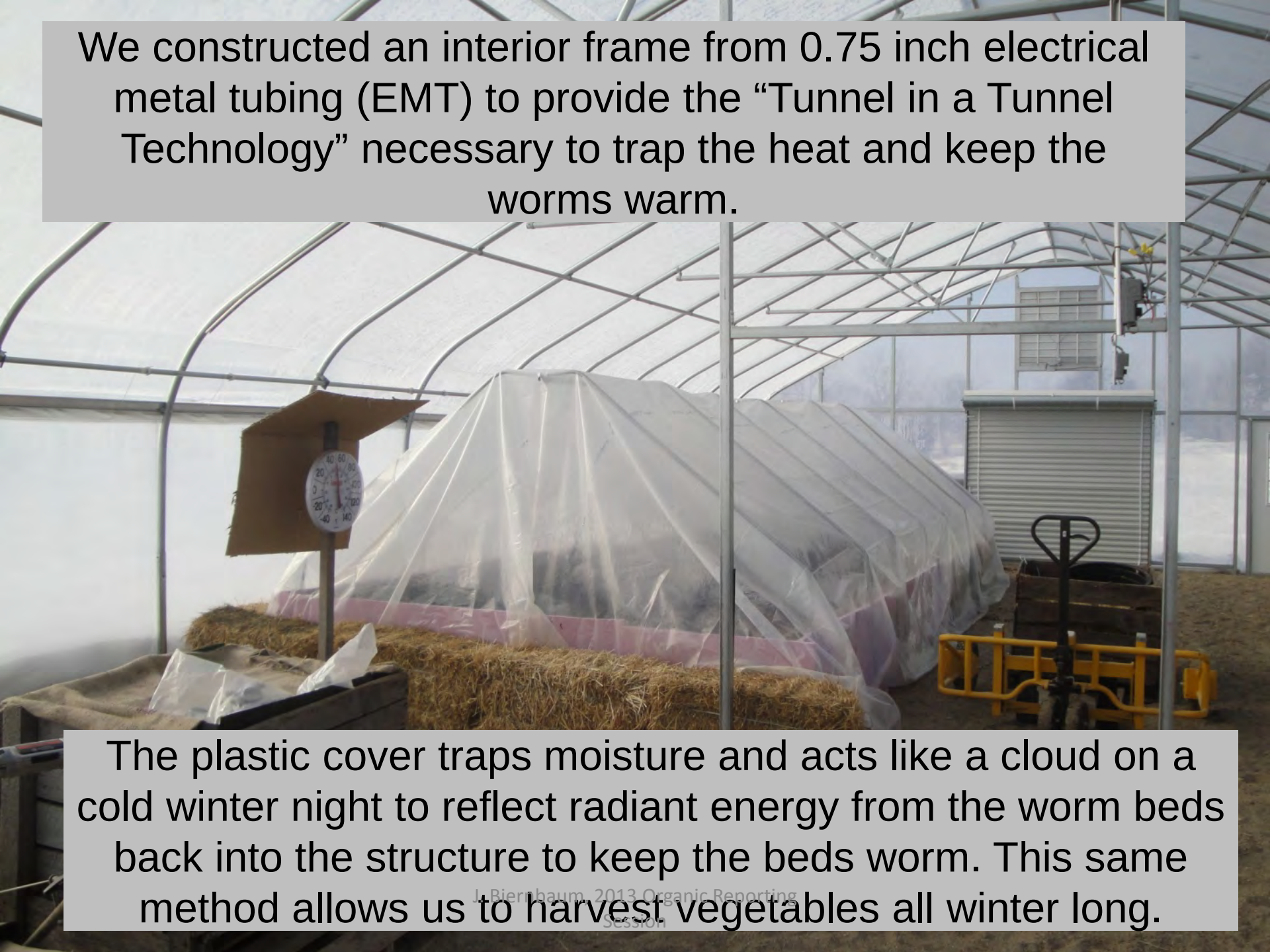
Composting Worms – Red Worms



- Reproduce quickly
- Survive in dense populations
- high moisture environments – near surface
- Can live for years
- Ingest approximately 0.5 to 1.0 times body weight per day

The Compost Commons – Oct 2010

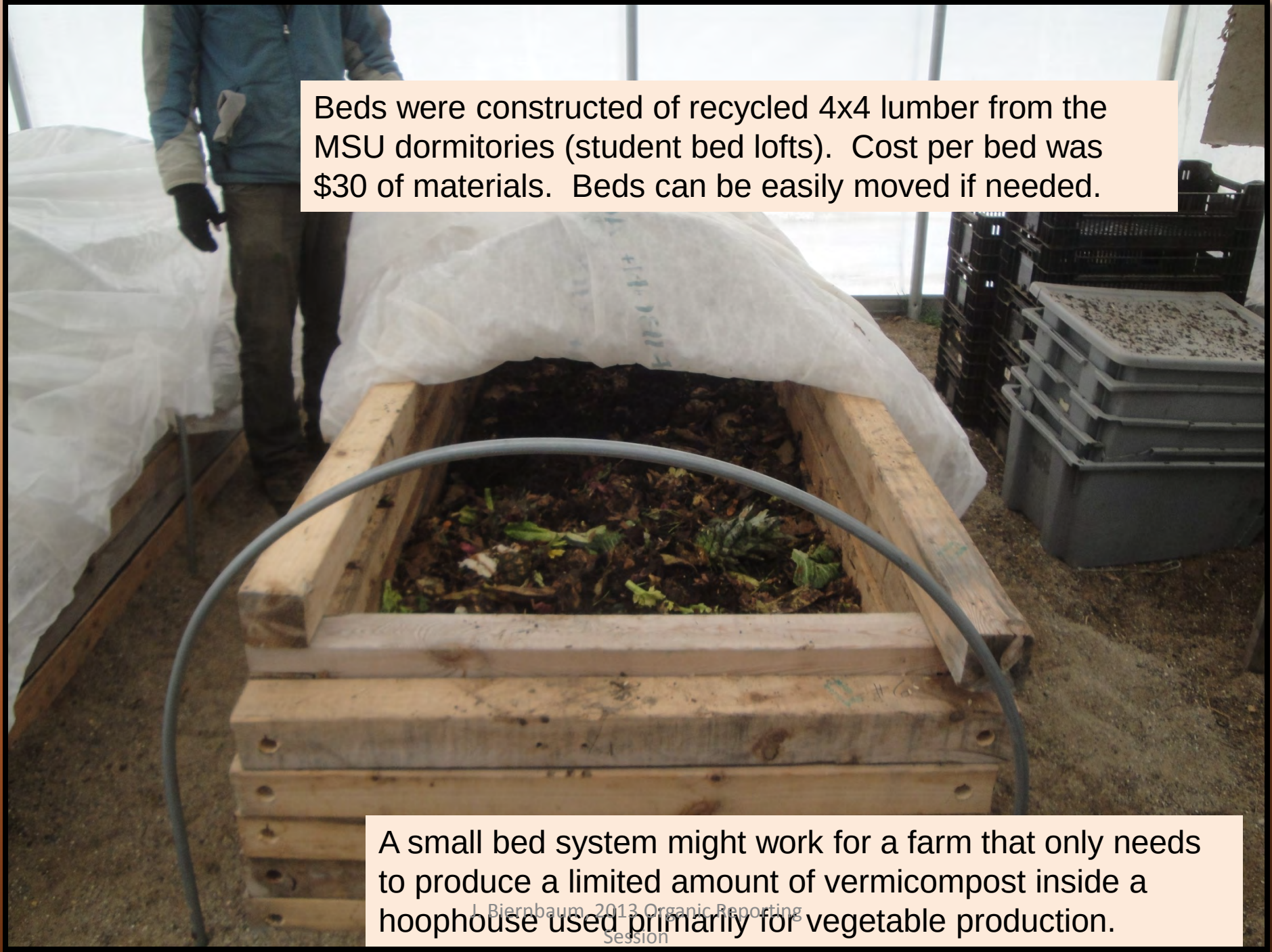
30’ x 72’ structure
extended side walls
drop down sides
all metal – no wood
thermostatic ventilation
single layer cover;
approximately $10,000.



We constructed an interior frame from 0.75 inch electrical metal tubing (EMT) to provide the “Tunnel in a Tunnel Technology” necessary to trap the heat and keep the worms warm.

The plastic cover traps moisture and acts like a cloud on a cold winter night to reflect radiant energy from the worm beds back into the structure to keep the beds worm. This same method allows us to harvest vegetables all winter long.


January 2012 – preconsumer kitchen residue is added and covered with precomposted post consumer residue.



Beds were constructed of recycled 4x4 lumber from the MSU dormitories (student bed lofts). Cost per bed was $30 of materials. Beds can be easily moved if needed.

A small bed system might work for a farm that only needs to produce a limited amount of vermicompost inside a hoophouse used primarily for vegetable production.


Worms were 3 to 4 inches below the surface on a cold day.

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 with Horse Manure and Newspaper Bedding at SCCF

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 three times per week . Straw, hay, leaves mixed with food residue. Later piles were made using wood chips provided by Landscape Services.

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

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

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

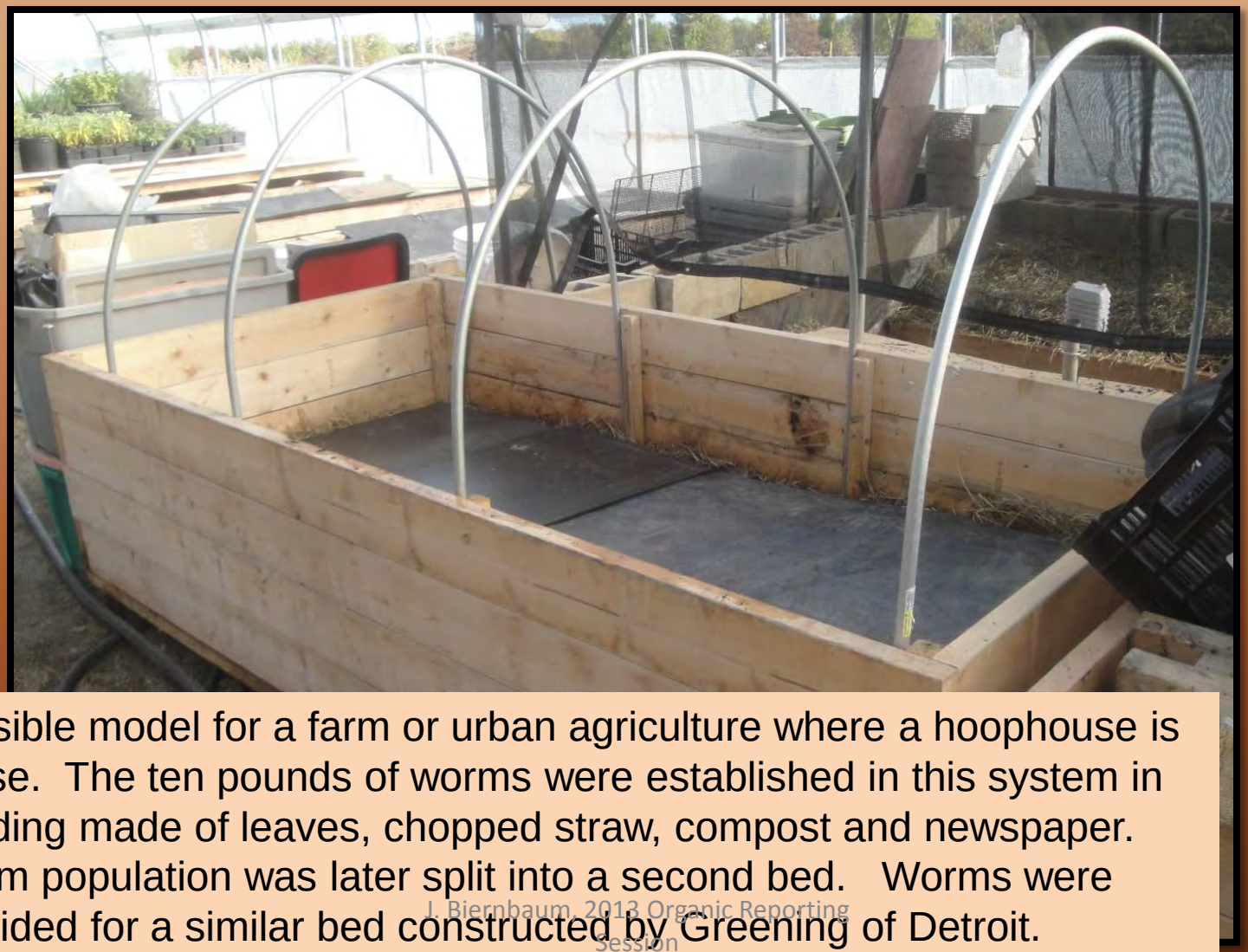
Worm Purchase Experiment

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’



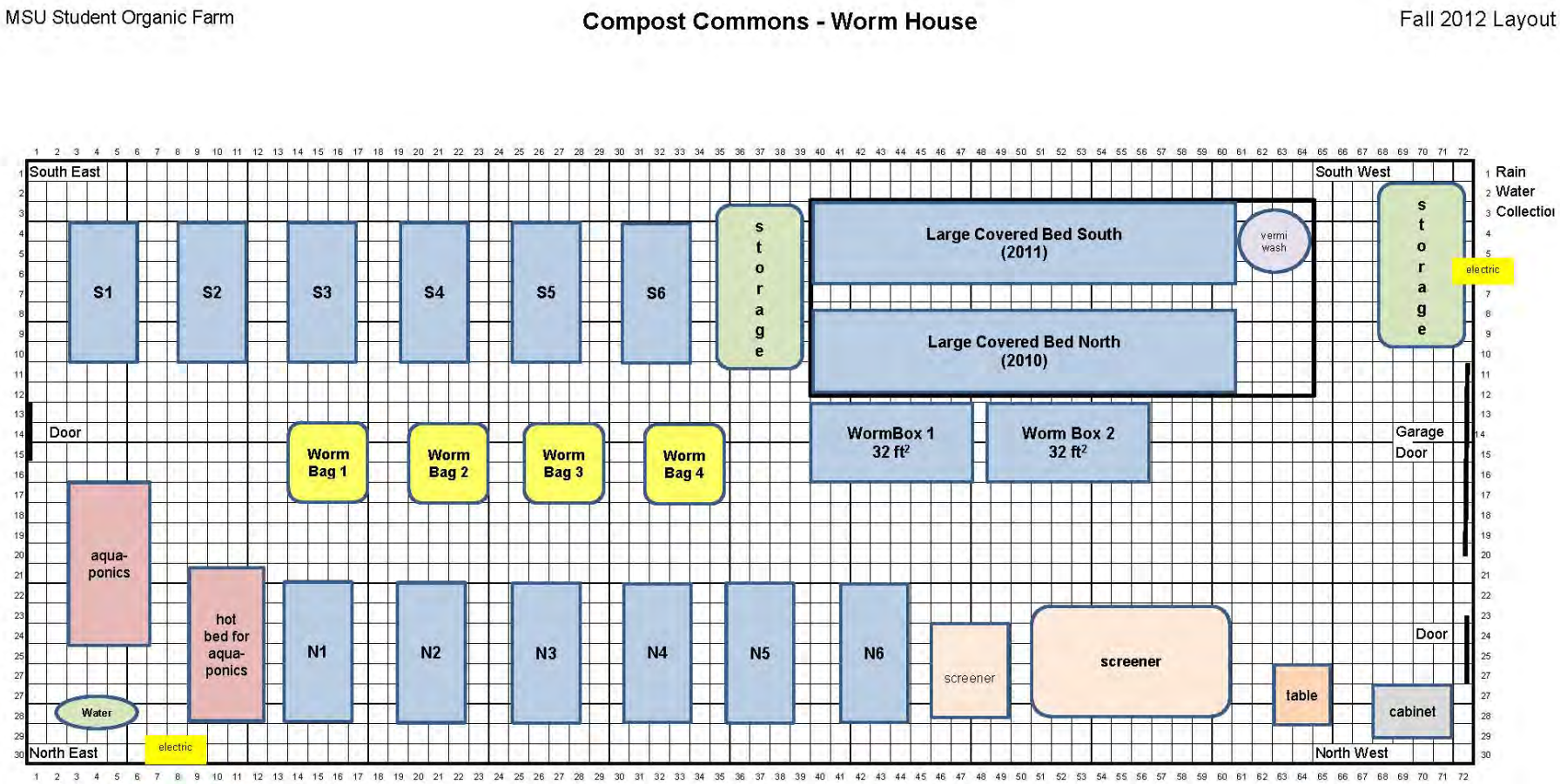
Possible model for a farm or urban agriculture where a hoophouse is in use. The ten pounds of worms were established in this system in bedding made of leaves, chopped straw, compost and newspaper. Worm population was later split into a second bed. Worms were provided for a similar bed constructed by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

Bulk Bag Worm Composting

Flow Through Worm Composting

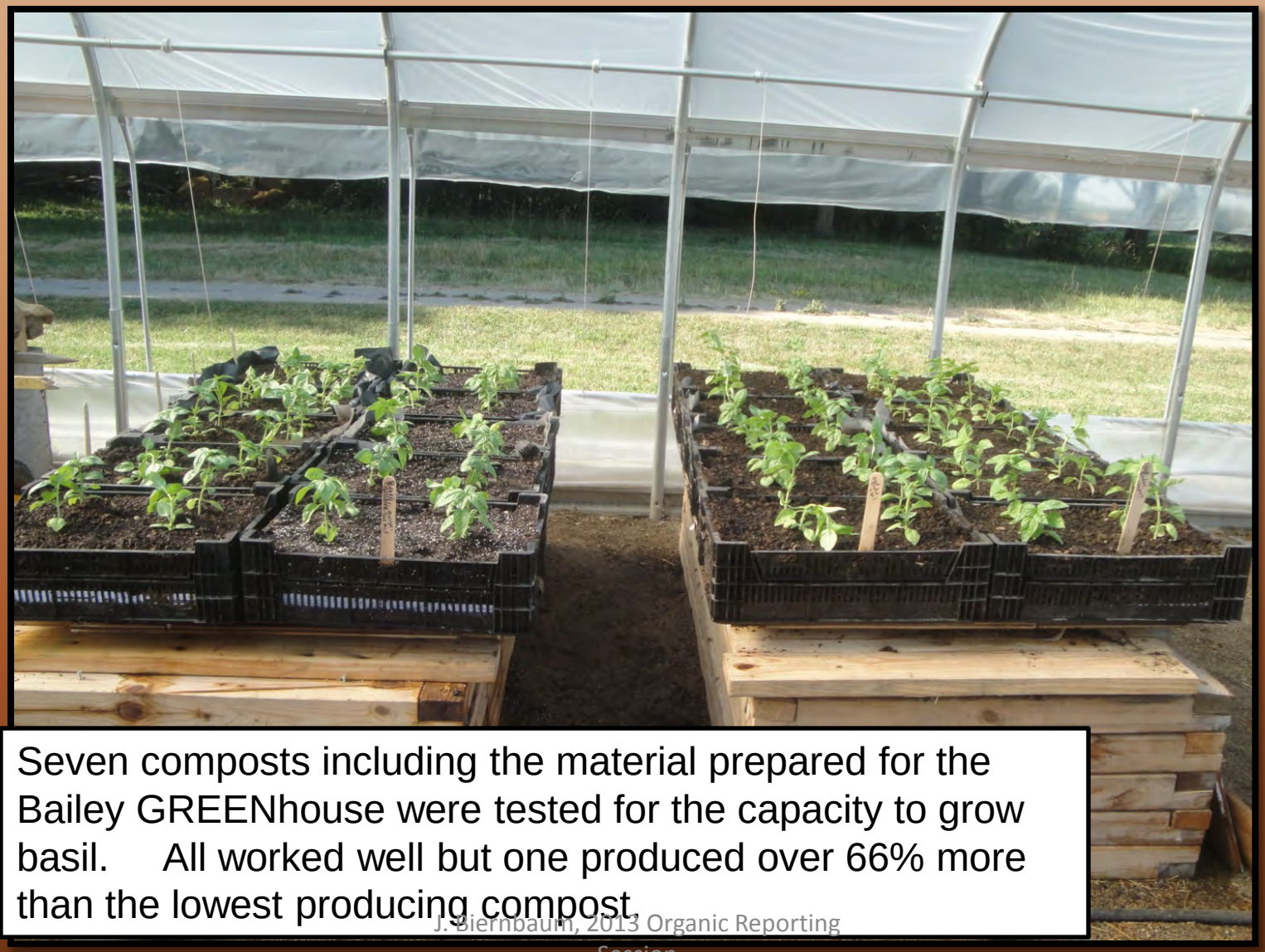
2012 Expansion of Worm Bed Area

6 new beds on north side of the worm house



December 26 – WORMhouse Ready for Winter

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.

Analysis of 10 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 10 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.

Future Research

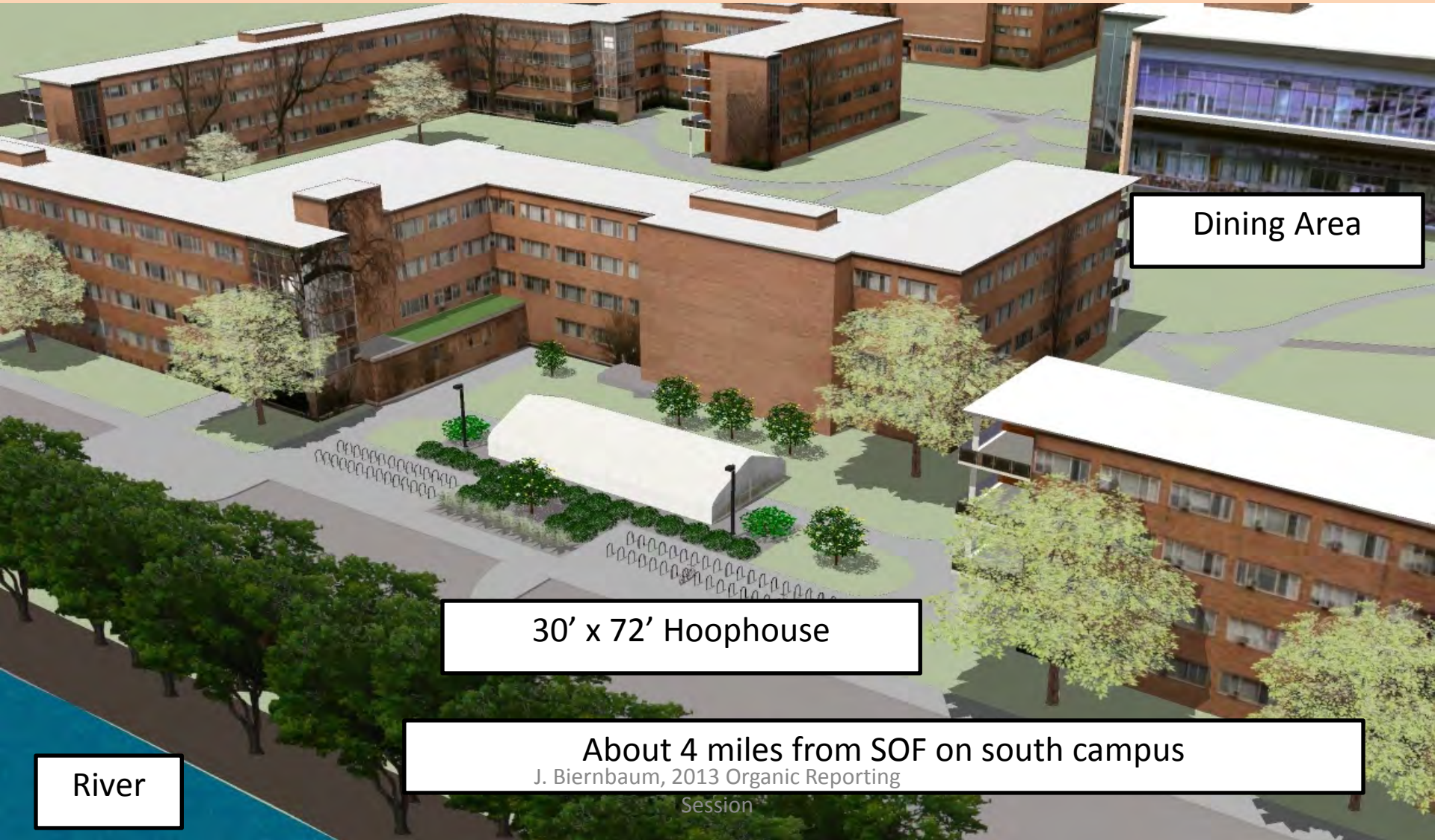
- Using the heat of composting to keep the worms warm but not “cooked” in winter.
- Potential for overwintering outdoor worm beds with appropriate protection.
- Contribution of specific types of food scraps to pH and fertility.
- Campus paper towels and athletic event food service containers as carbon source.
- Anaerobic digester liquid and solid effluent as a nutrient source.

Closing the Food Cycle Loop II

The Liberty Hyde Bailey GREENhouse Project

MSU Hoophouse Herbs

Project of Residential and Hospitality Services, Environmental Studies Program and Student Organic Farm



Propagation of Culinary Herbs

Independent Study Project by Horticulture Student during Fall 2011

All cuttings were obtained at no cost and from organic management from Pear Tree Farm.

Propagation of Herb Cuttings

Rosemary, Oregano, Sage, Thyme, Tarragon, Peppermint, Spearmint

Mist propagation accomplished at the Plant and Soil Sciences Teaching Greenhouses. Shoots kept moist initiated new roots and new plants.

June 26, 2012 Herbs ready for Planting

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.

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.

Preparing the “Soil” by Composting

Composting allows immediate organic certification which would not be possible with the 60% top soil and 40% compost blend initially planned.

Summer 2011, Feedstocks from South Campus Compost Facility

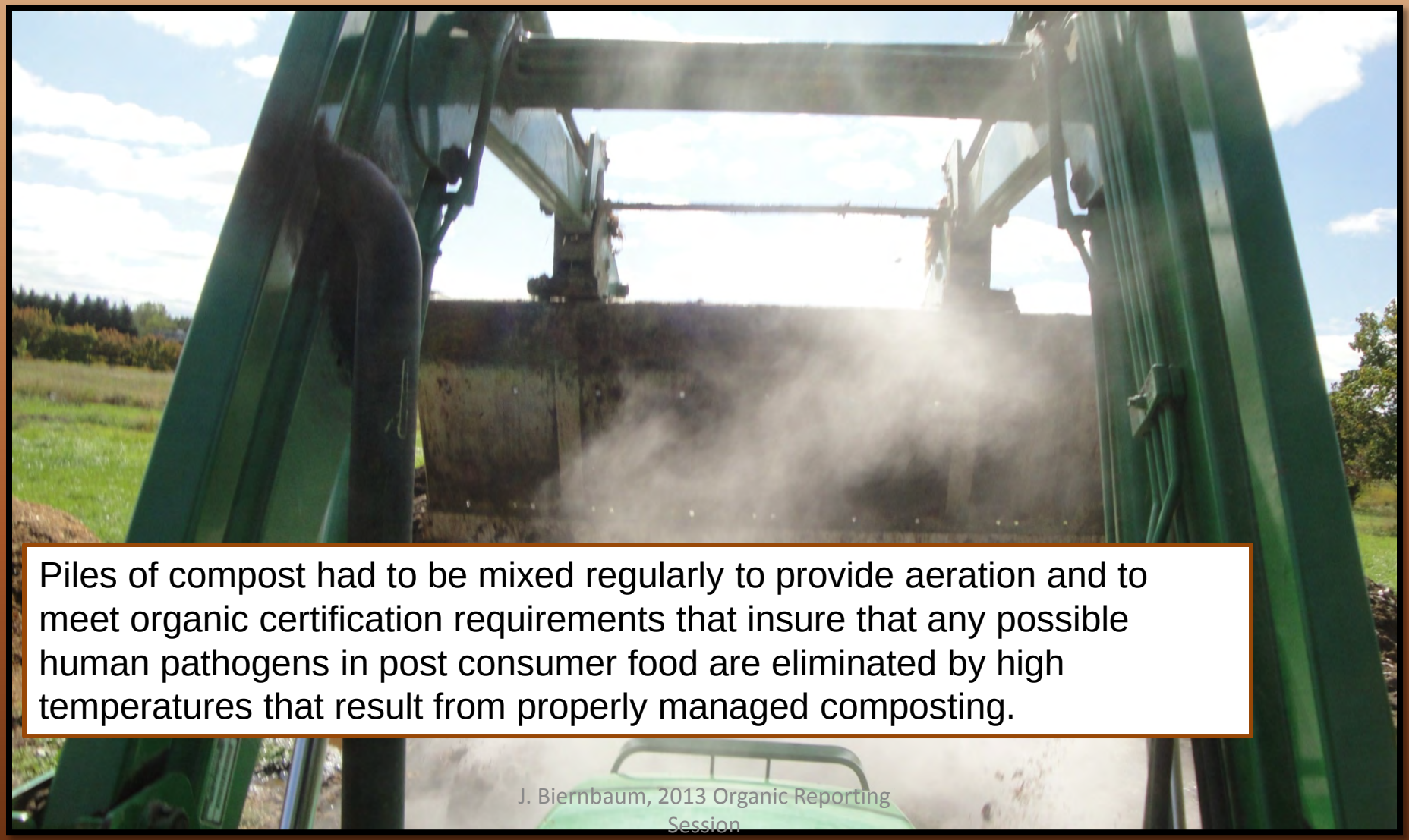
Preparation for Pulped Food Residue

Mixing in Pulped Food Residue

About 3 to 5 cubic yards per delivery.
Delivery Tuesday and Friday.
Cubic yard more than 1000 pounds.
Increase from 600 lbs/wk in spring to over 6000 lbs/wk

Mixing feedstocks and pulped food residue

Turning Hot Compost – Over 150ºF



Piles of compost had to be mixed regularly to provide aeration and to meet organic certification requirements that insure that any possible human pathogens in post consumer food are eliminated by high temperatures that result from properly managed composting.

“Finished” Brody Pulper Compost

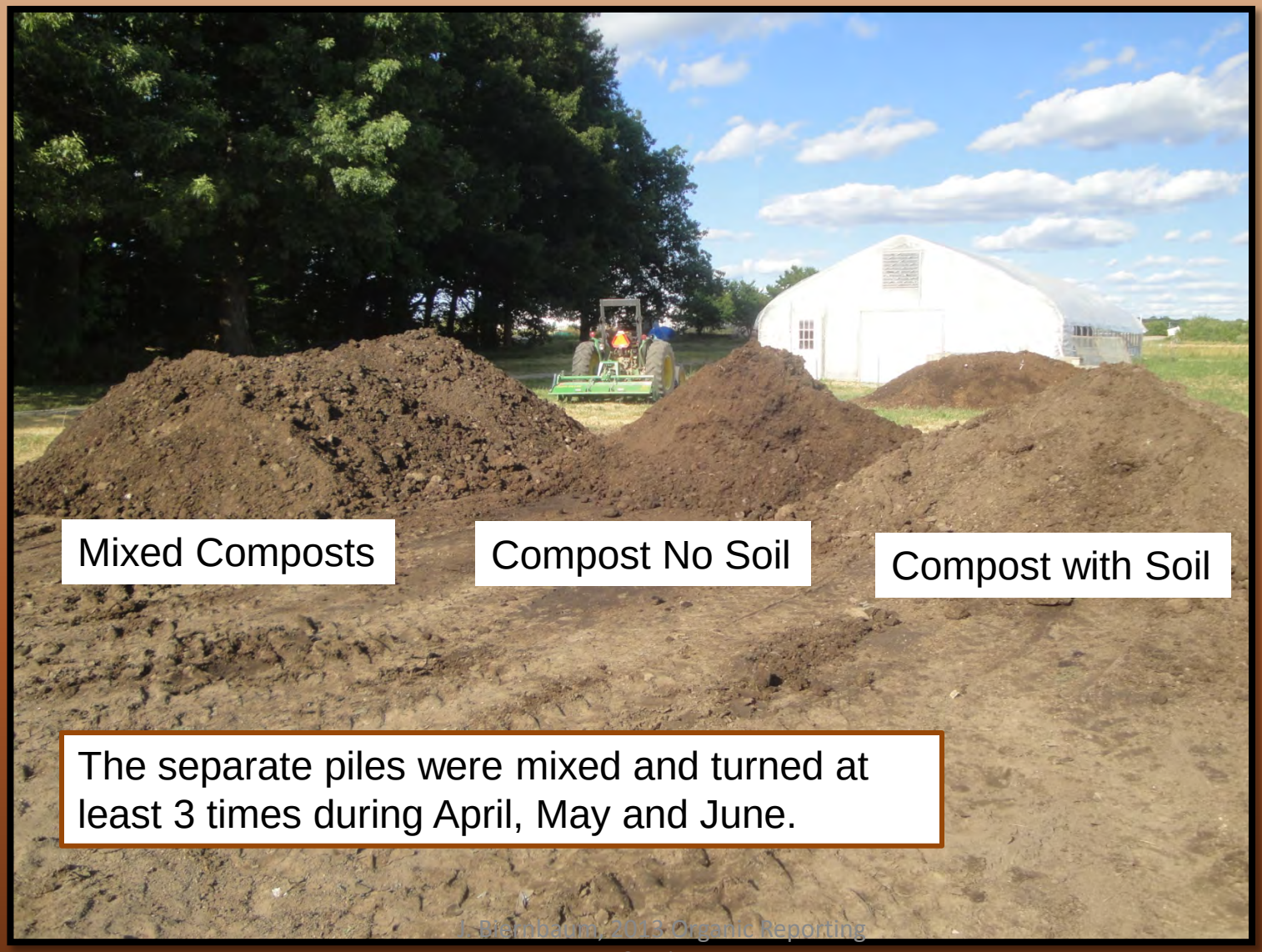
November 2011 – after hot composting. Three windrows this size of compost with no soil were produced.

March 4, Compost Prior to Mixing

Protected with covers over the winter.

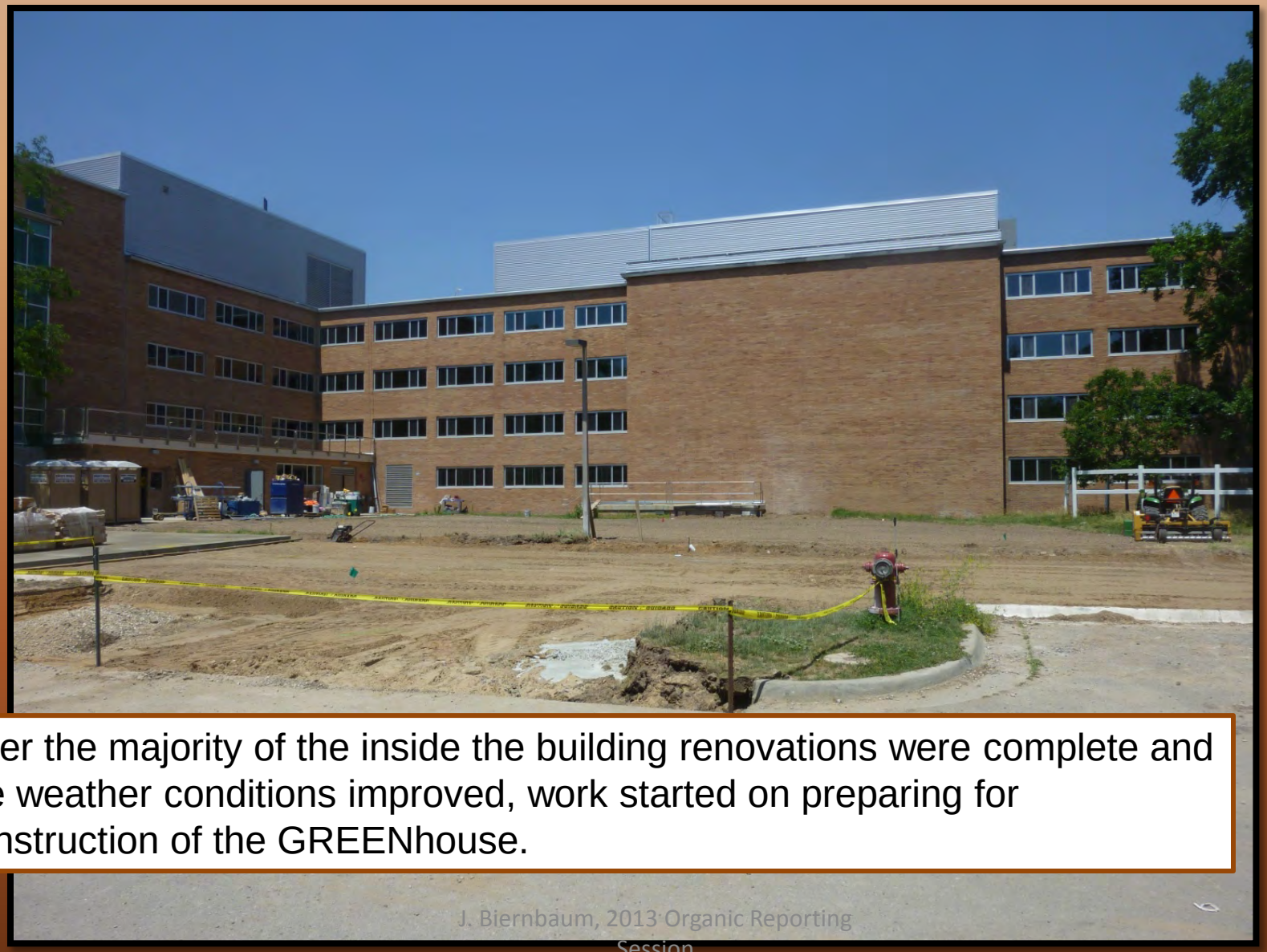
The piles maintained warm but not hot temperatures over the winter and were protected to prevent leaching of minerals and nutrients from the compost. As conditions dried the piles were turned more so the compost could mature. Eventually samples were analyzed and used to grow test crops of basil in small containers.

June 25, Mixing Piles



The separate piles were mixed and turned at least 3 times during April, May and June.

June 10 – Bailey Site Preparation



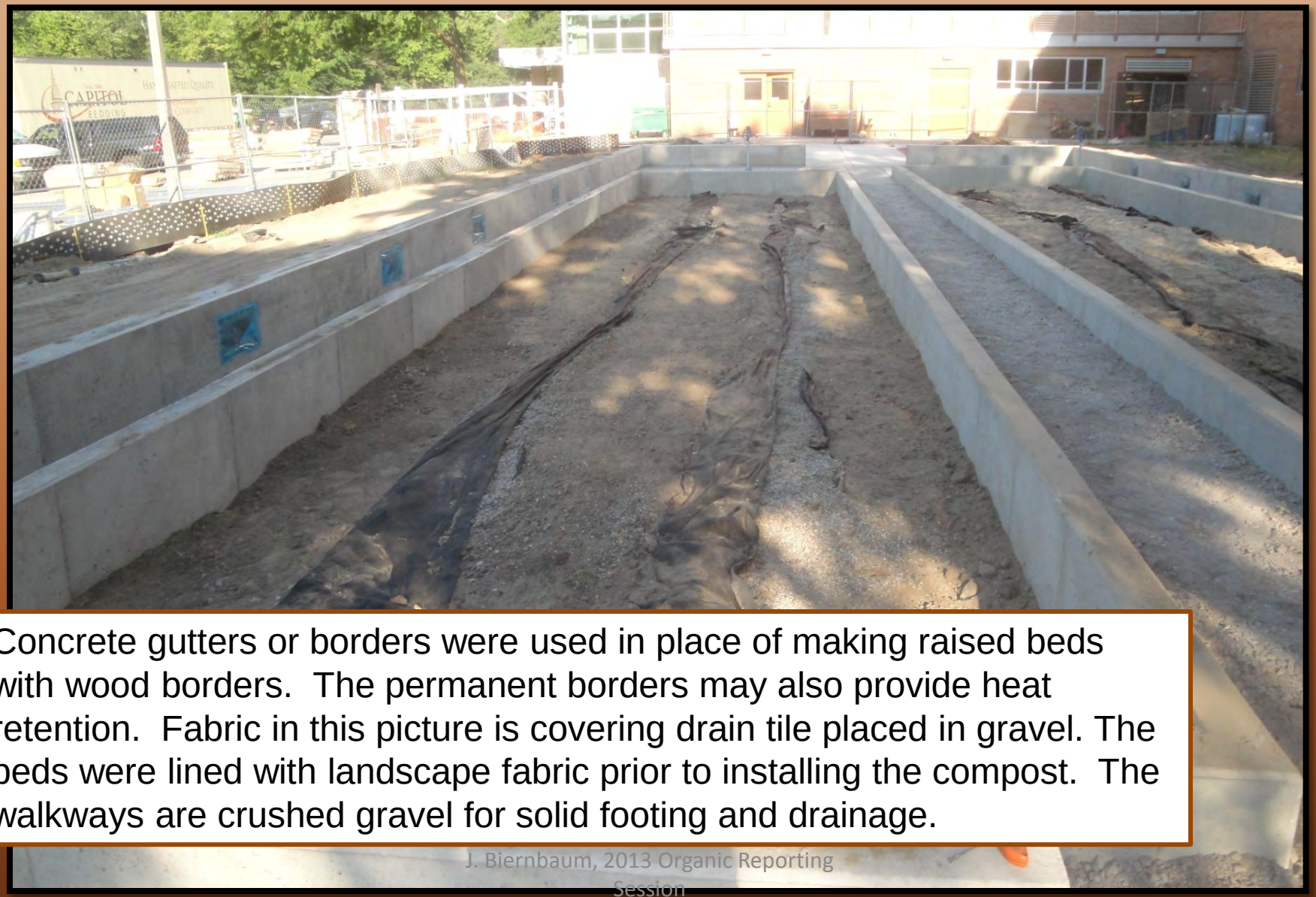
After the majority of the inside the building renovations were complete and the weather conditions improved, work started on preparing for construction of the GREENhouse.

June 21 - GREENhouse Foundation

The poured cement foundation with vents was required because the site is on a 100 year flood plain

July 9th Empty Beds with Drainage

Ready for Composted Soil



Concrete gutters or borders were used in place of making raised beds with wood borders. The permanent borders may also provide heat retention. Fabric in this picture is covering drain tile placed in gravel. The beds were lined with landscape fabric prior to installing the compost. The walkways are crushed gravel for solid footing and drainage.

Loading Mixed Compost at SOF

July 9, About 10:00 AM

July 2012 – compost is mature and ready to move to campus . Screening the compost would have improved uniformity but the necessary equipment was not available.

Delivery at Bailey Hall

3 truck loads moved, about 45 cubic yards

Filling the Beds

J. Biernbaum, 2013 Organic Reporting Session

Beds Filled

July 9 – Start of Frame Construction

Commercial Contractors built the greenhouse frame and covered the structure with plastic film.

July 13 – Frame and Plastic Completed

August 1Installing Bed Walkways

After leveling and compacting the compost, concrete blocks (8”x16”x4”) were placed to form the between bed walkways. Blocks cost $1 each.

August 8th Planting

Beds were prepared and spacing marked to simplify the planting of the well rooted plants waiting for more space and compost.

August 8 - Planting

Larger pots were planted in holes made with a post hole digger. Left side beds were planted in about 4 hours with 5 to 6 people working.

September 17 – Ready for Harvest

Overhead irrigation hose in place. Crops grew rapidly and were quickly ready for harvest.

Chefs get Involved

Chef Mike from Brody Squares explains to Karri how he likes thyme so it is easy to remove the leaves quickly. The GREENhouse is only a few hundred yards from the kitchen.

September Herb Harvests

Freshly cut herbs were collected in bowls or five gallon buckets, weighed, and placed in food grade, unsealed plastic bags. Herbs were walked to Brody Square or Kellogg Center.

Herb Harvest and Sales

September through December 17

Crop	Pounds	% of total	$/pound	Total Sales	% of total
Basil	34.65	16.6	$16	$554.40	18.1
Chives	5.89	2.8	$16	$94.24	3.1
Cilantro	46.82	22.4	$12	$561.84	18.3
Dill	2.02	1.0	$20	$40.40	1.3
Lemon Verbena	4.41	2.1	$24	$105.84	3.5
Microgreen	3	1.4	$48	$142.08	4.6
Oregano	6.21	3.0	$20	$124.20	4.1
Parsley	74.06	35.5	$12	$888.72	29.0
Pea Shoots	1.48	0.7	$48	$71.04	2.3
Peppermint	0.29	0.1	$16	$4.64	0.2
Rosemary	8.74	4.2	$20	$174.80	5.7
Salad Mix	10.92	5.2	$8	$87.36	2.9
Spearmint	1.35	0.6	$16	$21.60	0.7
Sunflower Shoots	0.56	0.3	$48	$26.88	0.9
Thyme	8.27	4.0	$20	$165.40	5.4
TOTAL	**208.63**	**100.0**		**$3,063.44**	**100.0**

Basil, cilantro and parsley accounted for 66% of sales based on dollar value and 70% by weight. This was consistent with prior purchasing trends. Additional herbs not sold but needing to be harvested were harvested for drying.

Future Research and Activities

- Selling herbs, greens and worm compost to fund student and staff labor.
- Managing fertility and water in the “soil” in the Bailey GREENhouse.
- Raised bed production outside using food scrap composts made during summer of 2012 to further test “compostponics” as an organic alternative to hydroponics.
- Student engagement in organic urban farming activities including edible landscape, hot composting, worm composting, transplant production and microgreens production.

Great Thanks to Laurie Thorp and Brendan Sinclair

The Bailey GREEN Team

The work is all about the students and these are the first in what will be a long tradition of Environmental Studies students making a difference on a campus of over 40,000 students.

More thanks to those that made the project possible.

- Dr. Fred Poston, Vice President for Finance and Operations (CANR Dean)
- Venie Gore, Vice President for Residential and Hospitality Services
- Jennifer Battle, Director of Office of Campus Sustainability
- Diane Barker, Carla Iansiti, Robbia Pipper, Chef Dave at Brody, Chef Mike at Kellogg

A GREEN and Organic Environment (An “Institutional” High Tunnel)