

PROGRESS REPORT 2010
North Central Region
Sustainable Agriculture Research and Education (SARE) Program

Project Title: *"Creating a Sustainable Year-Round Greenhouse Cropping System Using Straw-bale Culture and LED Lighting."*

Project Number: FNC09-747

Producer/Project Leader: Karen Weiss

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1. *Describe in detail your work activities and how you used your grant funds this year. (Use another sheet if necessary.)*

Layout and Schedule. The first task was to design the layout of the straw bales to create as much growing area as possible (230 sq. feet) in the greenhouse. See Attachment #1 as an example of our winter layout. We also wanted to establish a cropping schedule that would allow for 3 Phases to be completed in a calendar year. Phase 1 would be June 1-October 15. Phase 2 would be a short season of Nov. 1-Jan.1. Phase 3 would be Jan. 15- May 15.

Establishing growing media to use on straw bales. We wanted to determine the best topdressing medium so that we could replicate year over year and have a baseline for making adjustments and controlling variables. The greenhouse was divided into two sections. In Phase 1, on Side A we used straight compost and on Side B we used Sunshine Organic Potting Mix and Sustane fertilizer. In Phase 2 and 3, bales on Side A were top dressed with Sunshine Natural & Organic Planting Mix and Paramount Green Pure Natural Organic Worm Castings while bales on Side B were top dressed with Sunshine Natural & Organic Planting Mix and Sustane Fertilizer. See Attachment #1 and #2

Lighting. For Phase 1 (June-Oct15) we did not use supplemental lighting as day-length and light intensity was sufficient. In Phase 2, (Nov. 1-Jan.1) 25 Red, 220 diode, LED lights were arranged above the bales so that each light covered approximately 2 bales. The light came on at 3 pm and went off at 9 pm to create a total of 14 hours of light in the greenhouse (8 hours natural daylight and 6 hours LED lights). For Phase 3

(Jan 15-Present) we focused on a more rigorous research process to determine the effects of different lighting treatments on the crop. The greenhouse was arranged so that we could apply 3 different lighting treatments with 4 replication for each treatment. The treatments were: 4 red LED lights only; 2 full spectrum/blue LED and 3 red LED lights; and no LED lights. Mark Fleck, an LED expert with Grow with LEDs, was consulted to discuss the various treatment options. The lights come at 4am and turn off at 12 am for a total of 20 hrs of supplemental lighting. We chose this maximum amount of lighting based on previous research and the desire to maximize the differences in lighting treatments vs. no lighting.

Crops. A variety of crops were grown through the 3 Phases of this first year. The Phase 1 (summer) trial included tomatoes, peppers and strawberries. The Phase 2 (fall/winter) crops included lettuce, arugula, carrots, beets, sugar snap peas, radishes, spinach and tatsoi. The Phase 3 (winter/spring) crop is exclusively sugar snap peas.

2. *List the results of your project and what you have learned so far.*

Straw bales. While we have been lying the bales with stings up, we will most likely try bales on their edges with the strings on the sides for the next crop. Six bales in Phase 2 were placed on the narrow side, strings on the side and they held up the best. With the twine on top, there was more degrading so that when bales had to be moved the twine would often break and replacement bales or re-enforcement of some kind such as rebar pounded into the ground was required. The drawback of placing the bales on their sides is that it reduces the growing area thus requiring more straw bales per square foot. There also may be a drainage differences as well as most of the straw is then running up and down. Despite these issues, for the most part we were able to use the bales for two phases.

Media/top dressing. It was determined that there were no noticeable differences in germination results or plant growth between the different topdressing treatments. The top dressing chosen going forward will be based on what is most cost effective for the season. We will use Daniels Plant Food, a natural soy based fertilizer in conjunction with Sustane. We determined that fertility using just Sustane as a side-dressing in the bell peppers was not adequate. We will supplement with Danials Plant Food, a water soluble fertilizer in every other watering for both peppers and sugar snap peas.

Summer Crop. Tomatoes had a lot of vegetative growth but not a lot of fruit. One remedy may be to pollinate the tomatoes in the greenhouse. Another issue with the tomatoes is that a taller structure is needed to accommodate the height growth of the tomato plants. We lost a lot of tomatoes to mice and moles that seek shelter in the greenhouse and straw bales. We observed that strawberries could be a potential crop, but damage by mice and moles would have to be overcome in order to make it a viable summer crop.

Peppers were our best summer crop both in growth and in yield. We had no disease or pest pressure. The mice and mole did not bother the peppers and we were able to harvest an average of 4 peppers per plant without sun scald or blossom end rot both of which were encountered in our outdoor plantings. Going forward however, we will use Daniels Plant Food, a natural soy based fertilizer in conjunction with Sustane to provide additional fertility.

Fall/Winter Crop. Due to either poor germination, predation or excessively slow growth, it was determined that most of the winter crops would not be carried forward. Spinach, however was the exception. Spinach had no observed injury due to predators in the greenhouse, germinated in a close and short window, was ready to harvest in less than 60 days, and had an excellent sweet and mild flavor. The spinach also grew well without any apparent sensitivity to the amount of light in the greenhouse. We will focus on improving cultural practices to maximize our yield per sq.ft and shorten crop time in next winter's trial. Also, our first crop of sugar snap peas showed enough potential to continue to work with this crop for our winter/spring Phase 3.

Winter/Spring Crop. Based on our Phase 2 results, we have chosen to focus on sugar snap peas for Phase 3. As a high value crop that utilizes the vertical space in the greenhouse, does not need outside pollination and can be grown at reasonably cool temperatures it presents us with a very appealing crop option. As such, we began a detailed research project to identify the best lighting options for sugar snap peas. The finding from this component of our project will be presented to the Masters of Agriculture Department at the University of Minnesota in late May. The harvest date for the sugar snap peas is anticipated for mid-April/mid-May. We will include those research findings in our Final report.

Environmental Conditions. The straw bales did not break down or compost enough to create any significant root zone heat for the plants. Greenhouse heat retention was improved by approximately 3F when an inner cover was used. We maintained a minimum night temperature of 40F during the winter months. Our biggest challenge however, was controlling moles and mice in the greenhouse during all season. These rodents seek shelter in the straw bales and damage a number of crops in both early and late stages of growth. We have decided that rather than fight the mice and moles we will focus on growing crop that so far have not been appealing to them. Despite not being certified, our organic approach makes the controlling of rodents very difficult.

3. Describe your work plan for next year.

Going forward with this project, our focus for each growing season will be as follows:

1. Sweet Bell Peppers will be our Phase 1 crop. We will do detailed yield and economic evaluations as well as refining the cultural requirements.

2. Spinach will be our Phase 2 crop. Again our focus will be on detailed data collection for yield, economic and cultural requirements. We will use an inner covering, maintain a lower temperature, earlier planting date and supplemental lighting.
3. Work will continue on sugar snap peas for our Phase 3 crop. Based on results from this spring's harvest, we will modify environmental conditions and cultural requirements as needed.
4. We will continue to work with the local co-ops who have expressed interest in carrying our products.

4. How did you share information from your project with others? (Include the number of people who attended field days or demonstrations.) What plans do you have for sharing information next year?

The Phase 3 trial of sugar snap peas become part of a Master's Project and will be the foundation of a Research Presentation at the University of Minnesota for the Department of Agriculture. The presentation will be attended by University of Minnesota Masters of Agriculture faculty, and advisory committee members as well as other interested members of the sustainable agriculture community. In addition, the results of the sugar snap pea research will be provided to Mark Fleck and may become a part of his web page.

Additionally, we will partner with St. Croix Montessori in an outreach education program. Children in the primary grades will grow spinach in bales during the Fall of 2011. They will record a variety of data including light intensity, temperatures, germination, growth and yield. They will also make a field trip to the farm to see the farm production

Finally, several co-ops have been contacted and are interested in purchasing our products. We will continue to work with them as product becomes available.



Phase 2- Nov. 15



Phase 2- Dec. 15



Phase 2 -Dec 24



Phase 3- Jan 15



Phase 3- March 15

Farmer/Rancher Grant Program

Progress Report Budget Form

Please complete this form to show how grant funds were spent on this project to date.
Please note: NCR-SARE no longer asks for information about matching funds.

PERSONAL SERVICES

	Grant Funds
Major Participants (list below)	
Karen Weiss	0
Sally Doherty	0
Other Management or Labor Hired	
Salaried personnel:	
Hourly personnel:	
Melissa Glaus- Intern Stipend	500.00
SUBTOTAL	\$500.00

Please use this space to explain any major changes in expenses. Use additional paper if needed.











NON-PERSONAL SERVICES

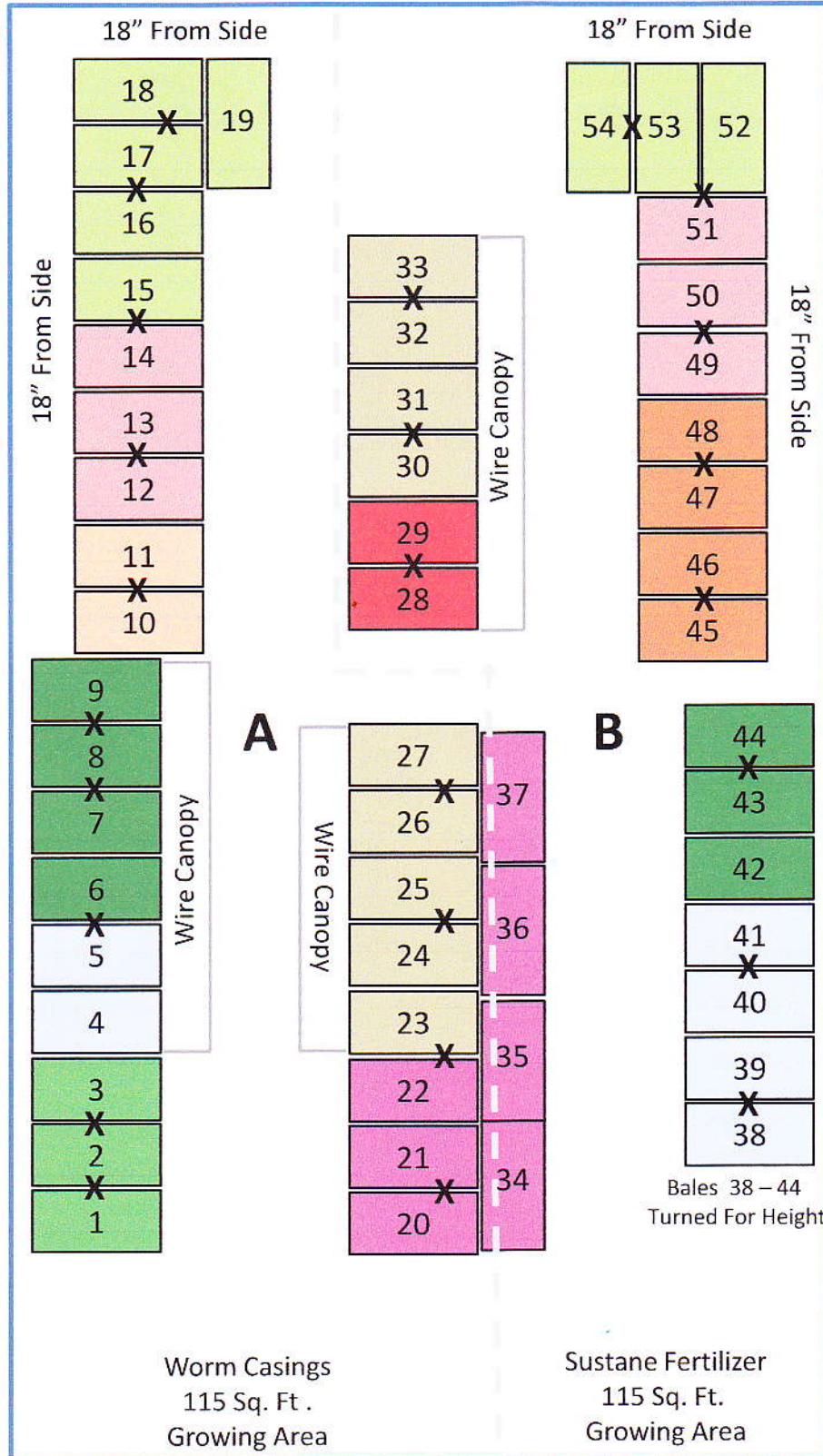
	Grant Funds
Travel	
Picking up straw bales 2 trips, 100 miles @ .55	55.00
Operating and Supplies	
Natural Gas	330.00
Straw Bales 60 @ 3.00	180.00
Sustane fertilizer	13.00
Worm Castings	87.00
Lease of Land, Equipment, and Buildings	
1 year greenhouse lease	660.00
Equipment Purchases	
LED Lighting	2,394.00
Electric supplies	68.00
Miscellaneous	
Outreach	
SUBTOTAL (for non-personal services)	\$ 3787.00
SUBTOTAL (for personal services)	\$500.00
TOTAL (grant fund spent)	\$3000.00

K. Anderson
 Signature of Applicant

3/23/2011
 Date

Greenhouse Layout

-  Lettuce 5 Star
-  Lettuce All Star
-  Arugula 'Astro'
-  Hybrid Carrot Mokum F1 Pellet
-  Hybrid Carrot Napoli F1
-  Beets Pronto
-  Cascadia Suger Snap Peas
-  Radish Cherry Belle
-  Spinach Tarry F1
-  Tatsoi



Environmental Conditions

Date	Minimum Temperature (F)	Maximum Temperature (F)	Interior Bale Temperature	Outside / Inside Temperature (F)	Night Heat (F)	Time	Water Y/N	LED Lighting	LED Lighting Time	Total Light Hours (LED + Sun)
11/10/2010	39°	91°	50°	51°	48°	1:00 PM	Y	N		8
11/12/2010	36°	72°		32° / 36°	48°		N	N		8
11/14/2010	33°	61°		26° / 32°	48°		N	Y	3:00 PM - 9:00 PM	14
11/14/2010				35°	48°	6:00 PM	Y	Y	3:00 PM - 9:00 PM	14
11/18/2010	42°	86°	58°	28° / 56°	48°	3:00 PM	Y	N		8
11/19/2010	43°	86°	66°	26° / 62°	48°	1:30 PM	N	Y	3:00 PM - 9:00 PM	14
11/26/2010	39°	85°	60°	16° / 52°	48°	1:30 PM	Y	Y	3:00 PM - 9:00 PM	14
12/3/2010	37°	81°	63°	12° / 62°	48°	1:30 PM	Y	Y	3:00 PM - 9:00 PM	14
12/10/2010	39°	73°	58°	8° / 50°	48°	1:30 PM	Y	Y	3:00 PM - 9:00 PM	14
12/17/2010	41°	82°	62°	17° / 55°	48°	1:30 PM	Y	Y	3:00 PM - 9:00 PM	14
12/24/2010	39°	85°	60°	6° / 58°	48°	1:30 PM	Y	Y	3:00 PM - 9:00 PM	14
12/29/2010	42°	88°	64°	21° / 72°	48°	1:30 PM	Y	Y	3:00 PM - 9:00 PM	14

Growing Media Phase 2 and 3

	Number of Bales*	Amount Per Bale Side A	Amount Per Bale Side B	Cost per Bale	Total Cost	Product Name
Worm Castings-Ph2	27	.16 cu. ft . or 1 gallon	NA	\$2.00	\$54.00	Paramount Green Pure Natural Organic Food Worm Castings
Fertilizer-Ph2 and 3	54	NA	7.0 oz	\$0.22	\$11.88	Sustane
Compost-Ph2	54	.48 cu. ft.	.64 cu. Ft.	\$0.24	\$13.00	Garden Compost
Potting Mix-Ph3	27	NA	NA	\$2.04	\$55.00	Sunshine Organic Potting Mix

* 1 bale = 18" x 36" or 4.5 sq. ft. of growing space