Northeast Sustainable Agriculture Research and Education Program

Farmer Grant Interim Report

Project Title: Planting Small Seeded Vegetable Crops into a High Residue, Reduced Tillage Environment

Grant # FNE09-667

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Goals of the project:

The goal is to develop a reduced tillage system that serves the needs of diversified vegetable farms. This will be accomplished by integrating the use of cover crops and conservation tillage practices.

"No-till" planted cover crops are used to reduce fuel, machinery use, labor, soil erosion, chemical runoff, and increase soil organic matter, water infiltration, and drainage through improved soil structure. Strip-tillage is used to ensure better seed bed preparation for cash crops. This system lets growers use conventional planting equipment for a diverse set of crops and still gain the benefits of cover crops and conservation tillage.

Various cover crops, selected for their weed suppressing characteristic, will be established using no-till techniques during different periods of the planting season. These cover crops, having produced enough biomass will be rolled down and killed prior to cash crop seeding. Strip-tillage equipment will be used to prepare narrow seedbeds, and then conventional machinery to plant small seeded vegetable crops.

Primary and secondary strip-tillage equipment will be evaluated for their effectiveness in various high residue situations. Cash crops will be measured for percent germination, quality and yield. Any observable alleopathic effects from the cover crops will be noted.

Updated information about the farm:

Myerov Family Farm (12 acres) located in Bucks County, Pa. A "CSA" producing a full array of vegetables and small fruits, served 130 families during the 2009 growing season. Farm facilities include a 3,000 sq. ft. heated greenhouse, machinery barn, walk in cooler, and large community room with kitchen and furnishings.

Committed to a reduced tillage direction, the farm was planted to either a rye cover crop fall of 2008 or an oat cover crop spring 2009. No plowing was preformed this season. No-till vegetable crops included sweet corn, melons, peppers and winter squash. Other crops received soil preparation using a subsoiler followed by rototilling to a 4" depth. I did not perceive any benefit from the subsoiling. Rototilling alone without plowing did not control perennial weeds adequately.

The soil rarely dried out this season due to the frequent and heavy rains. A very challenging season with many crop failures. Weed control using pre-emergent herbicides was inconsistent because of the wet weather diluting the chemicals and possibly the absorptive nature of the increased cover crop residue.

The SARE Research Project using new strip-till techniques yielded crops of mustard greens, radish and mizuna which were distributed to CSA members.

The role of technical advisers and cooperator:

Scott Guiser assisted in the evaluation of research plot results. He made suggestions for appropriate data reporting and improvements in future research plot layout and design. Asher Miller helped with statistical design and evaluation. Aaron Segall supplied technical assistance in planting, biomass collection and equipment development.

The Research Project 2009

Overview:

Two randomized blocks (36' x 220') were planted with 6 different cover crop treatments.

1. crimson clover and oats
2. soybeans and buckwheat
3. soybean and sorghum sudan grass
4. field peas and oats
5. field peas and sorghum sudan grass
6. buckwheat and sorghum sudan grass

Block #1 was planted 7/13/2009 and Block #2 was planted 8/9/2009. Biomass samples were taken from each treatment plot (6' x 55') two months after planting. Both wet and dry weight were measured.

The cover crop treatments were killed with the herbicide glyphosate. Then after a period of time, when the weather permitted the cover crops were rolled down, strip tilled and planted to small seeded vegetable crops. An additional treatment plot (6' x 220') was added along side each block to give a comparison to conventional tillage.

Block #1 was planted to radish, beets, mizuna and red mustard. Block #2 was planted to spinach. Vegetable crop samples were collected and weighed from Block #1. Block #2 produced no crop due to excessively wet conditions.

Results and accomplishments:

The goals for the 2009 season were to test the project design, solve equipment issues and experiment with new and unfamiliar crops.

This beginning segment of the research project demonstrated, at least in a qualitative way, that planting small seeded vegetable crops into a high residue reduced tillage environment can produce crops comparable to conventional tillage.

Biomass samples from both July and August cover crop plantings yielded consistent results. The cover crop treatment sorghum sudan grass with field pea produced the most biomass making this a good choice for the warm season production of biomass. The research project demonstrated that a significant amount of biomass/residue can be produced in only 2 months.

Conventional strip tillage equipment proved to be a poor match to this project. It was too aggressive, churning up an 8"-12" strip mixed with the surface residue. This would require more time for the residue to break down before planting, additional soil preparation, dilute the benefits of the cover crop and promote more weed competition.

A new type of strip tillage equipment was developed to accomplish the goals of the research project. This equipment prepares a 3" wide seed bed without getting clogged in the high residue conditions. The goal was to prepare an adequate seed bed but keep soil and residue disturbance to a minimum. The implement consists of a flat coulter to cut through the residue, followed by residue removers and a pair of disks.

Seed germination, crop weight and quality were similar to the conventional tillage control. No alleopahtic effects from the cover crop on the vegetable crops was observed. All cover crop treatments showed significant weed suppression compared to the conventional tillage treatment.

Site conditions that effected results:

The excessively wet nature of the 2009 growing season delayed planting the first research block until July. Yields were clearly reduced in areas with poorer drainage.

Although, positive qualitative observations were reported from Block #1 and samples of vegetable crops were collected and weighed, the statistical data is not conclusive due to areas washed out by rain.

There was some deer feeding on the soybean and buckwheat cover crops in Block #2. This is reflected in the lower biomass weights for those plots. Selecting cover crops which encourage deer feeding is not advised.

Economic findings/changes in expenses

The original grant proposal submitted and accepted stated that "cover crop biomass and weed biomass will be visually estimated". The SARE committee asked me to do actual sampling and measurements. This added an estimated 25 hours to the project.

New ideas generated by the project:

The project demonstrates a new production system for growers to add to their repertoire. It requires greater management and planning than conventional production systems. The choice of cover crop and it's management are as important as the cash crop.

Weed control may be the biggest problem. There are fewer options for controlling perennial weeds. Pre-emergent herbicides appear to be less effective when applied in a high residue situation.

Plans for the 2010 growing season:

Using an improved test plot design.

Starting earlier to test the system under different seasonal conditions.

Refining the strip till equipment.

Appendix

a. Experimental design

b. Cover Crop Height Data Plot #1

c. Biomass Data Plot #1

d. Biomass Data Plot #2

e. Biomass Comparison – Plot #1 and Plot #2

f. Biomass Chart Plot #1

g. Biomass Chart Plot #2

Photo #1 – Strip Till Implement

Photo #2– Mizuna, strip till planted into high residue environment

Photo #3 – Radish strip till planted into high residue environment

Photo #4– Beets strip till planted into a high residue environment

Photo #5 – Plot #1 cover crop treatments

Appendix -a

Experimental Design

Plot #1

The experimental design is a complete randomized block with 4 replications labeled a,b,c,d.
Each block (36' x 220') includes 6 randomized cover crop treatments.
Each treatment plot (36' x 55') consists of 6 beds (6' x 55”).

6 cover crop treatments labeled 1,2,3,4,5,6.

1-crimson clover and oats
2-soybean and buckwheat
3-soybean and sorghum sudan grass
4-field pea and oats
5-field pea and sorghum sudan grass
6-buckwheat and sorghum sudan grass

Seeding rate for each 6' x 55' treatment plot

1/3 lb.	Crimson clover - no variety stated
2 lb.	Oats - “Blaze” Seedway
2 lb.	Soybean - SG385C Seedway
21/2 lb.	Field pea - “Maxum” Seedway
1 lb.	Buckwheat – no variety stated
½ lb.	Sorghum Sudan grass – BMRM202 Seedway

Soil preparation was shallow rotary tilling to a maximum depth of 2”
Seed was broadcast by hand
Very light disking and seed bed firmed with a roller

A control strip 6' x 220' was added along side plot #1 later to compare the performance of the planted vegetable crops.

South

4d	5d	6d	1d	2d	3d	control
3c	4c	5c	6c	1c	2c	control
2b	3b	4b	5b	6b	1b	control
1a	2a	3a	4a	5a	6a	control

North Driveway----------

Appendix – b

Crop Height Data

08/26/09
Plot #1

2 man hours
Staff – Neil Myerov and Aaron Segall

Cover crop treatments 1-6
1-crimson clover and oats
2-soybean and buckwheat
3-soybean and sorghum sudangrass
4-field pea and oats
5-field pea and sorghum sudangrass
6-buckwheat and sorghum sudangrass

4 replications a,b,c,d
Data in inches
4 measurements taken from each treatment recoded north to south

					sum
a1	21	21	18	19	79
b1	17	20	20	23	80
c1	21	17	18	17	73
d1	13	8	11	14	46
a2	24	29	28	27	108
b2	20	25	28	24	97
c2	28	23	22	20	93
d2	18	18	16	11	63
a3	50	44	46	46	186
b3	44	44	49	45	182
c3	47	42	34	36	159
d3	35	29	37	31	132
a4	32	27	24	18	101
b4	24	20	20	18	82
c4	26	20	18	21	85
d4	20	19	17	18	74
a5	42	34	46	38	160
b5	48	42	35	40	165
c5	43	37	40	33	153
d5	33	34	32	32	131
a6	42	43	35	33	153
b6	41	39	44	35	159
c6	38	36	36	29	139
d6	40	38	33	35	146

Appendix - c

Biomass Data Plot #1

Collected and weighed 8/26/09-8/27/09
Air dried in greenhouse
Weighed 9/2/09-9/5/09
Sample size was 10" x 18", 180 square inches
Two samples were taken from each plot, two paces in from both ends on alternate
1-6 are the different cover crop treatments
a-d are the replications
S1 – sample 1
S2 – sample 2
Weight is in grams, scale used was accurate to 1/10 of a gram

	Wet	Dry
a1 s1	161.6	41.1
a1 s2	167.4	44.1
b1 s1	114.2	28.2
b1 s2	262.4	62.5
c1 s1	226.9	55.7
c1 s2	173.4	39.2
d1 s1	109.8	29.4
d1 s2	82.2	20.7
a2 s1	308	51.9
a2 s2	241.2	48.3
b2 s1	162.75	32.75
b2 s2	248.8	57.2
c2 s1	199.4	42.6
c2 s2	154.6	26.9
d2 s1	239	46.1
d2 s2	122.8	23.5
a3 s1	581.1	195.85
a3 s2	499.4	137.9
b3 s1	366.4	87.6
b3 s2	384.7	120.5
c3 s1	380.1	99.1
c3 s2	225.2	53.3
d3 s1	192.5	50.2
d3 s2	300.8	61.6
a4 s1	182	34.3
a4 s2	283.3	59.4
b4 s1	569.8	107.9
b4 s2	407.4	74.5
c4 s1	221.2	43.7
c4 s2	169.2	37.7
d4 s1	104.8	27.7
d4 s2	139.9	32.15
a5 s1	726.4	231.9
a5 s2	348	100.6
b5 s1	293.3	77.6
b5 s2	368.8	102.4
c5 s1	477.3	101.8
c5 s2	495.5	155
d5 s1	230.8	66
d5 s2	241.8	68.6
a6 s1	325	102.8
a6 s2	183.2	59.7
b6 s1	262.3	76.5
b6 s2	367.3	99.6
c6 s1	267	75.8
c6 s2	251.4	73.1
d6 s1	305.4	103.8
d6 s2	224.1	66.9

Appendix - d

Biomass Data Plot #2

Collected and weighed 10/9/09 – 10/10/09
Air dried in greenhouse
Weighed again 11/4/09
Sample size was 10" x 18", 180 square inches
Two samples were taken from each plot, two paces in from both ends on alternate sides.
1–6 are the different cover crop treatments
a–d are the replications
S1 – sample 1
S2 – sample 2
Weight is in grams, scale used was accurate to 1/10 of a gram

	Wet	Dry
a1 s1	116.8	26.85
a1 s2	153.3	36.2
b1 s1	151.1	40.9
b1 s2	241.1	75.8
c1 s1	271.3	57.4
c1 s2	332.2	68.2
d1 s1	257.5	60
d1 s2	439.3	86.6
a2 s1	68.1	18.15
a2 s2	48.9	10.3
b2 s1	113.7	36.1
b2 s2	134.2	43.55
c2 s1	121.9	49
c2 s2	130.7	46.45
d2 s1	134.9	40.1
d2 s2	106.7	28.4
a3 s1	222.1	62.1
a3 s2	217.2	56.95
b3 s1	229.4	68.5
b3 s2	338	112
c3 s1	294.9	96.95
c3 s2	314.8	87
d3 s1	233.8	74.8
d3 s2	377.3	137.8
a4 s1	78.1	18.6
a4 s2	223	46.1
b4 s1	258.5	64.2
b4 s2	373.9	81.4
c4 s1	374.8	72.2
c4 s2	455.2	86.6
d4 s1	502	92.3
d4 s2	295	63.4
a5 s1	218.8	64.8
a5 s2	238.2	62.35
b5 s1	302.1	100.4
b5 s2	151.2	40.6
c5 s1	374.5	114.3
c5 s2	740.6	248.1
d5 s1	599	191.8
d5 s2	319.8	84.6
a6 s1	54.2	16.85
a6 s2	260.1	97.5
b6 s1	128.3	39.1
b6 s2	233.1	67.5
c6 s1	342.8	128.1
c6 s2	254	89.9
d6 s1	513.3	191.5
d6 s2	334	123.1

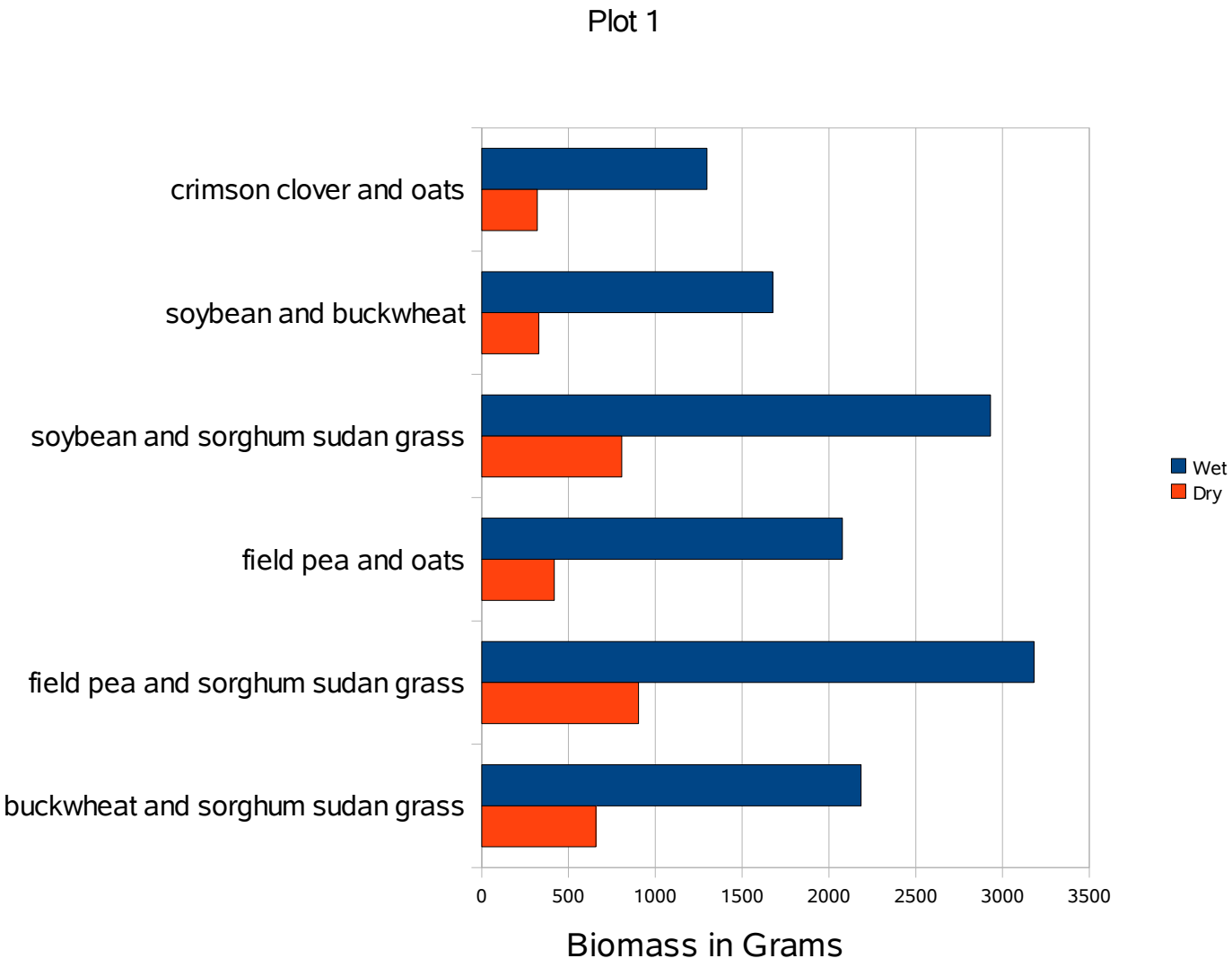
Appendix – e

Biomass Comparison – Plot #1 and Plot #2

	Plot #1 Wet	Plot #1 Dry		Plot #2 Wet	Plot #2 Dry	
a1 s1	161.6	41.1	a1 s1	116.8	26.85	
a1 s2	167.4	44.1	a1 s2	153.3	36.2	
b1 s1	114.2	28.2	b1 s1	151.1	40.9	
b1 s2	262.4	62.5	b1 s2	241.1	75.8	
c1 s1	226.9	55.7	c1 s1	271.3	57.4	
c1 s2	173.4	39.2	c1 s2	332.2	68.2	
d1 s1	109.8	29.4	d1 s1	257.5	60	
d1 s2	82.2	20.7	d1 s2	439.3	86.6	
total	1297.9	320.9		1962.6	451.95	
a2 s1	308	51.9	a2 s1	68.1	18.15	
a2 s2	241.2	48.3	a2 s2	48.9	10.3	
b2 s1	162.75	32.75	b2 s1	113.7	36.1	
b2 s2	248.8	57.2	b2 s2	134.2	43.55	
c2 s1	199.4	42.6	c2 s1	121.9	49	
c2 s2	154.6	26.9	c2 s2	130.7	46.45	
d2 s1	239	46.1	d2 s1	134.9	40.1	
d2 s2	122.8	23.5	d2 s2	106.7	28.4	
total	1676.55	329.25		859.1	272.05	Deer feeding
a3 s1	581.1	195.85	a3 s1	222.1	62.1	
a3 s2	499.4	137.9	a3 s2	217.2	56.95	
b3 s1	366.4	87.6	b3 s1	229.4	68.5	
b3 s2	384.7	120.5	b3 s2	338	112	
c3 s1	380.1	99.1	c3 s1	294.9	96.95	
c3 s2	225.2	53.3	c3 s2	314.8	87	
d3 s1	192.5	50.2	d3 s1	233.8	74.8	
d3 s2	300.8	61.6	d3 s2	377.3	137.8	
total	2930.2	806.05		2227.5	696.1	Deer feeding
a4 s1	182	34.3	a4 s1	78.1	18.6	
a4 s2	283.3	59.4	a4 s2	223	46.1	
b4 s1	569.8	107.9	b4 s1	258.5	64.2	
b4 s2	407.4	74.5	b4 s2	373.9	81.4	
c4 s1	221.2	43.7	c4 s1	374.8	72.2	
c4 s2	169.2	37.7	c4 s2	455.2	86.6	
d4 s1	104.8	27.7	d4 s1	502	92.3	
d4 s2	139.9	32.15	d4 s2	295	63.4	
total	2077.6	417.35		2560.5	524.8	
a5 s1	726.4	231.9	a5 s1	218.8	64.8	
a5 s2	348	100.6	a5 s2	238.2	62.35	
b5 s1	293.3	77.6	b5 s1	302.1	100.4	
b5 s2	368.8	102.4	b5 s2	151.2	40.6	
c5 s1	477.3	101.8	c5 s1	374.5	114.3	
c5 s2	495.5	155	c5 s2	740.6	248.1	
d5 s1	230.8	66	d5 s1	599	191.8	
d5 s2	241.8	68.6	d5 s2	319.8	84.6	
total	3181.9	903.9		2944.2	906.95	
a6 s1	325	102.8	a6 s1	54.2	16.85	
a6 s2	183.2	59.7	a6 s2	260.1	97.5	
b6 s1	262.3	76.5	b6 s1	128.3	39.1	
b6 s2	367.3	99.6	b6 s2	233.1	67.5	
c6 s1	267	75.8	c6 s1	342.8	128.1	
c6 s2	251.4	73.1	c6 s2	254	89.9	
d6 s1	305.4	103.8	d6 s1	513.3	191.5	
d6 s2	224.1	66.9	d6 s2	334	123.1	
total	2185.7	658.2		2119.8	753.55	

Cover crop treatments	Plot #1 wet	Plot #1 dry	Plot #2 wet	Plot #2 dry	total
1-crimson clover and oats	**1297.9**	**320.9**	**1962.6**	**451.95**	**4033.35**
2-soybean and buckwheat	**1676.55**	**329.25**	**859.1**	**272.05**	**3136.95**
3-soybean and sorghum sudan grass	**2930.2**	**806.05**	**2227.5**	**696.1**	**6659.85**
4-field pea and oats	**2077.6**	**417.35**	**2560.5**	**524.8**	**5580.25**
5-field pea and sorghum sudan grass	**3181.9**	**903.9**	**2944.2**	**906.95**	**7936.95**
6-buckwheat and sorghum sudan grass	**2185.7**	**658.2**	**2119.8**	**753.55**	**5717.25**

Appendix - f


Plot 1
crimson clover and oats
soybean and buckwheat
soybean and sorghum sudan grass
field pea and oats
field pea and sorghum sudan grass
buckwheat and sorghum sudan grass
0
500
1000
1500
2000
2500
3000
3500
Biomass in Grams
Wet
Dry

Appendix - g

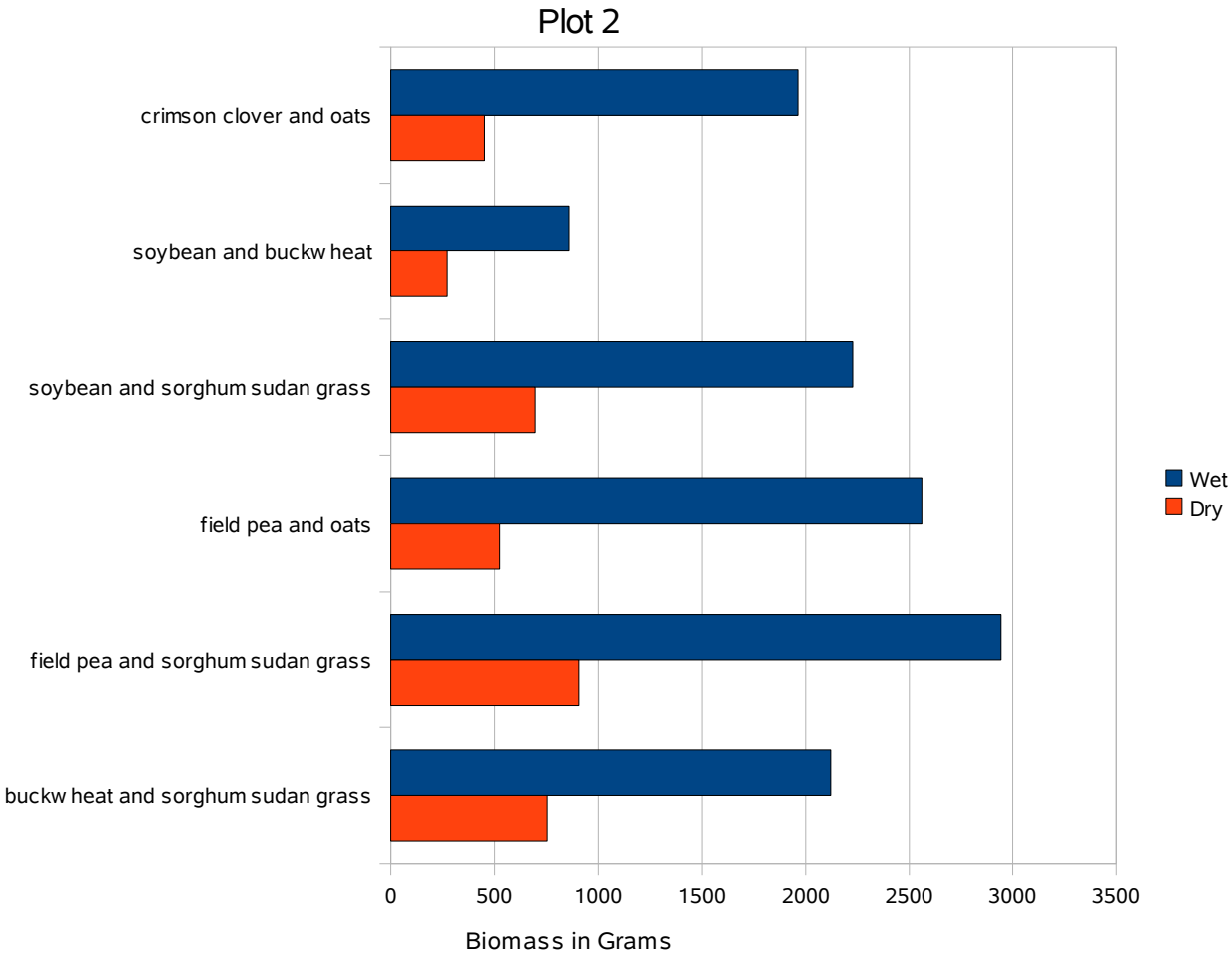

Plot 2
crimson clover and oats
soybean and buckw heat
soybean and sorghum sudan grass
field pea and oats
field pea and sorghum sudan grass
buckw heat and sorghum sudan grass
0
500
1000
1500
2000
2500
3000
3500
Biomass in Grams
Wet
Dry

Photo #1 – Strip Till Implement

Photo 2– Mizuna, strip till planted into high residue environment

Photo #3 – Radish strip till planted into high residue environment

Photo #4– Beets strip till planted into a high residue environment

Photo #5 – Plot #1 cover crop treatments