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Montana
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Soil Health Project Reports 2015

Bozeman Area

Welcome to the 2015 project reports from the Bozeman Area Soil Health (BASH) team. We hope that this document will be a useful tool for farmers, NRCS staff, and researchers. These fourteen reports are the field observations and measurements we made during the 2015 growing season, with one report from both 2014 and 2015. Keep in mind these are not replicated or repeated scientific trials. They are simply our best attempt at reporting what we saw in the field in one growing season.

Montana NRCS is divided into four administrative areas. The Bozeman Area consists of twelve counties and thirteen field offices, noted in brown in Fig. 1. This document is only from projects observed in the Bozeman Area.

Fig. 1. Montana NRCS Areas.

In 2015, the BASH team consisted of seven NRCS staff in the Area. Our mission is to promote NRCS's five main soil health principles throughout the Area. These principles include:

1. Minimize soil disturbance
2. Keep the soil armored (residue management)
3. Keep a living root in the soil
4. Increase crop diversity
5. Integrate livestock grazing

Use of these principles over time should result in increased soil organic matter and functioning, which is the key objective of improving soil health. Any project in the area that included one or more of these principles was eligible for inclusion in this report.

All projects were located on actual farms, and all field work was done by actual farmers. NRCS's role was to simply observe, measure, and report what we saw in the field. The choice of which projects to report was mainly based on the existing relationships that staff have with farmers in the Area.

For consistency and comparison across the Area, all AUM calculations use the assumption of 910 lb of forage per month for every 1000 lb animal unit, and that 50% of the forage is grazed and 50% is left in the field. All growing degree day (GDD) calculations used 40F as the base, with no upper temperature limit. GDD calculations were done with the online calculator at http://uspest.org/cgi-bin/ddmodel.us, using the same weather coop station used to report the monthly rainfall. Monthly rainfall measurement tables all come from the Western Regional Climate Center website, www.wrcc.dri.edu. The reported average annual precip amount is based on PRISM data and located in maps in section I of the Field Office Technical Guide (FOTG). Biomass was measured by clipping as close to the soil surface as possible, but did not include the tops of radish or turnip root fragments. Different drying methods were used throughout, with some clippings oven-dried at MSU and other clippings air-dried at the nearest field office.

We hope these reports will be informative and useful as we all learn more about the best ways to improve soil health across the Bozeman Area.

Sincerely, The 2015 BASH Team

Susan Tallman – lead, Bozeman Area Agronomist
Shalaine Watson – Billings, MT
Evan Van Order – Hardin, MT
Kristin Fletcher – Bozeman Area Cartographer
Ted Nelson – Columbus, MT
Chris Mahony – Bozeman, MT
Austin Shero – Roundup, MT

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Dryland Cover Crop for Grazing near Lodge Grass, Big Horn County

Evan Van Order, NRCS Soil Conservationist, Hardin, MT 2015

County: Big Horn, near Lodge Grass, MT
Average annual precip: 16-18”
MLRA: 58A, Northern rolling plains
Dominant Soil Type: Rld - Richfield silty clay loam
Acres: 422
Planting Date: May 30th, 2015
Seeding Rate: 1,073,300 seeds/ac, or 31.7 lb/ac
Seed cost: $20.69/acre (inoculant, seed, and delivery)
Seeding Method: John Deere no-till grain drill, single disk
Row Spacing: 7.5”
Tillage: No-till
Previous Crop and Year: 2014, winter wheat
Herbicides: Pre: glyphosate
Fertilizer: none
Irrigation: dryland
Termination Date: Aug. 1, 2015
Termination Method: Grazing and frost-kill
Next Crop: 2016, Spring wheat

Fig. 1. Dryland cover crop for grazing, Aug 19, 2015. Evan Van Order.

Monthly Precipitation at Yellowtail Dam, MT

Hardin	J	F	M	A	M	J	J	A	S	O	N	D	Total
30 yr avg 1981-2010	0.74	0.82	1.36	1.86	2.87	2.46	1.34	0.91	1.68	1.64	0.87	0.75	17.33
2014	1.18	1.15	4.0	2.59	1.79	2.23	0.96	2.55	1.65	0.22	1.43	0.82	20.57
2015	1.17	0.69	0.68	1.94	4.17	2.35	1.16	0.59	0.50	1.39	0.75	0.54	15.93

Fig. 2. Monthly precipitation at Hardin, MT. Western Regional Climate Center, station #249240.

Introduction: A full-season cover crop mix was planted as an alternative to fallow on a dryland winter wheat field. The field is 422 ac and is located near Lodge Grass, which has higher precipitation than Hardin. The producer planted cover crops for supplemental grazing to alleviate grazing pressure on the native range. Cattle were turned out in the cover crop on August 1st. The field will be planted to spring wheat in 2016.

Results: The cover crop established and grew well. Drill calibration issues were discovered after the first 40 acres were planted. The rate was almost doubled on these acres due to miscalculation during the initial calibration. On Sept 15th, 2015 sampling was conducted on 3 clipping sites that were randomly selected across the field. All sites were on silty clay loam soils. There were 108 growing days from the time of planting to the time of clipping, with 3268 growing degree days (base 40) in the same period (Yellowtail Dam Coop site). The cover crop had been grazed for 45 days before clipping occurred. An estimated 40% of the cover crop biomass had been grazed previous to clipping and was factored into the production estimates. Plants were separated by species in the field and air-dried at the Hardin Field Office. Total aboveground biomass after air-drying was 5888 lb/ac, or 2.9 ton/ac. There were 1365 AUMs available in this field, or 3.2 AUMs/ac. The 40 acres that were seeded at the double rate were not sampled but did not appear to have higher production rates, indicating that the original seeding rate was appropriate for the growth conditions of this site.

Summary and Discussion: Overall, this cover crop grew very well with good biomass accumulation, providing 1365 AUMs during a year when this field would normally be fallow. The stand was healthy with very little weed pressure. Warm-season species dominated the stand, with warm-season grasses and sunflower accounting for 66% and 28% of the total biomass, respectively. It is recommended that future cover crops seeded during this time window at this location should be predominately warm-season. Drill calibration was an issue and should be considered by NRCS staff advising producers who are new to cover crops. The long term effects on available moisture for the spring wheat cash crop in 2016 is yet to be seen, however this part of the county has higher precipitation than the drier areas around Hardin, which should minimize effects of soil moisture use by the cover crop. The main trade-off in this scenario is that spring wheat and not winter wheat must be grown in 2016 to allow for 2015 fall grazing. Spring

wheat yield will likely be less than potential winter wheat yield. However, the economic value of the cattle forage might make up for this difference.

Fig. 3. Warm-season grasses provided excellent forage production, September 15th, 2015, Seanna Torske.

Fig. 4. Root channels in the soil, August 18th 2015, Seanna Torske.

	Seeding Rate (lb/acre)	Percent of Mix by # of Seeds	Cover Crop Biomass %
Pea, spring	10	32	0
Lentil	9.6	30	3
Sorghum-sudan	3.2	10	66*
Millet, proso	1	3	--
Millet, German	2	6	--
Corn	3	9	--
Turnip	1	3	1
Forage collard	1	3	2
Sunflower	1	3	28
Total	31.8	99	100

Fig. 5. Comparison of planned seed mix percentage vs actual aboveground biomass percentage
*66% is the combined total biomass of the millets, corn, and sorghum-sudan.

Cover Crop as Alternative to Hailed-out Corn Crop, Big Horn County

Evan Van Order, NRCS Soil Conservationist, Hardin, MT 2015

County: Big Horn
Average annual precip: 11-12”
MLRA: 58A, Northern rolling plains
Dominant Soil Type: Va: Vanada clay, 0-2% slope
Acres: 66
Planting Date: August 17, 2015
Seeding Rate: 915,000 seeds/ac, or 29 lb/ac
Seed cost: $22.46/acre (inoculant, seed, and delivery)
Seeding Method: Double-disk no-till grain drill
Row Spacing: 10”
Tillage: No-till for about 3 yrs
Previous Crop and Year: (2015) Grain corn, hailed out June 19, 2015
Herbicides: Pre and Post: none
Insecticides/Fungicides: none
Fertilizer: Residual from corn crop
Irrigation: Center pivot
Termination Method and Date: Frost kill Nov. 15, 2015
Next Crop: (Spring 2016) Alfalfa, seeded with nurse crop

Fig. 1. Radish blossom in the cover crop Oct 6, 2015. Evan Van Order.

Monthly Precipitation at Hardin, MT

Hardin	J	F	M	A	M	J	J	A	S	O	N	D	Total
30 yr avg 1981-2010	0.46	0.43	0.75	1.33	2.06	1.76	1.22	0.70	1.20	1.08	0.54	0.43	11.97
2014	0.47	1.28	1.23	0.68	2.65	1.97	0.24	2.46	1.09	0.40	0.66	0.54	13.67
2015	0.97	0.16	0.08	1.30	2.94	3.22	1.04	0.81	0.56	1.03	0.39	0.37	12.87

Fig. 2. Monthly precipitation at Hardin, MT. Western Regional Climate Center, station #243915.

Introduction:

Grain corn was planted the spring of 2015 and a severe hail storm destroyed the corn stand on June 19th. A cover crop mix was selected and planted August 17th on the hail damaged acres to provide ground cover and also an alternative income source by leasing out grazing rights of the cover crop after it frost killed in the late fall.

Results:

The producer used a box drill and had calibration issues in the beginning due to the seed mix was settling. He mentioned that he wished he had stopped and agitated the seed mix periodically. On Oct 6th, 2015 sampling was conducted on 3 clipping sites that were randomly selected across the field. All sites were on Vanada clay soils. There were 50 growing days from the time of planting to the time of clipping, with 1241 growing degree days (base 40) accumulated during this same period. Plants were separated by species in the field and oven-dried at MSU Bozeman. Total aboveground biomass after oven-drying was 1980 lb/acre, or 1.0 ton/acre. Assuming 910 lbs of forage per animal month, and 50% utilization rate on 66 acres, there were 72 AUMs available in this field.

Brassica species (turnip, radish, collards) dominated the stand and accounted for 85% of the clipped dry weight even though they were only 28% of the seed mix. Both legumes and warm-season grasses under-performed in the mix. Legumes were 15% of the seed mix, yet were only 2% of the biomass. Warm-season grasses (millets, sorghum-sudan) were 54% of the seed mix, yet were only 5% of the biomass. Both sunflower and safflower performed as expected.

Summary and Discussion:

Overall, this cover crop grew well, with good biomass accumulation for only 50 growing days at the time of clipping. The cover crop stand was healthy and had very little weed pressure. However, there were calibration issues to begin with, and possibly some seed settling occurred resulting in some uneven plant populations throughout the field. In

addition, the mid-August planting may have been too late for optimal growth of the warm-season grasses. An early, light frost in September may have set the warm-season grasses back and opened an opportunity for the brassiscas to dominate the stand. For future reference, cool season grasses might have been more competitive in this growing window than warm-season grasses. The cover crop was allowed to grow until frost killed in mid-November. Starting in December, 48 head of cattle grazed the field for 48 days, giving the producer an alternative source of income to help offset the loss from the hailed out corn crop.

Fig. 3. Radish and turnip growth, Nov 15, 2015. Producer photo.

Fig. 4. Clipping site #2, Oct. 6th, 2015. Seanna Torske.

	Seeding Rate (lb/acre)	Percent of Mix by # of Seeds	Cover Crop Biomass %
Clover, Yellow Sweet	0.5	10	0
Soybean	6	2	0
Pea, spring forage	10	3	2
Sorghum-sudan	4	8	5*
Millet, Proso	2.2	29	--
Millet, Pearl	2	17	--
Forage Collards	0.7	13	13
Turnip, purple top	0.7	13	57
Radish, nitro	0.7	2	15
Sunflower	1	1	4
Safflower	1	2	3
Total	29	100	100

Fig. 5. Comparison of planned seed mix percentage vs actual aboveground biomass percentage
*5% is the combined total biomass of both the millets and sorghum-sudan.

Cover Crop as Fallow Replacement in Dryland, Big Horn County

Evan Van Order, NRCS Soil Conservationist, Hardin, MT 2015

County: Big Horn, near Hardin
Average annual precip: 11-12”
MLRA: 58A, Northern rolling plains
Dominant Soil Type: Cp-Colby Silty Clay Loam, 4-8% slope
Acres: 30
Planting Date: June 10, 2015
Seeding Rate: 767,380 seeds/acre, or 24 lb/acre
Seed cost: $26.71/acre (inoculant, seed, and delivery)
Seeding Method: John Deere no-till grain drill, double disk
Row Spacing: 7.5”
Tillage: No-till
Previous Crop and Year: 2014, winter wheat
Herbicides: Pre: glyphosate
Fertilizer: none
Irrigation: dryland
Termination Method and Date: Frost kill, Nov 15, 2015
Next Crop: 2016, spring wheat

Fig. 1. Cover crop one week after seeding, June 17, 2015. Evan Van Order.

Monthly Precipitation at Hardin, MT

Hardin	J	F	M	A	M	J	J	A	S	O	N	D	Total
30 yr avg 1981-2010	0.46	0.43	0.75	1.33	2.06	1.76	1.22	0.70	1.20	1.08	0.54	0.43	11.97
2014	0.47	1.28	1.23	0.68	2.65	1.97	0.24	2.46	1.09	0.40	0.66	0.54	13.67
2015	0.97	0.16	0.08	1.30	2.94	3.22	1.04	0.81	0.56	1.03	0.39	0.37	12.87

Fig. 2. Monthly precipitation at Hardin, MT. Western Regional Climate Center, station #243915.

Introduction:

A full-season cover crop mix was planted as an alternative to fallow on a dryland winter wheat field. The field itself is 65 acres, and the cover crop was planted on approximately 30 of those acres. The entire field will be planted to spring wheat in 2016 giving us opportunity to monitor the effects of the cover crop vs. fallow on the subsequent cash crop. The cover crop was frost-terminated and is being used for winter grazing.

Results:

The cover crop established and grew well. Cool season species faded quickly in July due to high temp/low moisture conditions, and warm season species dominated the rest of the season. On Sept 15th, 2015 sampling was conducted on 3 clipping sites that were randomly selected across the field. All sites were on silty clay loam soils. There were 97 growing days from the time of planting to the time of clipping, with 3043 growing degree days (base 40) during that same period. Plants were separated by species in the field and air-dried at the Hardin Field Office. Total aboveground biomass after air-drying was 6718 lb/ac, or 3.4 t/ac. There were 3.7 AUMs per acre, or 110 total AUMs available in this field. Warm-season grasses dominated the mix, with sorghum-sudan and millet providing 84% of the aboveground biomass. Sunflower also did well.

Summary and Discussion:

Overall, this cover crop grew well with good biomass accumulation. The stand was healthy with very little weed pressure. The warm-season species were especially suited to this growth window. In the future, consideration should be given to decreasing the amount of cool-season seeds in the mix when planted at this time. The cover crop was allowed to grow until frost-killed in mid-November and will be used for winter grazing and calving pasture for heifers. More information will be provided from the 2016 spring wheat yield comparison to complete this story.

Fig. 3. Warm Season Grasses, August 25th, 2015, Seanna Torske.

Fig. 4. Cover Crop Tour, August 25th 2015, Seanna Torske.

	Seeding Rate (lb/acre)	Percent of Mix by # of Seeds	Cover Crop Biomass %
Lentil	8	14	0
Hairy vetch	2	3	1
Sorghum-sudan	8.8	30	84*
Millet, pearl	3	29	--
Yellow mustard	0.5	6	2**
Gold mustard	0.5	6	--
Rapeseed	0.5	1	--
Forage collard	0.5	10	3
Sunflower	1	1	10
Total	25	831,000	100

Fig. 5. Comparison of planned seed mix percentage vs actual aboveground biomass percentage

*84% is combined total biomass of sorghum-sudan and pearl millet.

**2% is combined total biomass of both the mustards and the rapeseed.

Cover Crop for Winter Grazing on Manure Treatment Field, Big Horn County

Evan Van Order, NRCS Soil Conservationist, Hardin, MT 2015

County: Big Horn, near Hardin
Average annual precip: 11-12”
MLRA: 58A, Northern rolling plains
Dominant Soil Type: Wy- Winnett complex silty clay loam
Acres: 45
Planting Date: June 1st, 2015
Seeding Rate: 714,090 seeds/acre, or 31 lb/acre
Seed cost: $25.00/acre (inoculant, seed, and delivery)
Seeding Method: Hoe-opener air drill
Row Spacing: 7.5”
Tillage: disking, manure incorporation
Previous Crop and Year: 2014, fallow
Herbicides: Pre: glyphosate
Fertilizer: none
Irrigation: dryland
Termination Method and Date: Frost, Nov. 15, 2015
Next Crop: 2016, fallow; 2017, cover crop

Fig. 1. Cover crop on August 25th, 2015. Seanna Torske.

Monthly Precipitation at Hardin, MT

Hardin	J	F	M	A	M	J	J	A	S	O	N	D	Total
30 yr avg 1981-2010	0.46	0.43	0.75	1.33	2.06	1.76	1.22	0.70	1.20	1.08	0.54	0.43	11.97
2014	0.47	1.28	1.23	0.68	2.65	1.97	0.24	2.46	1.09	0.40	0.66	0.54	13.67
2015	0.97	0.16	0.08	1.30	2.94	3.22	1.04	0.81	0.56	1.03	0.39	0.37	12.87

Fig. 2. Monthly precipitation at Hardin, MT. Western Regional Climate Center, station #243915.

Introduction:

A full-season cover crop mix was planted on acres that were previously treated with manure applications during the fallow year. The producer alternates between two fields each year that will receive manure applications from the associated truck wash-out business adjacent to the fields. Tillage is used to incorporate the manure into the soil and to control weeds during the fallow year. The field is 45 acres and the producer planted cover crops with two goals in mind. First, he wanted to use the excess nutrients in the soil from the manure wash-out, and second, he wanted additional forage for winter grazing of cattle.

Results:

The cover crop established and grew well. On Sept 15th, 2015 sampling was conducted on 3 clipping sites that were randomly selected across the field. All sites were on silty clay loam soils. There were 108 growing days from the time of planting to the time of clipping, with 3316 growing degree days (base 40) during that same period. Plants were separated by species in the field and air-dried at the Hardin Field Office. Total aboveground biomass after air-drying was 6849 lb/ac, or 3.4 t/ac. There were 3.8 AUMs per acre, or 169 total AUMs available in this field.

Summary and Discussion:

Overall, this cover crop grew well with good biomass accumulation providing 169 AUMs of winter grazing. The stand was healthy but with some weed pressure, primarily bindweed. The presence of weeds in the system are likely due to the manure applications and tillage operations. The overall disturbance to the soil in this system is significantly higher than the no-till systems as a result of the truck wash-out business and the need to spread manure on an on-going basis. Warm-season plant species dominated the mix, with warm-season grasses and sunflowers providing 47 and 28% of the aboveground biomass, respectively. Turnips also did well, with 22% of the biomass. Very few legumes were present. Buckwheat and flax were not highly abundant, yet they did provide some pollinator habitat. Cover crops have proven to be a useful tool in this operation to provide diversity to the crop ground and winter forage for the livestock operation.

Fig. 3. Warm-season grasses, August 3rd, 2015, Evan Van Order.

Fig. 4. Blue Flax, August 3rdth 2015, Evan Van Order.

	Seeding Rate (lb/acre)	Percent of Mix by # of Seeds	Cover Crop Biomass %
Soybean	4.1	2	0
Hairy vetch	2	3	1
Lentil	3.2	7	0
Pea, spring forage	6.5	2	1
Sorghum-sudan	4.2	16	47*
Corn	2.6	1	--
Millet, proso	1.5	26	--
Turnip	0.7	17	22
Sunflower	1.8	2	28
Buckwheat	2.9	7	2
Flax	1.5	17	1
Total	31	714,900	102

Fig. 5. Comparison of planned seed mix percentage vs actual aboveground biomass percentage
*47% is the combined total biomass of the sorghum-sudan, corn, and millet.

Dryland Cover Crop as Fallow Replacement, Musselshell County

Susan Tallman, NRCS Bozeman Area Agronomist 2015

County: Musselshell
Average annual precip: 13-14”
MLRA: 58A, Northern rolling plains
Dominant Soil Type: 158A Ethredge-Verson clay loam, 0-2% slope
Acres: 660
Planting Date: June 12-14, 2015
Seeding Rate: 935,000 seeds/acre, or 28 lb/acre
Seed cost: $25.89/acre (inoculant, seed, and delivery)
Seeding Method: Concord 5012 air seeder, ¾” dutch openers
Row Spacing: 12”
Tillage: No-till
Previous Crop and Year: 2014, Winter wheat, 40 bu/acre
Fertilizer: none
Irrigation: Dryland
Termination Date: Sept 2015
Termination Method: Herbicide
Next Crop: Winter wheat, seeded Oct 2015

Fig. 1. Cover crop July 20, 2015. Susan Tallman.

Monthly Precipitation at Roundup, MT

Roundup	J	F	M	A	M	J	J	A	S	O	N	D	Total
30 yr avg 1981-2001	0.37	0.37	0.73	1.36	2.32	2.61	1.65	1.19	1.25	0.97	0.54	0.41	13.75
2014	0.66	0.83	1.65	0.88	1.77	3.97	0.71	6.77	0.83	0.16	0.58	0.28	19.09
2015	0.54	0.13	0.23	1.00	2.50	0.89	1.38	1.01	0.19	1.87	0.88	0.82	9.05

Fig. 2. Monthly precipitation at Roundup, MT. Western Regional Climate Center, station #247214.

Introduction:

Cover crop planted as fallow replacement in a winter wheat-fallow rotation and terminated with herbicide. No haying or grazing occurred.

Results:

NRCS staff visited the field on July 20, 2015. The cover crop was very green and growing well, with little weed pressure. Sampled on Aug 19, 2015. There were 68 growing days from the time of seeding to the time of clipping, with 2189 growing degree days (base 40) accumulated during this same period. Five clippings were taken in soil type 158A, across a diagonal transect. Plants were separated by species in the field and air-dried at the office. Total aboveground biomass after air-drying was 3216 lb/ac, or 1.6 t/ac. Assuming 910 lb of forage per animal month, and 50% utilization rate on 660 acres, there were 1,166 AUMs available in this field, or 1.8 AUMs/ac.

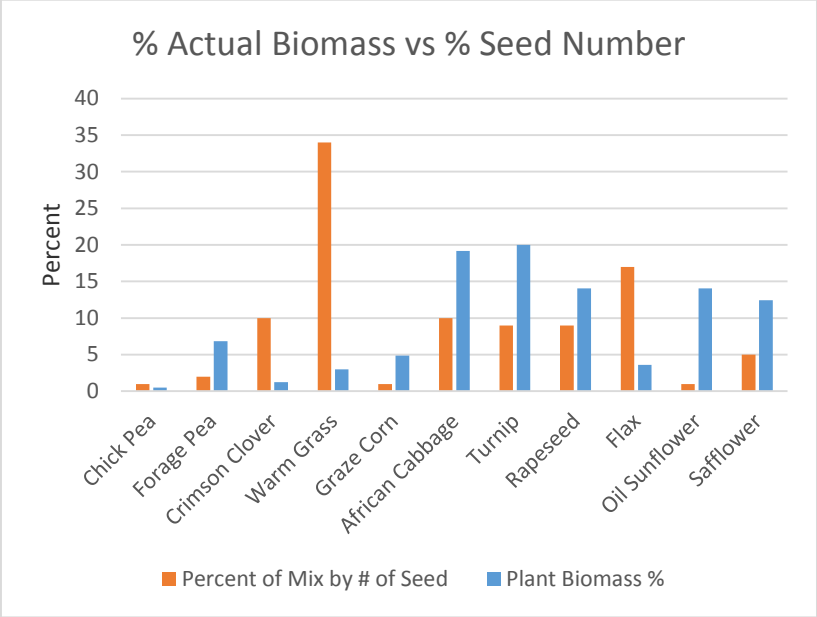
Plant biomass percentage by species varied compared with the planned seed mix. Of particular note, warm-season grasses (sorghum-sudan and proso millet) were 34% of the total seed number, but were only 3% of the biomass. Brassicas dominated the biomass at 58%, even though they were only 23% of the seed mix. Peas were the strongest legume. Sunflower and safflower produced better than expected. It is unclear what caused the lack of warm-season grasses, but we suspect the brassicas have strong early growth that limits early warm-season grass growth. Planners may want to consider decreasing the brassica component for future mixes planted in June.

Summary and Discussion:

Overall, this cover crop grew very well. We were very pleased to see low weed pressure and healthy dryland biomass production. We had expected to see more warm-season grasses in the mix as this seeding window should be ideal fo warm-season production. Ideally, this cover crop would be grazed for economic return. It should be noted that August 2014 precipitation was 6.77 inches, almost six times the 30 year average of 1.19 inches. This likely set the 2015 cover crop in good standing regarding soil moisture. RMA guidelines require a cover crop to be terminated 35 days prior to seeding of fall cash crop. This was probably not the case here. This timing can be essential for minimizing plant diseases carried by a green bridge, such as rhizoctonia, and for ensuring enough soil

moisture for proper germination of the fall crop. True success of the cover crop practice will not be known until the 2016 winter wheat harvest. It is possible that wheat yield may decline or disease pressure may be present. Dryland producers with a conservative risk threshold might consider planting a predominately cool-season cover crop in early spring and terminating by mid-June or first of July to optimmize the peak precip window. This field will have cover crop again in 2017, with long-term benefits not expected until after several appearances of the cover crop in the rotation.

Fig. 3. Cover crop at time of clipping, Aug 19, 2015. Austin Shero.



	Seed lb/ac	Percent of mix by # of seed	Cover Crop Biomass %
Chickpea	5	1	1
Forage pea	7	2	7
Crimson clover	1	10	1
Millet + Sorghum-sudan	5	34	3
Grazing Corn	2	1	5
African cabbage	0.5	10	19
Turnip	0.5	9	20
Rapeseed	0.5	9	14
Flax	2	17	4
Sunflower	1.4	1	14
Safflower	3	5	12

Fig. 4 and 5. Comparison of percentage seed number vs percentage actual aboveground biomass.

Cover Crop for Salinity Control, Yellowstone County

Shalaine Watson, NRCS Soil Conservationist, Billings, MT 2014 and 2015

County: Yellowstone, near Broadview
Average annual precip: 10-12”
MLRA: 58A, Northern rolling plains
Dominant Soil Type: Ay, Arvada-Bone clays, 0-1% slope
Acres: 20 acres of cover crop, 8 of control (chem fallow)
Planting Date: May 20, 2015
Seeding Rate: 896,400 seeds/acre, or 20 lb/acre
Seed cost: $21.99/acre (inoculant, seed, and delivery)
Seeding Method: John Deere 787 air seeder, ¾” dutch openers
Row Spacing: 15” at 1 ½” depth
Tillage: No-till since coming out of CRP in 2010
Previous Crop and Year: 2000-2010, CRP
2013, Spring wheat, 40 bu/acre
Herbicides: Pre: glyphosate
Fertilizer: none
Irrigation: Dryland
Termination Date: July 25, 2014
Termination Method: glyphosate
Next Crop: 2015, Winter wheat, seeded Oct 2014,
46 bu/acre yield

Fig. 1. Cover crop July 21, 2014. Shalaine Watson.

Monthly Precipitation at Billings, MT

Billings	J	F	M	A	M	J	J	A	S	O	N	D	Total
30 yr avg 1981-2010	0.50	0.51	1.03	1.63	2.22	2.12	1.27	0.84	1.32	1.09	0.64	0.50	13.67
2013	0.59	0.29	0.26	1.02	4.28	0.88	0.67	0.19	3.63	2.57	0.34	1.98	16.70
2014	1.02	2.06	1.32	1.18	2.25	1.75	0.34	1.97	0.57	0.16	0.74	0.67	14.03
2015	1.09	0.21	0.37	1.57	2.43	1.60	1.66	0.91	0.27	1.80	0.48	0.57	12.96

Fig. 2. Monthly precipitation at Billings, MT. Western Regional Climate Center, station #240807.

Introduction: This twenty-eight acre dryland field is located in the Broadview basin, with predominantely saline soils. Salinity is not a result of downward seep, but from upward evaporative wicking of salts from the subsoil. Perennial vegetation is the best management practice to control the salinity, as plant roots use soil moisture which prevents the upward movement of salts. As a result, the field had been in CRP for 10 years. Once it converted back to annual crop production in 2010, minimizing the fallow period became the best way to control salinity. In 2014, a cover crop mix was planted as a partial fallow replacement. Twenty acres of the field were planted to a mixed-species cover crop and eight acres were left fallow for comparison (Fig. 5). In the fall of 2014, all twenty-eight acres were seeded to winter wheat and harvested in 2015.

Results: The goal of the cover crop was to use excess moisture in the soil profile to control salinity, breakup soil compaction, and increase rotational diversity. NRCS measured soil moisture prior to planting of the cover crop as well as prior to termination. On July 11, 2014, average soil moisture in the treatment area with cover crop had up to 12% less soil moisture than fallow to a depth of 3 ft. (This difference was determined informally and should be interpreted as such.) Three cover crop clippings were taken on July 21, 2014. Plants were not separated by species and were air-dried at the Billings FO. Top producing species by visual estimate were barley, millet, and sorghum-sudan. The barley germinated quickly to provide cover. Turnip and radish, both cool season brassicas, bolted in mid-June, so tap root growth to break compaction was less than hoped for. Sunflower roots did reach compacted areas of the soil profile (8 in), evident from the zig-zag pattern of the roots. Flax also performed well, coming on later in the season as the radishes and turnips bolted, and providing pollinator habitat. No clover and very little cowpea were observed in the field. We are unsure of the performance of triticale as it may have been confused with barley. There were 66 days from cover crop planting to sampling, with 1756 growing degree days (base40). Total aboveground biomass was 3458 lb/ac, or 1.73 t/ac. For grazing purposes, there were 1.9 AUM/ac, or 38 total AUMs in the 20 ac cover crop treatment. Average winter wheat yield across the field was 46 bu/ac. Yield maps indicate the

cover crop did decrease wheat yield somewhat, however soil salinity was the primary factor in yield reduction. Haney soil tests were collected in 2014 in both treatments to serve as a baseline for future comparison.

Summary and Discussion: It should be noted that August 2014 was unseasonably wet, with over twice the precipitation of the 30 yr average, making favorable conditions for winter wheat germination and establishment. As a more conservative approach, dryland producers might consider planting a predominately cool-season cover crop in early spring and terminating by June 15-July 1 to match the peak precip window. The cover crop did use more soil moisture than fallow, however, tradeoffs in soil moisture use need to be made to balance salinity control with cash crop yield. In the long-term, repeated use of the practice and/or intensification of cash crop production should help alleviate salinity when compared with fallow. However, it is uncertain whether this annual intensification can control salinity as well as perennial vegetation. The producer plans to repeat the cover crop in 2017.

Fig 3. Cover crop on July 22, 2014. Shalaine Watson.

	Seeding Rate (lb/acre)	Seeds per acre	Percent of Mix by # of Seeds
Clover, subterranean	2	140,000	15
Cowpea	4	16,400	2
Barley, spring forage	2	26,000	3
Triticale, winter	2	22,000	2
Sorghum-sudan	1	18,000	2
Millet, proso	1	120,000	13
Turnip, purple top	1	170,000	19
Radish, nitro	1	25,000	3
Rapeseed	1	175,000	20
Sunflower	3	24,000	3
Flax	2	160,000	18
Total	**20**	**896,400**	**100**

Fig 4. 2014 Cover crop seed mix.

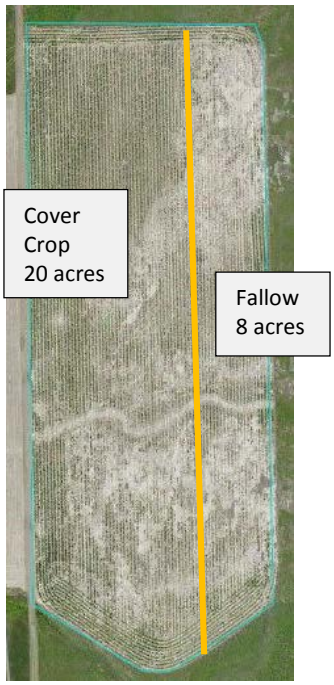


Fig 5. Aerial view of field with 2014 treatments. NRCS Web Soil Survey, Photo taken Aug 2011.

Dryland Cover Crop for Grazing, Yellowstone County

Shalaine Watson, NRCS Soil Conservationist, Billings, MT 2015

County: Yellowstone, near Broadview
Average annual precip: 10-12”
MLRA: 58A, Northern rolling plains
Dominant Soil Type: El- Elso clay loam, 7-15% slope
Acres: 41 ac
Planting Date: June 12-14, 2015
Seeding Rate: 967,500 seeds/acre, or 25 lb/acre
Seed cost: $21.89/acre (seed and delivery)
Seeding Method: John Deere 787 air seeder, ¾” dutch openers
Row Spacing: 15”
Tillage: No-till for over 10 years
Previous Crop and Year: 2014, malt barley, 35 bu/acre
Herbicides: Pre: glyphosate
Fertilizer: none
Irrigation: dryland
Termination Date: August 2015
Termination Method: Grazed Aug 2015, frost-kill in fall, will spray Spring 2016 if needed
Next Crop: 2016, malt barley

Fig. 1. Cover crop on July 31, 2015. Shalaine Watson.

Monthly Precipitation at Billings, MT

Billings	J	F	M	A	M	J	J	A	S	O	N	D	Total
30 yr avg 1981-2010	0.50	0.51	1.03	1.63	2.22	2.12	1.27	0.84	1.32	1.09	0.64	0.50	13.67
2014	1.02	2.06	1.32	1.18	2.25	1.75	0.34	1.97	0.57	0.16	0.74	0.67	14.03
2015	1.09	0.21	0.37	1.57	2.43	1.60	1.66	0.91	0.27	1.80	0.48	0.57	12.96

Fig. 2. Monthly precipitation at Billings, MT. Western Regional Climate Center, station #240807.

Introduction: This forty-one acre dryland field is located in northwestern Yellowstone County. The producer has a diverse rotation of small grains, alfalfa, and sunflowers and corn and has been using no-till practices for about 20 yrs. He planted the cover crop to build soil organic matter and provide supplemental income from leased grazing. The cover crop mix consisted of spring forage peas, spring lentils, sorghum-sudan, white wonder millet, proso millet, purple top turnip, rapeseed, sunflower, buckwheat and phacelia.

Results: NRCS staff visited the site on July 31, 2015 and took three biomass clippings in a random pattern. Cover crop was starting to dry down, and the canopy had not closed completely during growth stage. Plants were clipped by total biomass, not by individual species, and were air dried in the office. There were 49 days from cover crop planting to sampling, with 1553 growing degree days (base 40). Total aboveground biomass was 1767 lb/acre, or 0.9 ton/acre. For grazing purposes, there were about 1 AUM/ac, or 41 total AUMs available in the field. In practical terms, this would mean approximately 100 head of cattle for ten days of grazing.

Summary and Discussion: 2015 was drier than normal, but at the time of photos the cover crop was the greenest field in the surrounding landscape of small grains and native range. Forage peas performed well in the early season until the hot weather hit in July. At the time of sampling, the peas had formed seed pods. Lentils were rarely present and dried out. Sorghum-sudan and the millets produced the most grazeable forage, as compared to the other species in the mix. Buckwheat was present in the expected proportion and provided pollinator forage. Turnip and rapeseed were fairly rare and plant size was small. Sunflower did well, but phacaelia was rarely seen. It should be noted that all plant performance information is solely based on visual observation. The field was leased to a neighbor for grazing of cattle in August. The cover crop field was not fenced separately and was in the same paddock with other crop fields and surrounding rangeland. Cattle preferred the cover crop over the grain stubble or native range. As a result, about 75% of the cover crop was grazed, leaving less than ideal aboveground residue for building organic matter in the long-term. Overall, the predominately warm-season cover crop mix was well matched

to the mid-June planting window and brought some diversity to this rotation. What is unknown is the impact the cover crop will have on the 2016 malt barley crop due to soil moisture use. Yield information from 2016 is needed to provide complete information on the relative success of this cover crop. Dryland producers with a low risk tolerance or just starting a cover crop practice might consider planting a predominately cool-season cover crop mix in early spring and terminating by mid-June to early July to match the peak precipitation window. While this decreases the plant diversity in the rotation, it also decreases the risk of yield reduction in the subsequent cash crop. It may take several appearances of the cover crop in the rotation for positive benefits to be realized.

Fig 3. Cover crop at sampling July 31, 2015. Shalaine Watson.

	Seeding Rate (lb/acre)	Seeds per acre	Percent of Mix by # of Seeds
Peas, spring forage	10	32,000	3
Lentil	4	60,000	6
Sorghum-sudan	3	54,000	6
Millet, white wonder	1	200,000	21
Millet, proso	1	120,000	12
Turnip	1	170,000	18
Rapeseed	1	175,000	18
Sunflower	1	8,000	1
Buckwheat	2	36,000	4
Phacelia	0.5	112,500	12
Total	**24.5**	**967,500**	**101**

Fig 4. Cover crop seed mix.

No-Till Sugar Beets, Carbon County

Ted Nelson, NRCS District Conservationist, Columbus, MT and Garrett Larson, Soil Conservationist, Joliet, MT 2015

County: Carbon, near Fromberg
Average annual precip: 14-15"
MLRA: 58A, Northern rolling plains
Dominant Soil Type: Fc -Fort Collins loam, 0-2% slope
Acres: 80
Planting Date: April 15, 2015
Seeding Method: Double disc no-till planter
Row Spacing: 24"
Tillage: no-till for 2 years
Previous Crop and Year: 2014, corn
Fertilizer: Yes
Irrigation: Center pivot
Next Crop: 2016, malt barley

Fig. 1. No-till sugar beet, July 8, 2015. Ted Nelson.

Monthly Precipitation at Bridger, MT

Bridger	J	F	M	A	M	J	J	A	S	O	N	D	Total
30 yr avg 1981-2001	0.47	0.37	0.72	1.34	1.98	1.80	0.74	0.73	1.23	1.11	0.56	0.43	11.67
2014	1.49	0.81	1.17	2.18	1.78	2.22	0.00	1.12	1.18	0.07	1.58	0.48	12.91
2015	0.03	0.32	0.22	1.10	3.03	0.97	0.62	0.82	0.03	1.89	0.18	0.89	10.10

Fig. 2. Monthly precipitation at Bridger, MT. Western Regional Climate Center, station #241102.

Introduction: The producer has been active in soil health activities for several years and has planted fields to no-till sugar beets for the last two years in a corn-beet-malt barley rotation. Both the sugar beet and the corn are Roundup Ready™. In this case, "no-till" means that the only tillage is the beet harvesting operation. He also grows conventionally tilled beets which provides for comparison between the two systems. In 2015, both systems were grown side-by-side in two 80 acre fields. Overhead sprinkler irrigation in these field makes the possibility of reduced-tillage more feasible.

Results: Refer to Figure 5 for a summary comparison of the two systems in 2015. It should also be noted that in 2015, this producer had Fusarium head blight (FHB) in his malt barley in a separate no-till field, leading to rejection at the malting elevator.

Summary and Discussion: The producer has been very pleased with the results of his no-till sugar beets. The producer estimates that no-till saves him at least $120/ac compared with conventional tillage. Besides the reduced inputs of herbicide, fungicide, and fuel, he is also disturbing the soil as little as possible and he has noticed a reduced incidence of fungal pressure on the beets compared to conventional management. He also reports that weed pressure is less in the no-till system. Yield is likely similar if harvested at the same time. Software modelling using the NRCS Wind Erosion Prediction Software (WEPS) indicates that average annual wind erosion can be reduced from 21 t/ac/year with conventional tillage to 2 t/ac/yr with no-till, bringing the system well under the allowed soil loss tolerance of 5/t/ac/yr for this particular soil. While this is very positive for soil health improvement, it is important to recognize there can be negative consequences to a no-till beet system. Specifically, the increased grass crop residue in no-till creates the perfect conditions for growth and spread of FHB, leading to rejection of malt barley at the elevator, due to increased toxin (DON) levels. As a result, <u>producers implementing a reduced-till beet system need to carefully design their crop rotation for disease management</u>. A long, diverse crop rotation is the best management tool to control FHB in a reduced or no-till system. Back-to-back years of grass crops (barley, wheat, and corn) should not be grown, and specifically, malt barley should not follow corn. FHB is not carried on the residue of broadleaf crops, therefore, a rotation similar to alfalfa-alfalfa-alfalfa-barley-beets may provide control of this disease in a reduced-till system.

Fig. 3. Comparison of no-till beets on the left and conventional beets on the right, June 10, 2015. Ted Nelson.

	Conventional Sugar Beets	No-Till Sugar Beets
Field Operations	Disk Ripper / Roller Harrow 2X / Level 2X / Ridge 2X	No-till
Harvest Date	Early Dig Sept. 15-17	October
Yield	32 t/ac	35 t/ac
Sugar %	17%	17.30%
Pros	Easier digging	Less inputs, no waiting on irrigation or rain for germination, soil was holding enough moisture under the residue to provide adequate germination, greater soil health benefit
Cons	High equipment and fuel costs, decreased soil health benefit, waited on rain for germination, germinated 10 days later.	Tougher digging

Fig. 4. Comparison of no-till vs. conventional sugar beets in 2015 crop year.

Fig. 5. Corn residue present in no-till sugar beets, July 8, 2015. Ted Nelson.

Silage Corn/Soybeans Interseeding, Carbon County

Ted Nelson, NRCS District Conservationist, Columbus, MT 2015

County: Carbon, near Fromberg
Average annual precip: 14-15”
MLRA: 58A, Northern rolling plains
Dominant Soil Type: Kc – Kyle Clay, 0 to 2 % slopes
Acres: 114.9
Planting Date: May 7, 2015
Seeding Rate: Corn, 51,000 seeds/ac
Soybean, 104,000 seeds/ac
Seeding Method: No-till planter
Row Spacing: 7.5” Alternate spacing corn/soybeans
Tillage: No-till (prob less than 5 years)
Previous Crop and Year: 2014, barley
Herbicides: Pre: May 6, herbicide
Inoculant: yes, for soybeans
Insecticides/Fungicides: none
Fertilizer: Yes, prior to seeding
Irrigation: Center pivot
Harvest Date: September 18, 2015

Fig. 1. Silage corn with soybeans interseeded at chopping, Sept. 18, 2015.

Monthly Precipitation at Bridger, MT

Bridger	J	F	M	A	M	J	J	A	S	O	N	D	Total
30 yr avg 1981-2001	0.47	0.37	0.72	1.34	1.98	1.80	0.74	0.73	1.23	1.11	0.56	0.43	11.67
2014	1.49	0.81	1.17	2.18	1.78	2.22	0.00	1.12	1.18	0.07	1.58	0.48	12.91
2015	0.03	0.32	0.22	1.10	3.03	0.97	0.62	0.82	0.03	1.89	0.18	0.89	10.10

Fig. 2. Monthly precipitation at Bridger, MT. Western Regional Climate Center, station #241102.

Introduction: This producer has enthusiastically embraced soil health principles in the last few years and has been trying innovative new practices to increase diversity and reduce tillage while maintaining, or increasing, profitability. In 2015 he interseeded soybeans with irrigated silage corn with the goals of decreasing his need for N fertilizer, increasing silage yield, and increasing crop diversity. This is the second year he has tried the practice.

Results: The producer seeded corn and soybean at the same time, with 7.5” row spacings. Corn population was 51k/ac and soybean was 104k/ac. <u>It is important to note that a late-maturing soybean variety should be used for this technique to be successful in Montana to prevent the soybean from setting pods and to keep the nitrogen in the leaves and roots.</u> The producer also had a field of conventionally tilled corn silage that was not interseeded as a comparison, with a corn population of 51k/ac on 15” spacings. The no-till corn did germinate a little slower in the spring but it soon caught up and passed the conventional corn in size and vigor. Figure 5 details the comparative yield and feed analysis data. The energy content of the interseeded silage is slightly less than the conventional silage, but the 25% increase in yield more than compensates for this. Soil test results taken from the 0-6” depth on October 23, 2015 showed available nitrogen of 22 lb/ac in the conventional corn field versus 46 lb/ac in the interseeded field.

Summary and Discussion: The producer has been very pleased with the results of two years of interseeding soybeans with silage corn. He stated that the cost of adding the soybeans was insignificant compared to the

improved yield and protein content of the silage, along with the added soil nitrogen and soil building benefits of increased diversity.

Fig. 3. Nodules on soybean root, Aug 27, 2015. Ted Nelson

Fig. 4. Soybeans and corn, July 8, 2015. Ted Nelson.

	Corn	Corn/Soybeans
Field Operations	Disk, Ridge or Disk, Roller-Harrow, Ridge	No-Till
Yield	32 t/ac	40 t/ac
Crude Protein %	7.80%	8.60%
Acid Detergent Fiber %	21.80%	27.10%
Total Digestible Nutrients %	72.50%	69.00%
Calculated Net Energy Lactation, Mcal/lb	0.77	0.71
Calculated Net Energy Maintenance, Mcal/lb	0.78	0.73
Calculated Net Energy Gain, Mcal/lb	0.5	0.45

Fig. 5. Comparison of feed analysis values of conventionally tilled corn silage versus no-till corn silage with soybeans interseeded.

Fig. 6. Barley residue remaining in no-till corn and soybeans, July 8, 2015. Ted Nelson.

Cover Crops Following Hay Barley in Carbon County

Ted Nelson, NRCS District Conservationist, Columbus, MT 2015

County: Carbon, two locations
Average annual precip: 13-14"
MLRA: 58A, Northern rolling plains
Dominant Soil Type: Fc, Fort Collins Loam, 0 to 2 % slopes and Heldt silty clay loam, 0-2% slopes
Acres: 60 ac. and 150 ac.
Planting Date: August 1 and August 10, 2015
Seeding Rate: 1,309,835 and 1,315,935 seeds/acre
Seed cost: $25.19/acre and $22.85 (seed, inoculant, delivery)
Seeding Method: Broadcast, then heavy harrow
Row Spacing: n/a
Tillage: No-till
Previous Crop and Year: 2015, hay barley
Herbicides: Pre: none prior to cover crop planting
Fertilizer: Yes
Irrigation: Center pivot
Termination Method and Date:
Field 1: Swathed and baled, Nov. 2015
Field 2: Frost killed and grazed, Dec. 2015
Next Crop: 2016, Field 1 – corn, Field 2 – sugar beets

Fig. 1. Cover crop with volunteer barley, Field 1. Aug 27, 2015. Ted Nelson.

Monthly Precipitation at Bridger, MT

Bridger	J	F	M	A	M	J	J	A	S	O	N	D	Total
30 yr avg 1981-2001	0.47	0.37	0.72	1.34	1.98	1.80	0.74	0.73	1.23	1.11	0.56	0.43	11.67
2014	1.49	0.81	1.17	2.18	1.78	2.22	0.00	1.12	1.18	0.07	1.58	0.48	12.91
2015	0.03	0.32	0.22	1.10	3.03	0.97	0.62	0.82	0.03	1.89	0.18	0.89	10.10

Fig. 2. Monthly precipitation at Bridger, MT. Western Regional Climate Center, station #241102.

Introduction:

Two producers in Carbon County tried broadcasting a cover crop on a hay barley field after hay harvest. Both producers have center pivot irrigation and opportunity for cattle grazing.

Results:

In Field 1, the cover crop was not clipped for biomass, but the producer swathed and baled the field in the fall with the yield being 2.5 t/ac. There were about 92 growing days in Field 1, with 1956 growing degree days (base 40) during this same period. Most of the growth in Field 1 was volunteer barley. In Field 2, NRCS staff clipped the cover crop on November 10th, resulting in 5027 lb/ac or 2.5 t/ac of oven-dried biomass. There were 92 growing days in Field 2, with 1692 growing degree days (base 40) during this same period. Clippings from Field 2 were not separated by species, but staff estimates that volunteer barley was the dominant species in the cover crop. Both fields produced similar amounts of biomass, resulting in about 2.8 AUMs/ac for grazing purposes. There were 168 total AUMs in Field 1 and 280 total AUMs in Field 2.

Summary and Discussion:

In both fields, the volunteer barley out-produced and restricted cover crop growth and establishment. For the future, both producers commented they would apply herbicide to volunteer barley after hay harvest to allow for growth of the other cover crop species. It seems there are two options in this scenario. Option 1 would be to spray out the volunteer hay barley prior to planting a mixed-species cover crop for fall grazing. For a planting window of August or later in Carbon County, a predominately cool-season cover crop should be used. Option 2 would be to

simply let the hay barley regrow after harvest without planting a cover crop. Option 1 would provide increased diversity to the rotation, but would have the added cost of herbicide, seed, and labor. Option 2 would not provide diversity, but would cost less and would still provide soil cover and root mass to improve organic matter. For soil health purposes, either of these option are preferable to the alternative of spraying out the hay barley after harvest and growing no crop at all.

	Seeding Rate (lb/acre)	Percent of Mix by # of Seeds
Clover, crimson	2	16
Austrian winter pea	5	2
Winter lentil	5	6
Annual ryegrass	3	44
Turnip	0.8	9
Radish	1	2
Safflower	2	2
Sunflower	2	1
Flax	3	18
TOTAL	24	100

Fig. 3. Field 1 seeding mix.

	Seeding Rate (lb/acre)	Percent of Mix by # of Seeds
Austrian winter pea	5	2
Winter lentil	5	6
Annual ryegrass	3	43
Winter oats	5	7
Sorghum-sudan	1.5	2
White wonder millet	1	15
Turnip	0.8	7
Radish	0.3	1
Forage collard	1	9
Sunflower	2	5
TOTAL	25	97

Fig. 4. Field 2 seeding mix.

Irrigated Warm-Season Cover Crop for Grazing, Carbon County

Ted Nelson, NRCS District Conservationist, Columbus, MT 2015

County: Carbon, near Bridger
Average annual precip: 13-14"
MLRA: 58A, Northern rolling plains
Dominant Soil Type: Hs – Heldt Silty Clay Loam
Acres: 13
Planting Date: June 23, 2015
Seeding Rate: 26.5 lbs/ac
Seed cost: unknown
Seeding Method: Double disc drill
Row Spacing: unknown
Tillage: Plow, disc
Previous Crop and Year: Grass/legume hay
Herbicides: Pre: none
Post: none
Insecticides/Fungicides: none
Fertilizer: none. Inoculant only.
Irrigation: Gated pipe
Termination Method and Date: Frost-kill, Nov.
Next Crop: Grass/legume mix for hay and forage

Fig. 1. Cover crop at the time of clipping, September 10, 2015. Mark Doely.

Monthly Precipitation at Bridger, MT

Bridger	J	F	M	A	M	J	J	A	S	O	N	D	Total
30 yr avg 1981-2001	0.47	0.37	0.72	1.34	1.98	1.80	0.74	0.73	1.23	1.11	0.56	0.43	11.67
2014	1.49	0.81	1.17	2.18	1.78	2.22	0.00	1.12	1.18	0.07	1.58	0.48	14.08
2015	0.03	0.32	0.22	1.10	3.03	0.97	0.62	0.82	0.03	1.89	0.18	0.89	10.10

Fig. 2. Monthly precipitation at Bridger, MT. Western Regional Climate Center, station #241102.

Introduction:

This was a grass/legume hay field that was due for renovation. The producer wanted to try a multi-species cover crop to be used for grazing for one year before reseeding the field back to a perennial grass/legume mix in 2016. The species mix would not only provide forage but also benefit the soil by introducing more broadleaf plants and warm-season grasses.

Results:

NRCS staff visited the field on September 10, 2015. The cover crop was actively growing and vigorous. Three random clippings were taken and oven-dried, but not separated by species. There were 78 days between the planting and sampling dates, with 2326 growing degree days (base 40) during this same period. The average production from the clippings was 8136 lbs. of dry matter per acre, or 4.1 t/ac. Budgeting three-fourths of the forage for grazing and allowing 910 lbs/AUM results in 6.7 AUMs/ac, or 87 AUMs for the entire 13 acre field. Assuming $30.00/AUM, the forage value is $2610 for the field. As mentioned, species were not separated after clipping but generalizations can be made. Sorghum-sudangrass dominated the mix and provided the bulk of the aboveground biomass. The radishes and turnips were successful as were the sunflowers, safflowers, and millet. The pinto beans were not successful. Cattle were turned in for grazing in November after the first frost, and after the risk of prussic acid toxicity in the sorghum-sudan.

A concern with sorghum-sudangrass when used for forage is the risk of prussic acid (hydrocyanic acid) toxicity. A sudden disruption of growth such as frost, drought, or cutting causes prussic acid to be released inside the plant at a more rapid rate. High prussic acid levels can be lethal to cattle. Prussic acid will break down in one to two weeks so

material made into hay or silage is safe to use. Horses should not be allowed to graze these plants as they can develop a potentially fatal cystitis syndrome and pregnant mares may abort. Cattle can safely graze a week after a killing frost as the prussic acid usually dissipates within 7 days. Excessive nitrate levels can also occur if a high level of nitrogen fertilizer was applied, there is prolonged drought followed by rain, or any condition which kills the leaves while the roots and stems remain active. When in doubt, have the forage tested for nitrates before feeding.

Summary and Discussion:

Overall, this cover crop grew extremely well and was the top-producing site we sampled across the twelve–county area in 2015. The combination of irrigation, sorghum-sudangrass, and a warm-season growing window resulted in very impressive growth. We were very pleased to see low weed pressure and excellent biomass production. There was significant nocturnal grazing pressure from an elk herd that resided nearby, but the producer was very pleased with the results. This would appear to be an economical and soil-health-building tool for livestock producers who are renovating irrigated hay fields.

Fig. 3. Cover crop on September 29, 2015. Ted Nelson.

	Seed Mix %	Cover Crop Biomass
Legumes	13	Poor
Brassicas	9	Good
Warm-Season Grasses	26	Very good
Warm-Season Broadleaves	52	Good

Fig. 4. Seed mix and observed biomass performance.

Cover Crop after Sprayed Hay Barley, Broadwater County

Susan Tallman, NRCS Bozeman Area Agronomist 2015

County: Broadwater
Average annual precip: 11-12”
MLRA: 44B, Central Rocky Mountain Valleys
Dominant Soil Type: Ut-Ustic Torriorthents, saline
Acres: 65
Planting Date: July 20
Seeding Rate: 17.5 lb/ac
Seed cost: $30.42 per acre
Seeding Method: Drilled the barley, cover crop seed broadcast with fertilizer and then cultipacked
Tillage: lightly disked the field prior to blowing the seed on
Previous Crop and Year: 2014-Alfalfa; 2015- Hay barley
Herbicides: Pre: July 15, sprayed RT-3 and LV-6 after hay barley
Insecticides/Fungicides: none
Fertilizer: 100lb/ac of 16-20-14
Irrigation: Overhead sprinkler
Termination Date: Oct 20, 2015
Termination Method: Frost and grazing
Next Crop: not sure, prefer high value hay crop for horses

Fig. 1. Cover crop Oct. 5, 2015. Susan Tallman.

Monthly Precipitation at Townsend, MT

Roundup	J	F	M	A	M	J	J	A	S	O	N	D	Total
30 yr avg 1981-2001	0.26	0.25	0.49	0.78	1.82	2.24	1.35	1.13	0.89	0.54	0.33	0.30	10.38
2014	0.20	0.68	0.73	0.94	0.23	2.26	1.09	2.50	0.74	0.45	0.75	0.23	10.80
2015	0.29	0.22	0.40	1.15	0.87	1.07	1.46	0.78	1.56	0.77	0.44	0.37	9.38

Fig. 2. Monthly precipitation at Townsend, MT. Western Regional Climate Center, station #248324.

Introduction:

The producer’s goal is to optimize profits and soil health on their cattle and irrigated hay operation. This cover crop was planted after hay barley harvest as supplemental fall grazing for cattle. The field is located close to Townsend, MT in the Missouri River floodplain. Soils are saline and the 65 acre field is under pivot irrigation. The field has been in alfalfa for 8 years and was taken out in 2014 for renovation. Hay barley was planted at the end of April and harvested on July 10, with average yield of 2 t/ac. Field was sprayed to kill residual alfalfa, volunteer barley and dandelions after barley harvest on July 15. Cover crop mix was planted on July 20 and was terminated by fall frost. Cattle were turned in for grazing in December.

Results:

NRCS staff visited the field in May, Sept, and Oct. In Sept and Oct, cover crop was green and lush and consisted mostly of turnips. We took three random clippings on Oct. 5, 2015. Clippings were not separated by plant species and were oven dried at MSU. There were 1756 growing degree days (base 40) between the date of seeding and the date of clipping. Total aboveground biomass was 4793 lb/ac, or 2.4 t/ac. For grazing purposes, there were about 2.6 AUM/ac, or 169 total AUMs available in this field. By visual estimate, turnips completely dominated this mix. Some radish were present, there was very slight annual ryegrass and no balansa clover. Turnips and radishes were planted at a high rate of about 4 lb/ac each, which is the amount used in a single-species seeding of these crops. When used in a mix, a common rate for these species is no more than 0.5 lb/ac, depending on the number of species in the mix.

Summary and Discussion:

This was one of four cover crops we sampled in Broadwater County in 2015. It is interesting to note that this cover crop yielded 2.4 t/ac, while a similar cover crop less than five miles away following hay barley yielded only 1.4 t/ac (see “Cover Crop after Unsprayed Hay Barley, Broadwater County”). In this case study, the herbicide application

probably limited the competitive regrowth of the barley. Fertilizer application may have also boosted cover crop yield. Future cover crops following hay barley may want to consider an herbicide application for strongest cover crop growth, depending on species selection and timing. Cows were turned onto the field on Dec 10th with the producer gaining 2 to 3 months of grazing for 60 head. The producer has not had any nitrate or choking issues and has added some supplemental hay in the field for roughage. Future mixes in this same scenario would benefit from the addition of a grass species, to balance the forage ration for the cattle. It is unclear if a warm-season grass would fit, as by July 20th the warm-season window is closing. NRCS staff from Madison County report that annual ryegrass may re-appear in the field next year due to seed dormancy.

Species	Seeding Rate lbs/acre
Radish	4.3
Turnip	3.9
Annual ryegrass	6.2
Balansa clover	3.1

Fig 3. Seeding rate of cover crop

Fig 5. Cover crop at about knee height, Oct. 5, 2015. Susan Tallman.

Fig 4. Turnip and radish root length, Oct. 5, 2015. Susan Tallman.

Fig 6. Saprophytic fungal hyphae present on much of the soil surface, breaking down the high carbon barley residue. Notice good soil aggregation and worm castings. Oct. 5, 2015. Susan Tallman.

Cover Crop after Unsprayed Hay Barley, Broadwater County

Susan Tallman, NRCS Bozeman Area Agronomist and Kristin Fletcher, Bozeman Area Cartographer 2015

County: Broadwater, near Townsend
Average annual precip: 11-12"
MLRA: 44B, Central Rocky Mountain valleys
Dominant Soil Type: Vd – Villy silty clay loam, drained
Acres: 14
Planting Date: Hay barley, May 25, 2015; Cover crop, Jul 25, 2015
Seeding Rate: 19 lb/ac
Seed cost: unknown
Seeding Method: Broadcast with fertilizer
Tillage: hay barley was planted no-till with a disc drill
Previous Crop and Year: 2015, Hay barley, harvested Jul 20, 2015. Field was previously in alfalfa.
Herbicides: Pre: none
Post: none
Insecticides/Fungicides: none
Fertilizer: 100# of 16-20-0 broadcast on the 14 acres with cover crop
Irrigation: Pivot irrigation
Termination Method and Date: Frost, Oct 15, 2015
Next Crop: 2016, Hay barley followed with cover crop

Fig. 1. Cover crop Oct. 1, 2015. Susan Tallman.

Monthly Precipitation at Townsend, MT

Roundup	J	F	M	A	M	J	J	A	S	O	N	D	Total
30 yr avg 1981-2001	0.26	0.25	0.49	0.78	1.82	2.24	1.35	1.13	0.89	0.54	0.33	0.30	10.38
2014	0.20	0.68	0.73	0.94	0.23	2.26	1.09	2.50	0.74	0.45	0.75	0.23	10.80
2015	0.29	0.22	0.40	1.15	0.87	1.07	1.46	0.78	1.56	0.77	0.44	0.37	9.38

Fig. 2. Monthly precipitation at Townsend, MT. Western Regional Climate Center, station #248324.

Introduction:

This irrigated cover crop was seeded after hay barley harvest. The hay barley was not sprayed prior to cover crop planting, and volunteer barley regrowth was a major component of the cover crop. The producer's goal is to have grazing options, diversity in the rotation, improve soil health, and provide cover and forage for pheasants.

Results:

NRCS staff visited the field on Oct. 1, 2015 and took three random clippings. The field was green and lush at the time of our visit. We separated the clippings into volunteer barley and brassica components in the field, then oven-dried the samples at MSU. There were 66 growing days between the date of seeding and the date of clipping, and 1519 growing degree days (base 40) during that same period. Total aboveground biomass was 2800 lb/ac, or 1.4 t/ac. For grazing purposes, there were about 1.5 AUMs/ac, or 21 total AUMs available in this field. Volunteer barley dominated the stand, composing 79% of the aboveground biomass, while brassicas were about 21% of the total biomass. Radishes and turnips were each planted at a high rate. Maximum rate for each of these species in a mix is 0.5 lb/ac. Annual ryegrass was nowhere to be seen at the time of sampling. However, NRCS staff from Madison County report that it may appear in 2016, due to seed dormancy.

Summary and Discussion:

It is interesting to note that this cover yielded 1.4 t/ac, while a similar cover crop following hay barley less than five miles away yielded 2.4 t/ac (see "Cover Crop after Sprayed Hay Barley, Broadwater County"). The volunteer hay barley in the other case study was sprayed out after haying, limiting the competition from volunteer barley. In this case, cattle were turned out for grazing on Oct 25, 2015 and the entire field under the pivot was grazed. The producer waited ten days after the frost to avoid the potential of high nitrates, and 100 head of cattle grazed for two weeks. It should be noted that MSU Extension provides rapid-result nitrate tests for producers concerned with

the quality of their grazing forage. This producer did have his hay barley tested and it was below the level of concern (300 ppm). The producer observed that the cows improved their body condition score by 1 point after grazing.

Fig. 3. Overhead view of cover crop at time of clipping, Oct. 1, 2015. Notice dominance of volunteer hay barley. Susan Tallman.

Fig. 4. Worm castings on the soil surface. Oct. 1, 2015. Susan Tallman.

	Seeding Rate lb/ac	Cover Crop Biomass %
Radish	5	21*
Turnip	2	--
Annual ryegrass	12	0
Volunteer barley	--	79
Total	19	100

Fig. 5. Comparison of seeding rate vs actual aboveground biomass percentage
*21% is the combined total biomass of both the radish and turnip.

Irrigated Warm-Season Cover Crops for Grazing, Broadwater County

Susan Tallman, NRCS Bozeman Area Agronomist and Kristin Fletcher, Bozeman Area Cartographer 2015

County: Broadwater, near Winston
Average annual precip: 13-14"
MLRA: 44B, Central Rocky Mountain Valleys
Dominant Soil Type: McC –Martinsdale cobbly loam, 2-9% slopes
Acres: Mixed cover crop – 3 acres; Millet cover crop – 30 acres
Planting Date: Mixed – June 11, 2015; Millet – July 10, 2015
Seeding Rate: Mixed – 12-15 lb/ac; Millet – 15 lb/ac
Seed cost: $91/ac for both crops combined
Seeding Method: No-till drill
Row Spacing: 7"
Previous Crop and Year: alfalfa/grass hay
Herbicides: Pre: glyphosate
Post: glyphosate
Insecticides/Fungicides: none
Fertilizer: none
Irrigation: Overhead sprinkler
Termination Method and Date: Frost kill in late Oct 2015 for both
Next Crop: alfalfa

Fig. 1. Mixed cover crop July 23, 2015. Producer photo.

Monthly Precipitation at Townsend, MT

Roundup	J	F	M	A	M	J	J	A	S	O	N	D	Total
30 yr avg 1981-2001	0.26	0.25	0.49	0.78	1.82	2.24	1.35	1.13	0.89	0.54	0.33	0.30	10.38
2014	0.20	0.68	0.73	0.94	0.23	2.26	1.09	2.50	0.74	0.45	0.75	0.23	10.80
2015	0.29	0.22	0.40	1.15	0.87	1.07	1.46	0.78	1.56	0.77	0.44	0.37	9.38

Fig. 2. Monthly precipitation at Townsend, MT. Western Regional Climate Center, station #248324.

Introduction: This producer operates a black angus cattle operation with 430 acres of irrigated hay. The hay field productivity is in decline and needs renovation. The producer planted two different cover crops in adjacent plots during the renovation phase of the hay ground. One was a predominately warm-season mixed species cover crop on 3 acres, planted mid-June. The other was a single-species millet cover crop on 30 acres, planted a mid-July. Both cover crops frost killed and the producer used both for winter grazing of cattle.

Results: NRCS staff visited the field on Oct. 1, 2015 and took three random clippings of each cover crop. In the mixed cover crop, plants were separated by species in the field. All clippings were oven-dried at MSU. There were 111 and 82 growing days from the time of seeding to the time of clipping of the mixed cover crop and the millet, respectively. There were 2714 and 1906 growing degree days (base 40) during this same period. Total aboveground biomass after drying was 6187 lb/ac, or 3.1 t/ac for the mixed cover crop and 2066 lb/ac, or 1 t/ac for the millet. This converts to 3.4 AUMs/ac for the mixed cover crop and 1.1 AUMs/ac for the millet cover crop. The warm-season grasses were the top performing species in the mixed cover crop, with 76% of the total biomass. Turnip and radish did well in the mix and provided a nice cover in the understory. We did observe peas in the mix, however, they were only 7% of the total biomass, but had been 43% of the seed mix. Cattle were turned in for grazing in the fall and initially preferred the single-species millet. Once they became used to it, they grazed the mixed cover crop just fine. It should be noted that this field can have quite a bit of grazing pressure from elk.

Summary and Discussion: Both cover crops grew very well, with the mixed cover crop having the highest amount of biomass of all four cover crops we clipped in Broadwater County in 2015. We believe that the mixed cover crop out-performed the millet for two reasons. First, sorghum-sudan is known as one of the highest producing cover crops, when conditions are favorable. Secondly, the mixed cover crop had an extra month of growth, or an additional 808 growing degree days. For future interest, it would have been interesting to have compared the early-seeded mixed cover crop with a later seeding of sorghum-sudan. One advantage of the later July seeding is it allows for the harvest of a spring forage crop such as hay barley. Producers wishing to try this technique will need to weigh the tradeoffs of cover crop production with the ability to grow two forage crops in the same season. In addition, sorghum-sudan can

have prussic acid toxicity when grazed immediately after a frost. Producers are cautioned to wait several days after a killing frost before grazing to minimize this danger.

Fig. 3 and 4. Millet (left) and mixed species cover crops (right) at time of clipping, Oct. 1, 2015. Susan Tallman.

	Seed Mix %	Cover Crop biomass %
Sorghum-sudan	25	57
Millet	11	19
Pea	43	7
Turnip	7	10
Radish	7	6
Clover	7	1

Fig. 5. Comparison of planned seed mix percentage vs actual aboveground biomass for the mixed species cover crop.