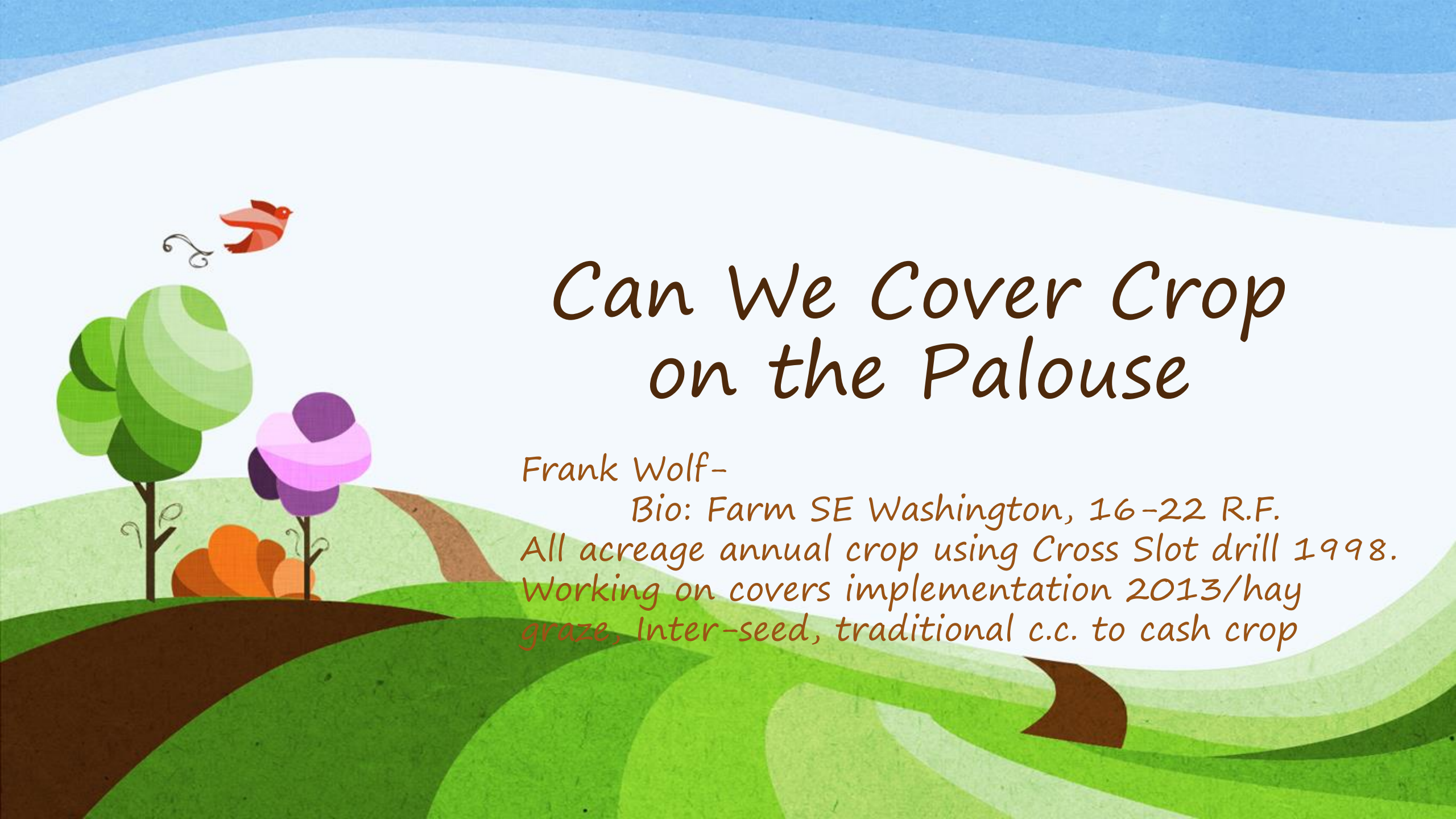


Can We Cover Crop on the Palouse

Frank Wolf-

Bio: Farm SE Washington, 16-22 R.F.

All acreage annual crop using Cross Slot drill 1998.

Working on covers implementation 2013/hay graze, Inter-seed, traditional c.c. to cash crop

Recap '19 and moving on '20-'21

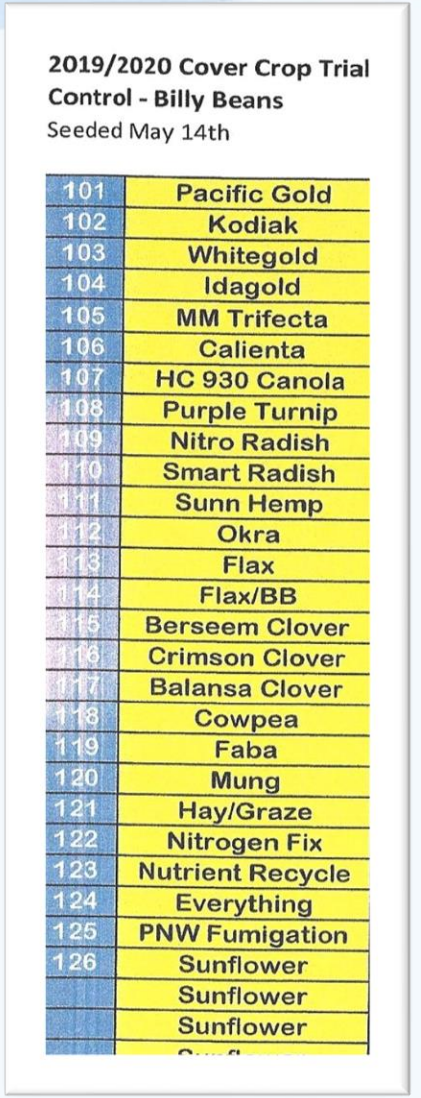
- Find cover that will be successful in promoting the following;
  - Grow either as inter-seeded or between cash crop rotation and show ROI
  - Help stabilize or increase soil pH
  - Nutrient Cycling
  - Feed the Biology
  - Less Use of Synthetic Chemistries (Fert, Pesticides)
- Integrate the cover into our cropping system;
  - Important to maintain income off ALL acreage for our farm model
  - No negative impact cash crop or acreage

Trials and Data Collection

2019-20 Partnered with:

P.N.W. COOP, University of Idaho, Palouse C.D., USDA P.M.C

- Planted 26 different plants/mixes
- Identify each plants impact
  - Establishment, competition, biomass, attractors, soil impact, and affect cash crop



2019/2020 Cover Crop Trial
Control - Billy Beans
Seeded May 14th

101	Pacific Gold
102	Kodiak
103	Whitegold
104	Idagold
105	MM Trifecta
106	Calienta
107	HC 930 Canola
108	Purple Turnip
109	Nitro Radish
110	Smart Radish
111	Sunn Hemp
112	Okra
113	Flax
114	Flax/BB
115	Berseem Clover
116	Crimson Clover
117	Balansa Clover
118	Cowpea
119	Faba
120	Mung
121	Hay/Graze
122	Nitrogen Fix
123	Nutrient Recycle
124	Everything
125	PNW Fumigation
126	Sunflower
	Sunflower
	Sunflower

Some Plot Pictures

Cover Crop Plots

Seeded May 14th

Establishment

Evaluations: June-July

Bio mass, Weed Con. Bloom

Full Bloom right before seed set termination/mow

July 19th

Plot Pics

Termination July 19th

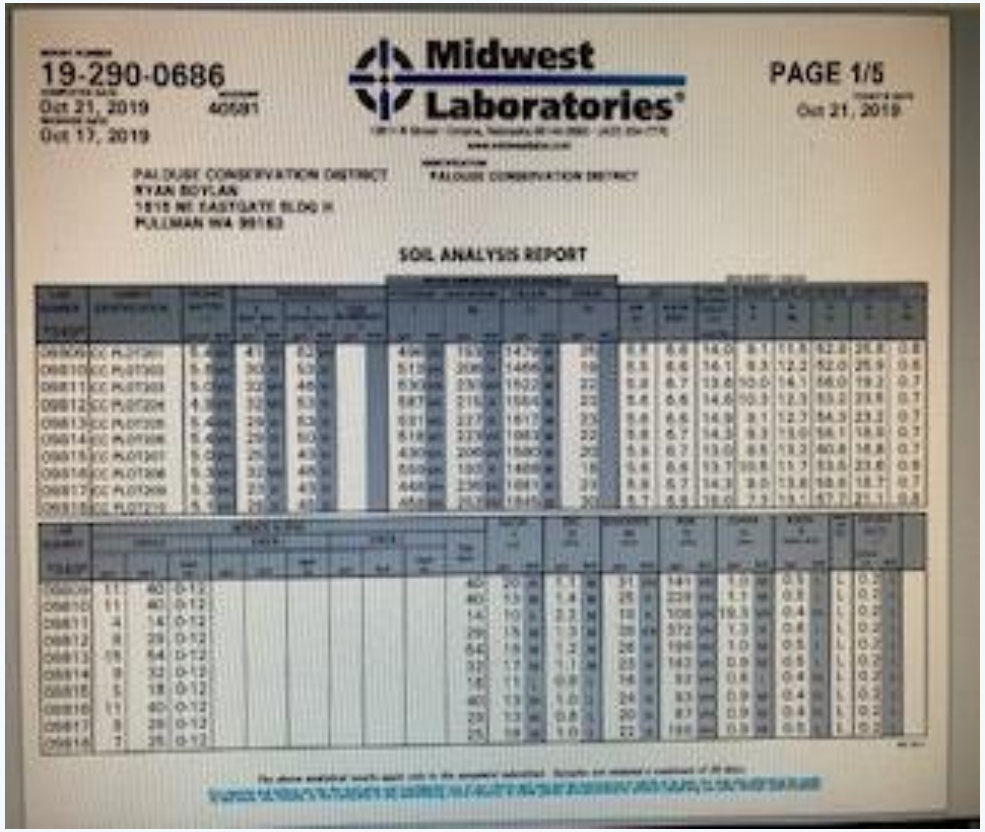
August:

Residue completely dried down with no observable regrowth (Including Weeds)

Seeded all plots Winter Wheat Oct 12th

Results

- Each Plot Evaluated
  - Weed control, Plant Density, Establishment, Bloom Set Date (P.M.C.), Insect/Disease Impact (U. of I.)
- Post Plot Evaluation: (P.C.D. Ryan Boylan)
  - Soil tested for Organic Matter, pH, Nutrient Cycling, Cash Crop Yield Impact (PNW COOP)
  - Develop a mix/es from high ranking plants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Midwest Laboratories
PAGE 1/5
Oct 21, 2019
Oct 17, 2019
PALOUSE CONSERVATION DISTRICT
RYAN BOYLAN
1615 NE EASTGATE BLDG H
PULLMAN WA 99163
SOIL ANALYSIS REPORT

Chart of Data

Rep	Cover Crop	Plants/acre	pH	CEC	POXC	Nitrate OM	Total OM N (lbs)	~~Nitrate Woods E~~ N (lbs)	Kyle N (lbs)	Woods N (lbs)
206	Pacific Gold	12	5.8	14.3	793	5.4	81	32	113	48
212	Kodiak	12	5.6	16.2	731	5	75	29	104	100
223	Whitegold	12	5.8	14.1	782	4.3	64.5	18	83	88
226	Idagold	12	5.7	15.2	730	4.4	66	22	88	98
210	MM Trifecta	12	5.7	16	766	5.1	76.5	25	102	105
202	Calienta	12	5.5	14.1	814	5.6	84	40	124	91
214	HC 930 Canola	12	5.4	15.8	759	5.2	78	32	110	71
203	Purple Turnip	10	5.8	13.6	793	5	75	14	89	103
201	Nitro Radish	8	5.5	14	873	5.4	81	40	121	104
215	Smart Radish	8	5.7	15.7	734	5.3	79.5	32	112	90
205	Sunn Hemp	8	5.6	14.9	793	5.4	81	54	134	130
224	Okra	8 lbs	5.7	13.8	807	4.3	64.5	72	137	122
222	Flax	40	5.8	14	765	4.2	63	18	81	81
225	Nitro Radish	8	5.6	14.4	873	4.7	70.5	14	85	94
204	Berseem Clover	25	5.6	14.6	762	4.9	73.5	29	103	72
221	Crimson Clover	25	5.7	14.8	796	4.8	72	29	99	73
213	Balansa Clover	25	5.7	15.2	738	4.7	70.5	29	100	97
211	Cowpea	5	5.5	15.3	738	4.8	72	40	112	84
209	Faba	5	5.8	14.3	766	5.3	79.5	29	109	56
207	Mung	5	5.9	13	804	5	75	18	93	78
217	Hay/Graze		5.9	14.7	1035	4.8	72	11	83	41
208	Nitrogen Fix		5.6	13.7	783	5.3	79.5	40	120	44
220	Nutrient Recycle		5.6	14.6	827	4.8	72	22	94	66
218	Everything		5.6	15.3	762	4.8	72	40	112	50
216	PNW Fumigation	12	5.4	15.1	662	4.9	73.5	18	92	44
219	Sunflower	1.5	5.5	14.9	789	4.9	73.5	43	117	50
	Sunflower	1.5	6	15.4	803	3.3	49.5	32	82	65
	Billy Beans	4	6	15.9	779	4.2	63	22	85	105
		MEAN:	5.68	14.7	787.8	4.9	72.8	30.1	103.0	80.4
		STDEV:	0.16	0.81	64.66	0.49	7.33	13.19	16.01	24.54

P (lbs)	K (ppm)	S (lbs)	Zn (ppm)	Mn (ppm)	Fe (ppm)	Cu (ppm)	B (ppm)	+/-	Cover Crop	Rep
58	518	34	1.1	23	162	0.9	0.5	1	Pacific Gold	206
60	487	30	1.2	23	217	1.1	0.5	-	Kodiak	212
34	294	20	0.6	15	69	0.9	0.3	-8	Whitegold	223
48	319	32	0.6	18	69	1	0.3	-3	Idagold	226
56	458	36	1	22	186	0.9	0.5	3	MM Trifecta	210
60	513	26	1.4	25	228	1.1	0.5	2	Calienta	202
48	527	40	1.3	29	227	1.1	0.6	2	HC 930 Canola	214
64	530	20	2.2	19	106	19.3	0.4	1	Purple Turnip	203
82	496	40	1.1	31	141	1	0.5	5	Nitro Radish	201
44	480	34	1.1	20	180	0.9	0.5	1	Smart Radish	215
58	531	32	1.2	26	196	1	0.5	6	Sunn Hemp	205
46	300	22	0.9	16	130	0.9	0.4	-2	Okra	224
44	279	20	0.6	15	63	0.9	0.3	-5	Flax	222
56	352	30	0.9	21	159	1	0.4	-1	Nitro Radish	225
64	587	30	1.3	39	372	1.3	0.6	2	Berseem Clover	204
46	319	36	0.6	20	92	0.9	0.3	-1	Crimson Clover	221
64	505	30	1.1	22	155	1	0.5	1	Balansa Clover	213
52	412	28	0.9	23	146	0.9	0.4	-1	Cowpea	211
46	448	26	0.8	20	87	0.9	0.4	-	Faba	209
50	430	22	0.8	16	92	0.8	0.4	-1	Mung	207
46	383	30	0.6	17	65	0.9	0.3	-1	Hay/Graze	217
64	559	26	1	24	83	0.9	0.4	1	Nitrogen Fix	208
50	350	28	1.1	26	145	1	0.4	-	Nutrient Recycle	220
50	439	34	0.8	21	98	0.9	0.4	-1	Everything	218
52	396	40	0.9	27	153	1	0.4	-1	PNW Fumigation	216
56	376	36	0.9	25	106	0.9	0.4	-1	Sunflower	219
42	313	18	0.5	11	46	0.8	0.3	-6	Sunflower	
32	421	16	0.6	13	50	1	0.3	-4	Billy Beans	
52.6	429.4	29.1	1.0	21.7	136.5	1.6	0.4	-0.4		
10.28	89.88	6.85	0.35	5.88	71.05	3.47	0.09	3.19		

STDEV

Soil Test Results

Palouse C.D./Western Laboratories

Cash Crop Results 2020 Harvest

Some plants had up to 12 bu increase over the check

Pulled October, 2019

Entry	Cover Crop	0-100 Fertility Score	0-50 Soil Health Score	Organic Matter	pH	lbs/ac Residual Nitrogen	lbs/ac Residual Phosphate	lbs/ac Residual Sulfur	Total Rotation Benefit	WW Yield Bu/ac
114	Flax/Billy Beans	72	25	5.4	5.5	40	82	40	271	127.5
111	Sun Hemp	76	26	5.4	5.6	54	58	32	257	120.2
112	Okra	72	23	4.3	5.7	72	46	22	245	109.5
126	Sunflower	65	22	4.9	5.5	43	56	36	232	117.6
106	Caliente	69	24	5.6	5.5	40	60	36	230	122.8
105	Mighty Mustard	74	27	5.1	5.7	25	56	36	229	125.2
117	Balance Clover	70	24	4.7	5.7	29	64	30	227	124.6
102	Brown Mustard	71	25	5.0	5.6	29	60	30	226	111.9
122	Nitrogen Fixation blend	61	22	5.3	5.6	40	64	26	224	121.8
115	Bersaem Clover	66	23	4.9	5.6	29	64	30	223	119.6
101	Oriental Mustard	63	23	5.4	5.8	32	58	34	221	121.6
118	Cowpea	68	24	4.8	5.5	40	50	28	220	127.3
107	HC 930 RR	65	22	5.2	5.4	32	48	40	218	124.4
110	Smart Radish	71	25	5.3	5.7	32	44	34	217	127.9
124	Everything blend	61	21	4.8	5.6	40	50	24	216	123.2
108	Turnips	73	26	5.0	5.8	14	64	30	208	119.4
116	Crimson Clover	64	20	4.8	5.7	29	46	36	206	109.7
125	PNW Fumigation blend	61	22	4.9	5.4	18	52	40	203	117.6
109	Nitro Radish	69	23	4.7	5.6	14	56	30	202	118.4
123	Nutrient Recycle blend	66	23	4.8	5.6	22	50	28	199	121.8
104	Idagold Cond. Must	69	22	5.3	6.0	22	42	32	196	115.9
119	Faba Beans	62	21	5.3	5.8	29	46	26	193	115.9
120	Mung Beans	68	24	5.0	5.9	18	50	22	193	118.2
113	Flax	67	23	4.3	5.8	18	44	30	182	114.7
121	Hay/Grass blend	61	22	4.9	5.4	11	46	30	180	90.1
103	White Gold Cond. Must	68	23	4.3	5.8	18	34	20	171	116.8
Check	Billy Beans	68	21	4.2	6.0	22	32	16	169	n/a
	MEAN:	67.4	23.3	4.9	5.6	30.4	53.5	30.1	213.5	118.6
	STDEV:	4.2	1.7	0.5	0.2	13.2	10.3	6.5	23.6	7.5

$65 acre over Check

2020 Winter Wheat Following:		100 Range lbs/120ft2	200 Range lbs/120ft2	300 Range lbs/120ft2	Wheat Yield Bu/Ac	$5.42/bu Gross $$ Per Acre
Entry	Cover Crop					
110	Smart Radish	24.0	20.0	19.3	127.9	$ 693.03
114	Flax/Billy Beans	23.0	20.1	20.0	127.5	$ 690.84
118	Cowpea	23.5	22.0	17.5	127.3	$ 689.75
105	Mighty Mustard	21.7	19.8	20.5	125.2	$ 678.80
117	Balance Clover	20.6	21.1	20.0	124.6	$ 675.52
107	HC 930 RR	22.0	19.9	19.7	124.4	$ 674.42
124	Everything blend	25.2	17.1	18.7	123.2	$ 667.85
106	Caliente	23.1	19.4	18.3	122.8	$ 665.66
123	Nutrient Recycle blend	23.3	19.5	17.5	121.8	$ 660.19
101	Oriental Mustard	21.4	20.0	18.8	121.6	$ 659.09
111	Sun Hemp	21.5	20.5	17.5	120.2	$ 651.43
115	Bersaem Clover	22.2	19.5	17.5	119.6	$ 648.15
108	Turnips	23.0	20.6	15.5	119.4	$ 647.05
122	Nitrogen Fixation blend	21.1	19.7	18.2	119.2	$ 645.96
109	Nitro Radish	23.3	17.8	17.5	118.4	$ 641.58
120	Mung	19.9	18.5	20.1	118.2	$ 640.48
125	PNW Fumigation blend	21.6	18.5	18.1	117.6	$ 637.20
126	Sunflower	23.5	17.3	17.4	117.6	$ 637.20
103	White Gold Cond. Must	21.4	17.6	18.8	116.8	$ 632.82
119	Faba	23.1	19.6	14.7	115.9	$ 628.44
104	Idagold Cond. Must	22.0	18.9	16.5	115.9	$ 628.44
113	Flax	23.0	18.6	15.2	114.7	$ 621.87
102	Brown Mustard	20.7	19.6	15.1	111.9	$ 606.54
116	Crimson Clover	22.7	17.6	14.0	109.7	$ 594.50
112	Okra	24.0	16.2	14.0	109.5	$ 593.40
121	Hay/Grass blend	16.0	14.6	14.0	90.1	$ 488.30
	MEAN:	22.2	19.0	17.5	118.5	$ 642.25
	STDEV:	1.72	1.57	1.99	7.52	$ 40.77

Miscellaneous | Clover | Legume
Small Grains | Brassica

2020

Plot Take Away

- Plots Showed us many things
  - Weed control potential
  - Input/output potential
  - adaptability of potential plants used for cover/alternative crops.
  - Seeding date importance
- Adding soil amendment (O.M., Nutrient)
- 2 application of herbicides 12 month period 24 months between Glyphosate (check 5apps pesticides/6 months between Glyphosate)
- Potential Higher return with following cash crop (up to $65/acre)

WSARE Grant

2020 received a WSARE Grant

Partnered with Palouse Conservation District

Scope of study is to look at:

Establishment techniques for different plant mixes for both inter-seed as well as over winter cover crop mix.

Seeding date/success

Study soil health benefits

Reduce synthetic inputs and monitor progress through a 3 year rotation (Year 1)

Develop a viable cropping rotation with integrated covers

In Field Trials (WSARE)

- Plot Layout (7/1 acre plots)
- 3 Different Mixes
- Collard/Turnip 340,000 seed/acre VS
  - Pea/Sorghum/Radish/Collard/Turnip/Sunflower (1,000,000 seeds/acre goal)
- Seeding Methods
  - Both at planting and after wheat established (No-till Drill)
    - Very good establishment of all plots. Warm season plants didn't show
  - Broadcast after wheat established (June 1st and June 15th)
    - Epic fail. Some small plant clovers/brassica germed and then die due to conditions

Spring 2020

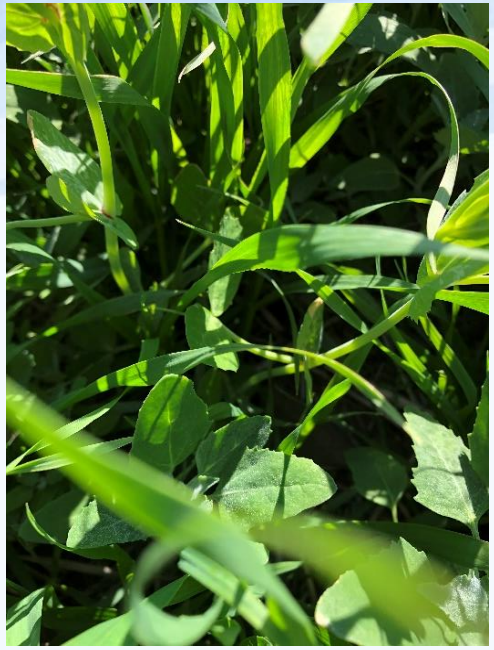
Spring Wheat (WSARE and 8 acre Trial)

- Collards 2.6#
- Turnip 2.7#

(these plants had high weed control in plots)

ROI (8 acre trial):

- Yield Response 8bu???? Increase ($44 Inc. Gross Return)
- Additional cost of $12.47/acre
  - $31 increase over rest of field
  - Need 2-2.5 bu increase to cover cost
  - ????-Plot best ground/check was rest of field hilltops,etc…
  - Will move to full field application to check economics



Take Away and 2021 direction

Take Away:

- Weed Control Advantage- Very Low-increase C.C. seed rate
- To early of termination (42 days to 60ish)
- Change mix to foster C.C. plant response (cool season)
- Eliminate warm season plants

2021 Mix for Sp. Grain:

(at time of seeding)

- Peas 10#
- Turnip 1#
- Radish 2 #
- Kodiak Mustard 1#
- $11.89/acre cost
- 2.0 bu/acre increase need

$5.75 bu

- Full field implementation/capture the data

2021 WSARE

- Currently have planted and over winter C.C. mix
- Will terminate at time of seeding for spring cash crop/cover inter-seed
- More tests/econ to evaluate
- To be cont'd