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Resilient Dryland Farming Alliance, 2020 – 2021 annual report: Alternative crop trial

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Summary

Annual precipitation of only 8 to 16 inches led to large scale adoption of wheat-fallow systems (WF) to recharge moisture for the next year's wheat crop in the eastern Oregon region. While beneficial for water storage, the fallow period is associated with negative impacts on soil erosion and soil carbon as compared to perennial or annual cropping systems. Alternatives to the WF production system are needed to enhance the soil health, resilience, profitability, and sustainability of dryland wheat operations. We conducted research to explore alternative crops to the winter wheat cash crop. This research is also an exploration of cropping intensification in the inland Pacific Northwest. The research was conducted at two locations: an intermediate rainfall site in Umatilla County (16 inches annual precipitation) and a low rainfall site in Morrow County (9 inches annual precipitation). At the intermediate rainfall site, alternative crop treatments replaced the typical fallow period. At the low rainfall location, alternative crop treatments followed a three-year rotation of winter wheat-alternative crops-fallow instead of the typical winter wheat-fallow system. The Resilient Dryland Farming Alliance (RDFA) is the product of a farmer-led initiative. The RDFA is evaluating intensified wheat-based systems to integrate alternative crops in order to reduce the number of fallow periods, enhance soil health, break cycles of disease, decrease fertilizer requirements, and change or reduce herbicide inputs. This report includes preliminary data for the second year of a three-year study. Data showed that winter pea and brown mustard produced the greatest amount of biomass of the alternative crops tested at both sites. Weed biomass was lowest under winter pea treatments at both sites. Brown mustard and flax both had higher yields at the Umatilla County site compared to the Morrow County site. Despite producing higher biomass and considerable yields, residual moisture under brown mustard was similar to fallow moisture in topsoils and was similar to other alternative crops at deeper depths. Due to a historic drought in crop year 2020-2021, biomass produced by many of the alternative crops was lower than expected.

Background: An alternative crop trial was established in two rainfall zones in the inland Pacific Northwest. There were nine treatments with four replications planted in a randomized complete block design. The low rainfall location in Morrow County, Oregon, USA (45.59 N, 119.56 W) receives a 30-year average annual precipitation of 9 inches. Only 6.5 inches of annual precipitation accumulated in the crop year 2020-2021. The moderate rainfall location in Umatilla County, Oregon, USA (45.72 N, 118.62 W) receives a 30-year average annual precipitation of 16 inches, and only 10 inches of annual precipitation accumulated in the crop year 2020-2021. Hereafter in this report research locations will be referred to as the Umatilla County site and the

Morrow County site. The Umatilla County site soil type is Walla Walla silt loam. The Morrow County site soil type is Ritzville silt loam. At the Morrow County site the WF system was intensified with alternative crops to a 2-crop, 3-year rotation as winter wheat-alternative crop-fallow. At the Umatilla County site, the WF rotation was intensified to an annual cropping system as a winter wheat-alternative crop rotation. All sites were managed under no-till conditions. Fall-seeded alternative crop treatments included winter pea cvs. 'USDA Klondike', 'Austrian', and 'Windham', winter lentil cv. 'Morton', and winter barley cv. 'Alba'. Plots were 14 ft × 40 ft and seeded with a Fabro no-till plot drill (Swift Current, Canada) with 12 in spaced hoe-type openers. Fall-seeded alternative crops were planted at the Morrow County site on 16 October 2020 and at the Umatilla County site on 2 November 2020. Spring-seeded alternative crop treatments included brown mustard cv. 'Kodiak', safflower cv. 'Baldy', and flax cv. 'Golden'. Spring seeded alternative crops were planted at the Morrow County site on 9 March 2021 and at the Umatilla County site on 30 March 2021. A chemical fallow treatment served as the experimental control. Glyphosate (Gly Star 5 Extra, 24 fl oz/ac; Albaugh LLC, MO) was applied at both sites to all plots (both spring- and fall-seeded) directly after fall seeding. Spring plots and fallow controls received a second application of glyphosate prior to spring crop emergence. Fall-seeded plots received one application of 24 fl oz/ac Gly Star 5 Extra whereas spring-seeded plots and the fallow controls received a total of 48 fl oz/ac Gly Star 5 Extra in a split application. Fall-seeded legumes received a spring application of 14 fl oz/ac of Assure II (DuPont, DE) and 15.4 fl oz/ac of Basagran 5L (BASF, NC). Fallow controls were hand-weeded as necessary.

The following data were collected from each treatment plot: (i) crop biomass, (ii) crop cover, (iii) weed biomass, (iv) weed cover, and (v) sensor-based soil moisture content to 40 in depth at increments of 4, 8, 12, 16, 24, and 40 in using PR2 profile probes with HH2 moisture reader (Delta-T Devices, Cambridge, UK). Crop biomass and yield of winter-seeded alternative crops was collected at the Morrow County site on 8 July 2021 and at the Umatilla County site on 13 July 2021. Crop biomass and yield of spring-seeded alternative crops were collected at the Morrow County site on 21 July 2021 and at the Umatilla County site on 4 August 2021. Additional details about the overall rationale, long-term vision, and funding for this project can be found in "*Designing Cover and Alternative Crops for Dryland Cropping Systems in Eastern Oregon*" by Singh et al., 2021 (link : https://extension.oregonstate.edu/crop-production/field-crops/designing-cover-alternative-crops-dryland-cropping-systems-eastern).

Plant biomass and weed cover: Alternative crop and weed biomass data are shown in Table 1 for both locations. At the Umatilla County site, Klondike pea and Austrian pea accumulated the greatest biomass while winter lentil, winter barley, and flax accumulated the least biomass. The greatest biomass of downy brome and prickly lettuce was observed in safflower. All pea varieties showed the lowest downy brome biomass compared to other crops at both sites. Among alternative crops at the Morrow County site, brown mustard accumulated the most biomass while winter lentil and safflower accumulated the least biomass. Safflower had the greatest weed

biomass at the Morrow County site. Biomass for all alternative crops was lower than expected due to a record drought year 2020-2021 at both sites.

Table 1: Dry biomass accumulation by alternative crops and dominant weed species at the Umatilla County and Morrow County, Oregon sites.

Alternative Crops	Biomass (lbs/ac)						
	Umatilla County			Morrow County			
	Crop	Downy Brome	Prickly Lettuce	Crop	Downy Brome	Prickly Lettuce	Volunteer Wheat
Klondike pea	2460 a[†]	79 c	67 bc	337 b	59.2 c	3.51 b	38.9 bc
Austrian pea	1888 ab	137 c	274 ab	208 bc	36.1 c	6.74 b	71.6 abc
Windham pea	1644 b	214 c	121 abc	212 bc	40.3 c	28.1 b	86.6 abc
Brown mustard	700 c	671 ab	226 abc	513 a	160 ab	36.4 ab	42.5 bc
Safflower	645 c	950 a	359 a	3 d	179 a	86.6 a	151 a
Flax	467 cd	664 ab	233 abc	63 cd	195 a	50.6 ab	41.9 bc
Winter barley	376 cd	745 a	17 bc	345 b	163 a	2.09 b	104 ab
Winter lentil	244 cd	307 bc	376 a	4.61 d	69.4 bc	14.9 b	163 a
Fallow control[‡]	0 d	0 c	0 c	0 d	0 c	0 b	0 c

[†]Numbers followed by different lowercase letters within a column denote statistically different means based on Least Square Difference (LSD) at $p \leq 0.05$.

[‡]Fallow control was hand-weeded in addition to the herbicide applications.

Weed cover based on visual assessment under all alternative crops is shown in Table 2. At the Umatilla County site, downy brome, volunteer wheat, and prickly lettuce were the most dominant weeds, while downy brome and volunteer wheat were dominant at the Morrow County site. The downy brome cover was highest in winter barley and lowest in Klondike pea at the Umatilla County site. In general, winter pea varieties produced more biomass and had lower downy brome infestation at both sites.

Table 2: Visual assessment of weed cover (%) in alternative crops at the time of termination at the Umatilla County and Morrow County, Oregon sites.

Alternative Crops	Weed cover (%)				
	Umatilla County			Morrow County	
	Downy Brome	Volunteer Wheat	Prickly Lettuce	Downy Brome	Volunteer Wheat
Winter barley	33.7 a[†]	13.20 a	1.06 cd	19.70 a	3.19 abc
Winter lentil	20.1 abcd	3.13 b	7.13 a	11.90 ab	4.38 a
Windham pea	12.3 cdef	1.13 bc	3.00 abcd	10.90 b	3.81 ab
Klondike pea	3.5 ef	0.88 bc	1.81 bcd	10.60 b	1.69 bcde
Safflower	33.3 ab	0.22 c	6.50 ab	9.63 b	1.31 cde
Flax	26.3 abc	0.31 c	4.50 abcd	9.50 b	0.75 de
Brown mustard	18.1 bcde	1.25 bc	5.47 abc	8.75 b	0.69 de
Austrian pea	9.3 def	0.53 c	6.03 abc	5.47 bc	3.03 abcd
Fallow control[‡]	0 f	0 c	0 d	0.50 c	0 e

[†]Numbers followed by different lowercase letters within a column denote statistically different means based on Least Square Difference (LSD) at $p \leq 0.05$.

[‡]Fallow control was hand-weeded in addition to the herbicide applications.

Alternative crop yields: Yields for selected alternative crops are shown in Table 3. Due to the historic drought, crop yields of only six crops at the Umatilla County site and two crops at the Morrow County site were above measurable amounts. Among winter pea varieties, yields followed the trends Klondike pea > Windham pea > Austrian pea. Brown mustard and flax both showed higher yield at the Umatilla County site compared to the Morrow County site.

Table 3: Yield of selected alternative crops at the Umatilla and Morrow County sites.

	Yield (lbs/ac)	
Alternative Crops	Umatilla	Morrow
Brown mustard	101.7	88.1
Flax	62.4	6.13
Klondike pea	899	BD[†]
Windham pea	680	BD
Austrian pea	520	BD
Winter lentil	122	BD
Winter barley	BD	BD
Safflower	BD	BD

[†]BD is below detection

Soil moisture following termination: Soil moisture (%) at each depth following termination of alternative crops is shown in Figure 1 (Umatilla County site) and Figure 2 (Morrow County site). The effects of different alternative crops on soil moisture were evaluated at six distinct depths in the soil profile: 4, 8, 12, 16, 24, and 40 in. Residual moisture varied among alternative crops at both sites. Overall, soil moisture levels were higher at the Umatilla County site than the Morrow County site. The fallow control plots had the greatest residual moisture of all treatments at both sites (Figures 1 and 2). Among alternative crops, there were no differences in residual moisture at 4, 8, and 16 in depths at the Umatilla County site. There were greater soil moisture differences observed among alternative crops at the Morrow County site. At 4 in there were no differences in moisture among the fallow, safflower, and brown mustard. Winter barley consistently showed lower residual moisture at all depths at the Morrow County site (Figure 2). Despite producing higher biomass and considerable yields, the brown mustard showed similar moisture levels to the fallow control at 4 in.

Summary statement:

The data presented here are preliminary and report only the second year of a three-year study. This year was a record drought year - therefore the results likely vary from a normal rainfall year. Finalized data and observations will be released in the future as peer-reviewed studies, reports, and extension articles.

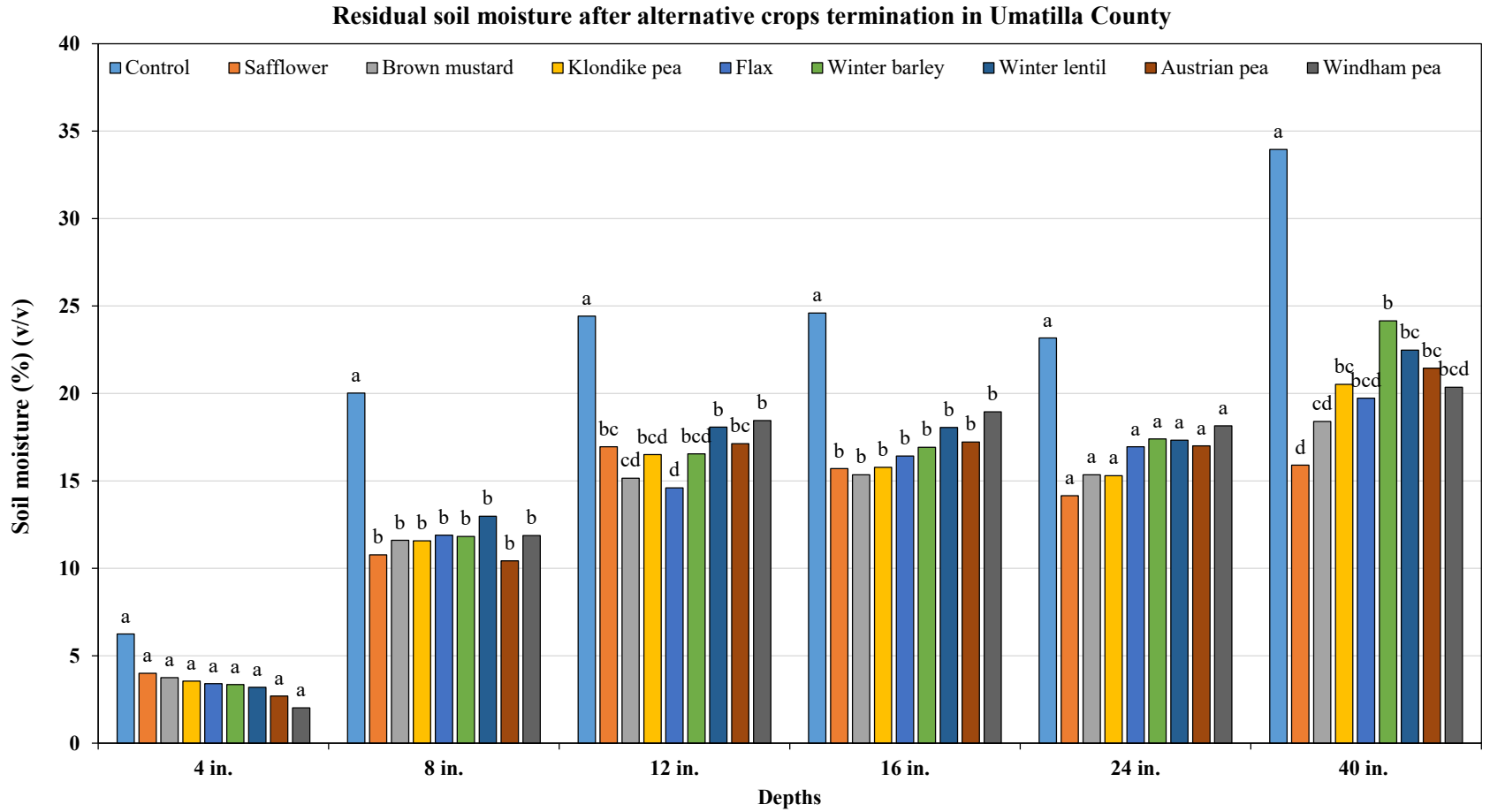

Figure 1: Residual soil moisture at different depths after alternative crop termination in Umatilla County, Oregon, USA. Different letters denote statistically different means within each depth based on Least Significant Difference (LSD) at $p \leq 0.05$. The control is chemical fallow.

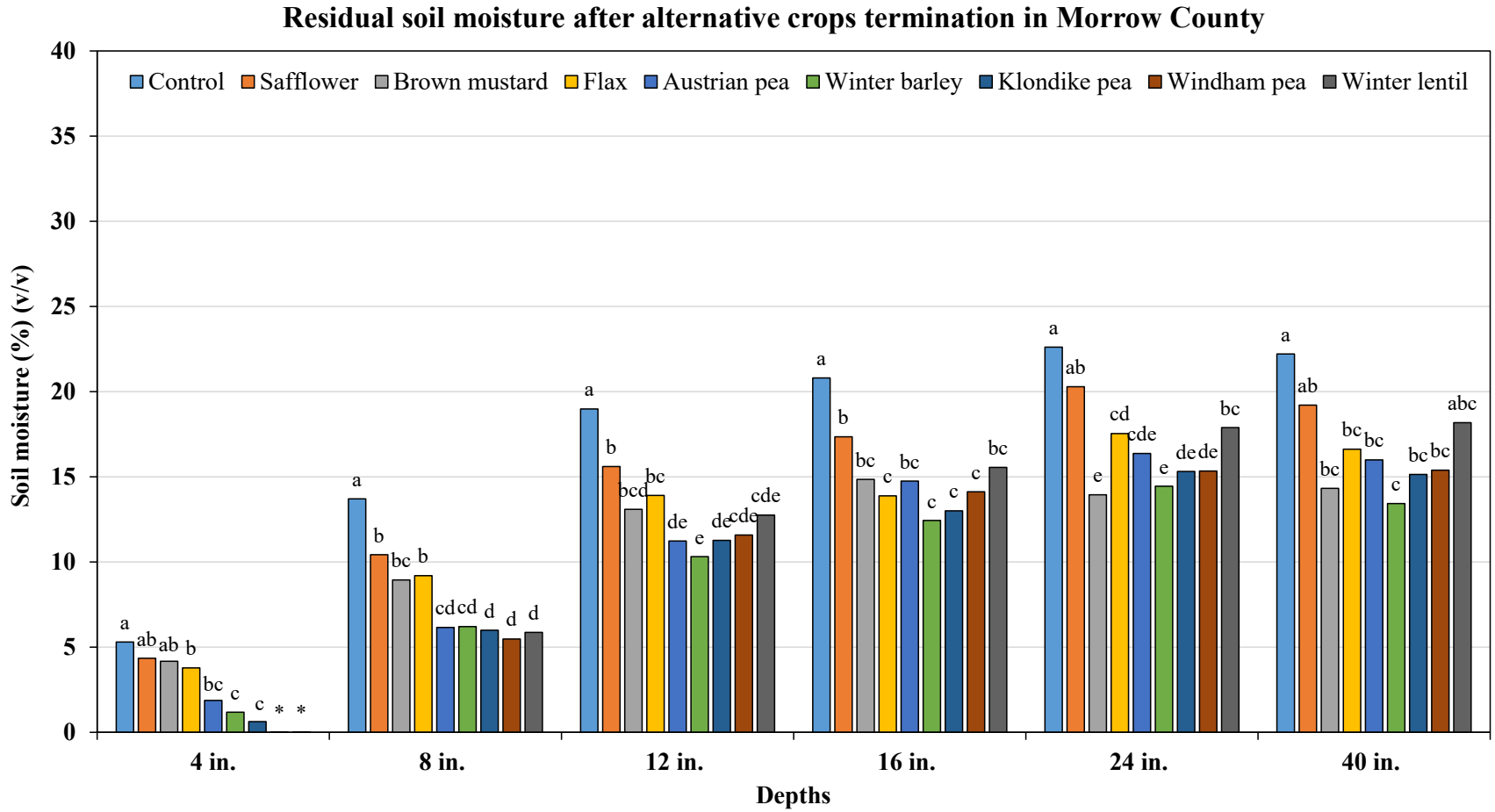

Figure 2: Residual soil moisture at different depths after alternative crop termination in Morrow County, Oregon, USA. Different letters denote statistically different means within each depth based on Least Significant Difference (LSD) at $p \leq 0.05$. The control is chemical fallow.

*Moisture levels below sensor detection limits