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Intensified Dryland Cropping Systems for Southern Montana

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Abstract

This study evaluated the impact of various crop sequences on the overall agronomic and economic viability of various crop sequences as compared to a traditional winter wheat/fallow. The design is a randomized complete block, with four replications. There are eight different crop sequences including winter wheat/fallow as the standard dryland rotation for the region (See Table 1). All phases of each crop sequence were present each year. The fourth full year of this study (2012) was just completed.

Growing conditions for the years 2009-2011 all had above average precipitation compared to the long-term norm for southern Montana. Precipitation for 2012 was below average (Table 2). Comparing yields following different previous crops, winter wheat yields were greatest following a lentil cover crop, but these yields were not significantly different when following fallow. When winter wheat was in a continuous crop system, grain yields were significantly reduced by about 20%.

Soil water use of spring crops such as lentil and spring pea was less than winter or spring wheat. Soil water use by camelina was similar to that of spring wheat. Adequate weed control can be achieved in all rotations except camelina where no broadleaf herbicides are registered. Economic analysis showed an advantage to continuous crop production for specific rotations. For example a winter wheat/spring wheat/lentil rotation improved net return by approximately 13% over wheat/fallow, when averaged over three years. As a general rule rotations that had winter wheat equal to or greater than 50% of the time were generally economically feasible. When the occurrence of winter wheat in the rotation dropped below 50%, the economics of the alternate crop rotation were less favorable.

Introduction

The traditional cropping system for dryland production in SC Montana is a winter wheat/fallow rotation. Rainfall in the region is 338 mm per year with the majority coming in May-June. A wheat-fallow system works, but is not the most efficient use of resources for a dryland cropping system. Additionally the extended 14 month fallow period leads to declines in soil organic matter and to a loss of productivity when viewed over a period of decades. This mono-crop system lacks diversity which provides a window of opportunity for the survival and increase of weed populations, diseases, and insect pressure. The number one weed control problem in the wheat/fallow system is typically cheatgrass, a grass weed that has a life-cycle that nearly matches that of winter wheat. Breeders have done an excellent job in improving varietal resistance to many plant diseases such as crown and root rots, and fungal diseases such as tan spot, stripe rust, and scab. But the potential for disease is always present in a wheat/fallow system primarily because these organisms remain alive and viable on crop residue and are ready to continue their life-cycle when a new crop of wheat emerges and if moisture conditions are favorable for development.

The way to break disease and weed pest cycles is to change the crop to a species that is not a host to these diseases, or to crops that are tolerant of herbicides that have high activity on weed species similar to wheat. This fact is fairly obvious to most producers and researchers but because of economics, traditions, and the lack of markets for alternative crops, wheat/fallow practices still predominate in dryland production. It takes a concerted effort to branch out into new ways of managing dryland systems and involves significant financial risk to do so.

This study was designed to quantify the risks inherent to diversified cropping in dryland systems and to attempt to find some general guidelines to those who are thinking of, or have already started to diversify their operations.

Methodology

Most field operations are performed using field scale equipment on large plots. Plots are approximately 10m by 30m to make certain residues from previous crops remain on the plots over winter, and to reduce edge effects common with small plot research. A small plot combine is used for one pass to estimate yield and grain quality. All plots are cleaned up using a conventional combine. The following lists contain finer details of the study.

Study Design

- No-till dryland field
- Replicated 4 times (Randomized complete block)
- Soil Type: Lohmiller silty clay grading to a Thurlow clay loam
- Varieties selected have varied by years for management but have generally been:
  - Yellowstone winter wheat
  - Vida spring wheat
  - Mozart yellow pea
  - CDC Redberry lentil for grain and Indian head lentil for cover crop
- For crop establishment and harvest the equipment used is:
  - John Deere No-till Drill (JD-752)
  - Custom field plot sprayer
  - IH 1680 combine with straw chopper & chaff spreader
  - Fertilizer management as per MSU guidelines

Economics

The economics presented in this poster are only primary input costs and commodity prices. A full economic analysis is planned. The following sources were used for these prices to place these values in line with those experienced by producers.

- Herbicide costs: North Dakota State University Weed Guide
- Seed costs: Local prices, Billings, MT
- Crop prices: (Average price of Aug-Oct each year)
  - Wheat…USDA AMS, PNW
  - Lentils…USDA AMS
  - Camelina…Contract price with Sustainable Oils
  - Barley…Local feed price

Rotation 8

Results

Table 1. Crop sequence matrix.

Trt	Year 1	Year 2	Year 3	Year 4
1	Winter wheat	Fallow		
2	Winter wheat	Spring wheat	Fallow	
3	Winter wheat	Spring pea	Fallow	
4	Spring Pea	Winter wheat	Fallow	
5	Winter wheat	Spring wheat	Lentil cover crop	
6	Winter wheat	Spring wheat	Spring Pea (or Lentil)	
7	Winter wheat	Spring wheat	Camelina	
8	Winter wheat	Lentil	Spring wheat	Camelina

Fig 1. Crop strips nearing harvest in 2009, Huntley, MT.

Table 3. Yields (Mg ha^{-1}) for each crop averaged across treatments, 2009-2012 Huntley, MT.

Crop	2009	2010	2011	2012	Mean
Winter wheat	5.1	5.5	5.2	2.6	4.6
Spring wheat	3.2	3.4	2.6	0.8	2.5
Spring pea	2.7	3.6	1.1	1.1	2.1
Lentil cover	2.5	3.3	2.6	1.7	2.5
Lentil grain	--	--	0.9	0.3	0.6
Feed barley	--	2.7	1.2	--	2.0
Camelina	0.9	1.2	0.9	0.5	0.9

Table 2. Annual Precipitation (mm), Huntley, MT

Year	Precip (mm)	% of LT avg	GDD_{50}
2009	427	126	1874
2010	411	122	2212
2011	491	145	2263
2012	213	63	2175

Table 4. Sequence effect on crop yields (Mg ha^{-1}), 2009-2012 Huntley, MT

Crop	Previous	2009	2010	2011	2012	Mean
Winter wheat	Fallow	6.2	6.1	5.6	4.2	5.5
	Lentil Cover	5.4	6.3	5.6	3.5	5.2
	Spring Pea	4.4	5.4	4.6	1.3	3.9
	Camelina	4.0	4.6	4.6	1.0	3.6
Spring pea	Fallow	2.9	4.4	1.3	1.6	2.6
	Winter wheat	2.6	3.2	1.1	0.6	1.9
	Barley	2.5	3.4	1.0	--	2.3
Camelina	Spring pea	0.8	1.3	0.9	0.6	0.9
	Spring wheat	0.9	1.1	0.8	0.4	0.8

Table 5. Net Annualized Income ($ ha^{-1}) of various crop sequences, 2009-2012, Huntley MT

Trt	Sequence	2009	2010	2011	2012	mean	CV
1	ww/F	$ 361 a	$ 539 ab	$ 623 a	$ 537 a	$ 514 a	21.4
2	ww/sw/F	$ 323 a	$ 601 a	$ 631 a	$ 348 b	$ 499 a	34.2
3	ww/p/F	$ 345 a	$ 488 b	$ 444 b	$ 389 b	$ 408 ab	15.0
4	p/ww/F	$ 249 b	$ 499 b	$ 372 b	$ 101 c	$ 304 bc	22.8
5	ww/sw/Lcv	$ 330 a	$ 576 ab	$ 625 a	$ 264 b	$ 420 ab	39.8
6	ww/sw/L	$ 352 a	$ 609 a	$ 700 a	$ 31 c	$ 429 ab	70.9
7	ww/sw/C	$ 233 bc	$ 548 ab	$ 640 a	$ 70 c	$ 382 abc	71.5
8*	ww/L/sw/C	$ 211 c	$ 387 c	$ 271 c	$ 73 c	$ 240 c	55.6

Different letters within a column indicate significant difference at 5% probability level.
Abbreviations used : ww▷winter wheat; sw▷spring wheat; p▷spring pea; L▷lentil; C▷camelina; cv▷cover crop
*Treatment 8 has been altered over the course of this study so averaged results are questionable.

Discussion

In the semi-arid west, water is everything. Conclusions drawn after the first three years of this study when precipitation was greater than the norm were brought into question with the addition of 2012 where precipitation was just 63% of the norm. Rotation (R)4 and R8 were consistently less profitable than wheat/fallow. Comparing R3 and R4 where the position of fallow in the rotation is the only difference, it is apparent that wheat with it's deeper rooting system benefits more from fallow than does pea. In dry years the difference is stark, but in wet years R3 consistently out-perfoms R4. The result is a substantial reduction in annualized income over the years for R3. For R8, the presence of low profitable crops of camelina (and barley in 2010 and 2011) reduced net returns making this rotation questionable for long-term profitability.

Acknowledgement

Thanks to Montana Wheat and Barley Committee for partial funding of this project, to Dr. Ken Kephart, Superintendent of SARC, for his support and freedom to pursue our own research direction. And thanks to Tom Fischer, farm foreman at SARC for logistics and entertainment.