Short-term Crop Production and Economic Returns for Biofeedstock Removal under Dryland Cropping

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Introduction

While substantial quantities of crop residues are produced in cropping systems in the semi-arid plains, limited data are available on crop productivity and economic effects of harvesting these materials for biofeedstocks or livestock feed.

A Bioenergy Cropping Systems (BCS) study was initiated in fall 2008 to investigate removal effects on crop production, environmental outcomes (see Poster 2739 for soil responses), and economic returns.

Methods

Site and Treatment Description

The field study site is at the USDA-ARS Northern Great Plains Research Laboratory, Mandan, ND (46.773° N, 100.904° W, elevation 591 m) . Mean annual precipitation (30 yr) at the site is 456mm, and average monthly temperatures range from -10.7 °C in January to 21.4 °C in July. Soils at the site are classified as Temvik-Wilton silt loams (Fine-silty, mixed, superactive, frigid Typic and Pachic Haplustolls).

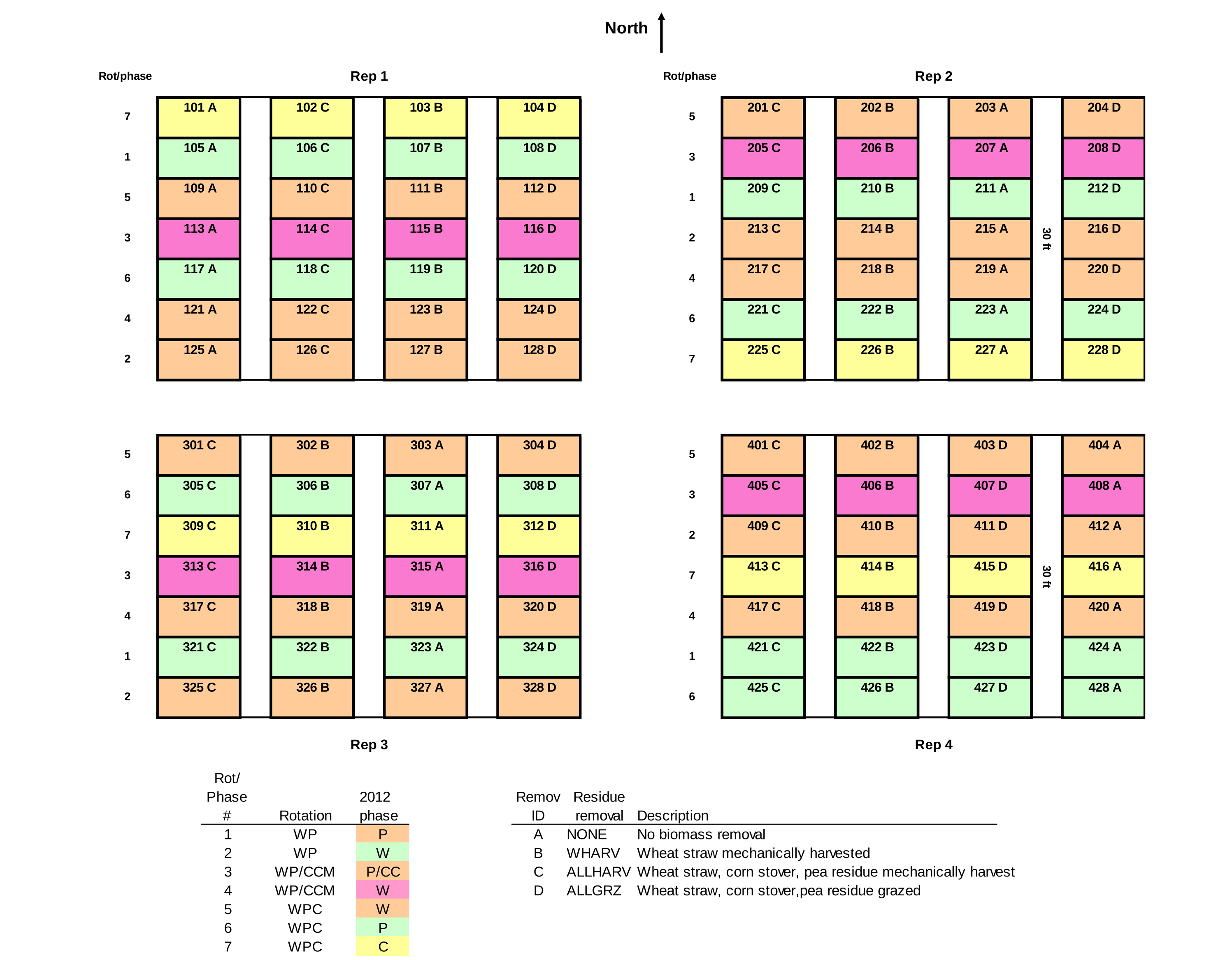
Plots (15 m wide by 30 m long) were established in a strip-plot randomized complete block design with four replicates. Crop rotation treatments include spring wheat (*Triticum aestivum* L.)-dry pea(*Pisum sativum* L.), **WP**; spring-wheat-dry pea/cover crop mix, **WP/CCM**; spring wheat-dry pea-corn (*Zea mays* L.), **WPC**. Each crop is present each year. Cover crops include a 7-species mix of purple top turnip (*Brassica rapa var. rapa* L.), proso millet (*Panicum miliaceum* L.) , soybean [*Glycine max* (L.) Merr.], Arvika pea, sunflower (*Helianthus annuus* L.), triticale (× *Triticosecale* Wittm. ex A. Camus), and canola (*Brassica napus* L.) planted after pea harvest. Biomass removal treatments included no biomass removal, **NONE**; harvest and remove wheat straw, **WHARV**; harvest and remove residues from each crop, **ALLHARV**; and graze all crop residues, **ALLGRZ**.

All treatments were managed using a no-till system. Fertilizer was applied to the plots before planting following NDSU Extension recommendations and based on soil samples taken the previous fall (60 cm depth). Grain yields were measured from a central 1.5 m wide strip within each plot using a plot combine. Biomass was harvested by turning off the combine straw spreader to deposit the residue in a windrow. The windrow was baled, and all bales from each plot were weighed to determine yield. Grazing use was measured by the number of cows grazing in each plot and the amount of time each plot was grazed.

Economic and Statistical Analysis

Enterprise budgets were constructed based on the measured grain and biomass yields and recorded input use. Input prices were actual prices paid to local suppliers. Machinery costs were calculated using an engineering approach and 2012 values (Lazarus, 2012). Crop prices for corn and spring wheat were actual prices received. Pea prices were from local elevator quotes for feed quality peas. Break-even prices were calculated for harvested and grazed biomass relative to the grain only treatment for each rotation and overall breakeven prices were calculated relative to the grain only treatment with the highest net return. No biomass transportation or storage costs were included in the breakeven calculations. Statistical analyses were conducted using SAS PROC MIXED with year and replication as random effects. Multiple comparison tests for differences among treatment means were identified using the Tukey-Kramer adjustment and a significance level of 5%.

Bioenergy Cropping Systems Study: USDA-ARS Mandan, ND



Cows grazing cover crop treatment.

Baling wheat straw.

References

Lazarus, W.F. 2012. Machinery Cost Estimates. U. of MN. Extension. St. Paul, MN.

Acknowledgements

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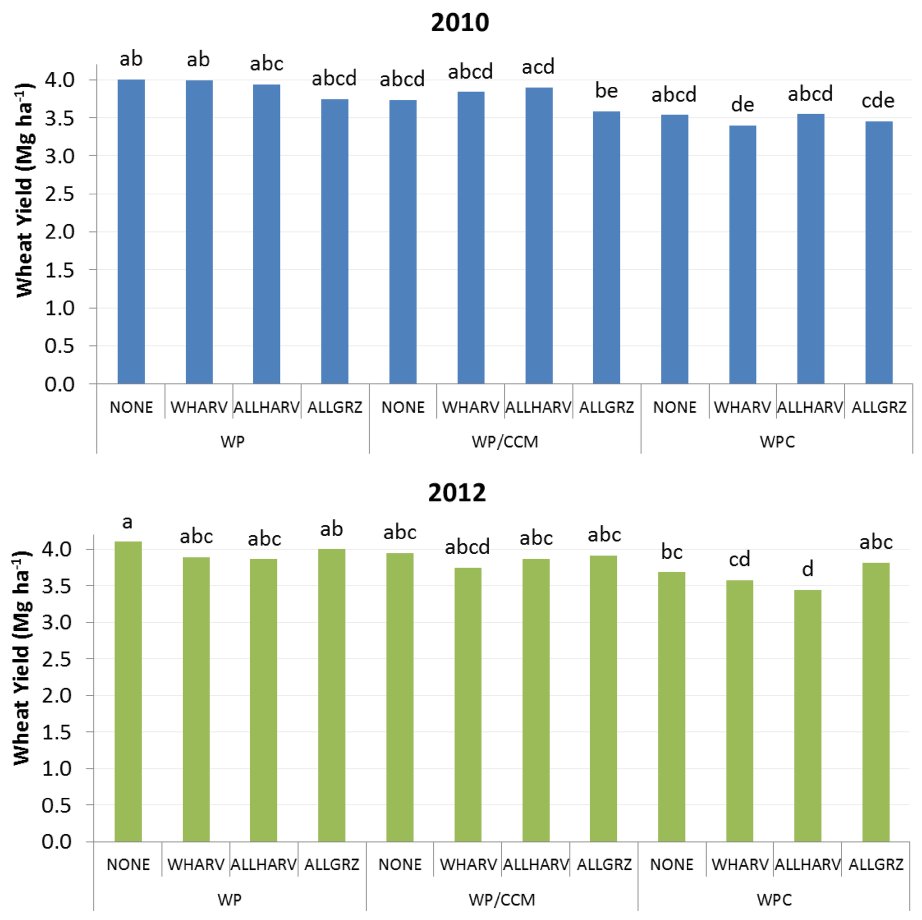
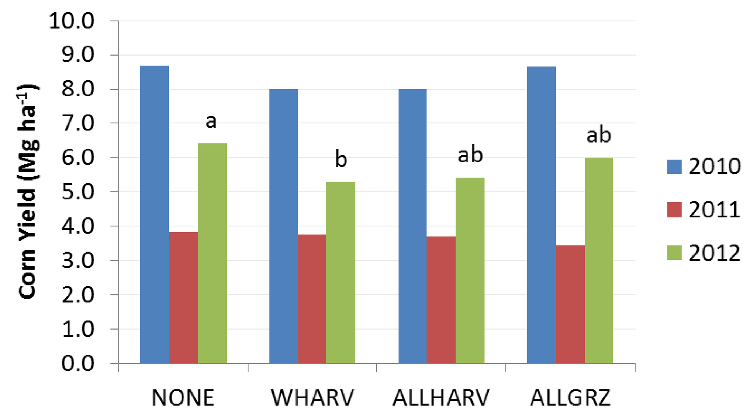
Results and Discussion

Treatment Effect on Crop Yield

	Pea 2010	Pea 2011	Pea 2012	Wheat 2010	Wheat 2011	Wheat 2012	Corn 2010	Corn 2011	Corn 2012
Removal	0.68	0.18	0.71	**0.05**	0.42	**<0.01**	0.07	0.70	**0.03**
Rotation	0.52	**0.02**	0.46	**0.02**	0.06	**0.02**			
Rem x Rot	0.44	**<0.01**	0.41	**0.01**	**0.01**	**0.04**			





Grain Yield

- All grain yields were relatively low in 2011 due to extreme wet conditions
- Wheat yields were lower in the WPC rotation than in the WP rotation in 2010 and 2012.
- There were significant Removal x Rotation interactions on wheat yield each year. Effects varied from year to year with reductions associated with grazing for WP/CCM or WPC and residue harvest for WPC in 2010 and with residue harvest for WPC in 2012. This provides some indication that short-term effects of residue harvest may be greater in more intensive rotations.
- Corn yield was reduced where wheat straw had been harvested (WHARV) compared to no biomass removal (NONE) in 2012

Average annual (2010-2012) grain net returns, bale yields, grazing use, and breakeven prices for each rotation and removal treatment. Grain net return includes income from grain produced and costs for all production activities including biomass harvest.

Rotation	Removal	Grain Net Return	Bale Yield	Grazing	Breakeven within Rotation		Overall Breakeven	
		$ ha^{-1}	Mg ha^{-1}	cow-day ha^{-1}	$ Mg^{-1}	$ cow-day^{-1}	$ Mg^{-1}	$ cow-day^{-1}
WP	NONE	287						
	WHARV	263	0.8		31		231	
	ALLHARV	226	1.5		41		144	
	ALLGRZ	264		84		0.27		2.09
WP/CCM	NONE	243						
	WHARV	201	0.8		53		303	
	ALLHARV	183	1.5		39		168	
	ALLGRZ	211		98		0.33		2.33
WPC	NONE	440						
	WHARV	367	0.3		209		209	
	ALLHARV	338	1.6		65		65	
	ALLGRZ	408		111		0.28		0.28

Bale and Grazing Yield

- For WHARV average annual bale yields were 0.3 Mg ha^{-1} in WPC and 0.8 Mg ha^{-1} in WP and WP/CCM, reflecting more frequent harvest in the two-year rotations.
- Average annual bale yields were 1.5-1.6 Mg ha^{-1} for ALLHARV, with no rotational differences

Economics

- Highest average grain net returns were observed for the WPC rotation. Largely due to the relatively high profitability of corn production, and because peas were priced at feed value, reflecting their actual use. It is possible that the peas could have been sold on the edible market in 2010 and 2012 making the other rotations more competitive with WPC
- Breakeven prices within rotation were lowest for WHARV in the WP rotation. Grazing breakeven prices ranged from $0.27-0.33 per cow-day.
- Overall breakeven prices were generally high, reflecting the relative high profitability of the WPC compared to the other rotations and the short-term negative effect of biomass harvest on corn and wheat yield in this rotation. Grazing crop residues typically did not have this negative effect, so overall grazing breakeven was relatively low in WPC.