SARE Integrated Crop and Livestock Systems Study: Crop Yields and Fertilizer Application

Douglas Landblom[1], Songül Şentürklü [1,2] and Larry Cihaeck[3]

[1]Dickinson Research Extension Center, North Dakota State University, Dickinson, ND
[2]Department of Animal Science, Çanakkale Onsekiz Mart University, Çanakkale, Turkey
[3]Associate Professor of Soil Science, NDSU School of Natural Resource Sciences, Fargo, ND

Project Brief:

The integrated crop and livestock systems (ICL) studied during the last 4-years includes two crops grown as cash crops (spring wheat and sunflower) and 3 forage crops that are grown for grazing (cover crop, corn, and field pea-barley intercrop). Corn and field pea-barley are grazed by yearling steers and the cover crop is grazed by cows after weaning in the fall. Wheat, oilseed, and forage yields for 2011-2014 and the 4-year averages are shown in Table 1. The 5-year crop rotation is as follows: spring wheat, double crop of triticale-hairy vetch followed by cover crop, corn, field pea-barley intercrop, and sunflower

Soil samples have been taken each fall and analyzed by the NDSU Soil Testing Laboratory, Fargo, ND. The amount of N-P-K-Cl to apply/ac to each 4.3 ac field was based on the laboratory recommendation for 50 bu/ac spring wheat, 1,500 lb/ac sunflower, 3.0 T/ac field pea-barley forage, and 80 bu/ac corn (4.0 T/ac forage (DM)).

Continuous spring wheat control (SPW-C) yield has averaged 43.7 bu/ac and spring wheat grown in the rotation (SPW-R) has averaged 40.6 bu/ac. There has been no difference in test weight (60.0 lb/bu), but the protein percent for SPW-R averaged 0.9 % lower than the control. In Table 2, fertilizer applications for the SPW-C were higher in 2011-2013 and were instrumental in the higher grain protein content. Grain, oilseed, and forage yields were low the first year of the study (2011) due to limited precipitation. However, subsequent years 2012-2014 have had precipitation that has been adequate to above average. Above average precipitation in 2014 delayed planting, which was followed by early frost on September 8. These two events severely impacted oilseed and forage yields, but spring wheat was less affected. Corn grain yield was variable over the 4-year period ranging from a low of 15 bu/ac to 87.9 bu/ac in 2013. Corn forage for grazing followed the same growth pattern ranging from a low of 1.65 T/ac dry matter (DM) to 4.01 T/ac in 2013. The 2014 corn crop was impacted by delayed planting due to early spring precipitation and the early killing frost. Grain yield was below the 4-year average, but the forage yield was slightly above the 4-year average.

Nitrogen fertilizer recommendations for sunflower in the rotation have been relatively low and variable ranging from a low of zero in 2013 to a high of 46 lb/ac in 2014. Figure 1 shows the cropping system's nitrate-N (NO_3-N) from June through October 2014 for the triticale-hairy vetch hay and cover crop (T-HV-CC) portion of the rotation. This curve illustrates the uptake of N by the triticale-hairy vetch crop up to haying where it is the lowest. After haying, the soil N increases due to N mineralization from organic matter. However, soil N again declines under the cover crop until the end of the season because of the uptake and storage of N in the crop. Figure 1 shows the ending cover crop N value and Figure 2 shows end of season N values for each of the crop components. The ending cover crop N value was 7 lb/ac (Fig. 1), ending soil organic matter (SOM) content was 3.9%, and the NDSU Soils Lab 2015 recommended amount of N to apply per acre for corn was 17 lb/ac (Table 2). The small N recommendation for corn can be explained by the fact that N is sequestered and protected from denitrification and leaching until the next growing season and should be available for the subsequent corn crop.

Table 1. SARE crop rotation yields for grain, oilseed, forage, and cover crop (2011-2014)

Crop	Units	2011	2012	2013	2014	Avg[b]
Spring Wheat – Control	Bu/Ac	28.0	55.7	46.8	44.2	43.7
Protein Content	%	13.4	15.0	14.5	13.7	14.2
Test Weight	Lb	59.3	58.3	60.4	62.1	60.0
Spring Wheat – Rotation	Bu/Ac	30.1	45.1	39.2	47.9	40.6
Protein Content	%	13.7	13.4	13.2	13.0	13.3
Test Weight	Lb	58.8	59.5	60.2	61.9	60.0
Sunflower (oilseed type)	Lb/Ac	891	1590	1959	1060	1375
Percent oil Content	%	-	37.3	37.6	40.4	38.4[c]
Corn Grain (90 Day forage type)	Bu/Ac	15.0	55.2	87.9	45	50.8
Corn Forage (Dry Matter (DM))	T/Ac	1.65	3.66	4.01	3.5	3.35
Triticale – Hairy Vetch Hay	T/Ac	2.71	1.59	0.00[a]	0.66	1.65[c]
Pea Grain	Bu/Ac	19.1	-			19.1
Pea-Barley Forage (DM)	T/Ac	-	3.11	4.53	3.75	3.80[c]
Cover Crop: (Sept.)	T/Ac	-	4.25	3.25	0.62	2.71

[a] Triticale winter killed. No hay harvested. Cover crop planted late June 2013. [b] 4-year average. [c] 3-year average.

Table 2. Fertilizer application for 2011-2015

CROPS	lb/Ac[a]				
	2011	2012	2013	2014	2015
Spring Wheat – Control					
N	58	77	70	0	0
P	5	15	0	0	0
Cl	0	0	45	30	30
Spring Wheat – Rotation					
N	42	11	0	0	0
P	0	0	0	0	0
Cl	0	48	43	15	30
Corn					
N	13	13	60	88	17
P	0	0	0	0	0
Cl	0	0	0	0	0
Field Pea-Barley					
N	0	0	0	0	0
P	0	0	0	0	0
Cl	0	0	42	43	0
Sunflower					
N	23	7	0	46	0
P	13	0	0	0	0
Cl	0	0	0	0	30
Triticale-Hairy Vetch (Sept Application)					
N	12	12	12	12	12
P	40	40	40	40	40
S	10	10	10	10	10
Z	1	1	1	1	1

[a] Zero value indicates that no nutrient was recommended. K is not reported here because these soils have high soil test values and additional K fertilizer was not needed.

Figure 1. 2014 Cropping System Nitrate-N (NO_3-N).

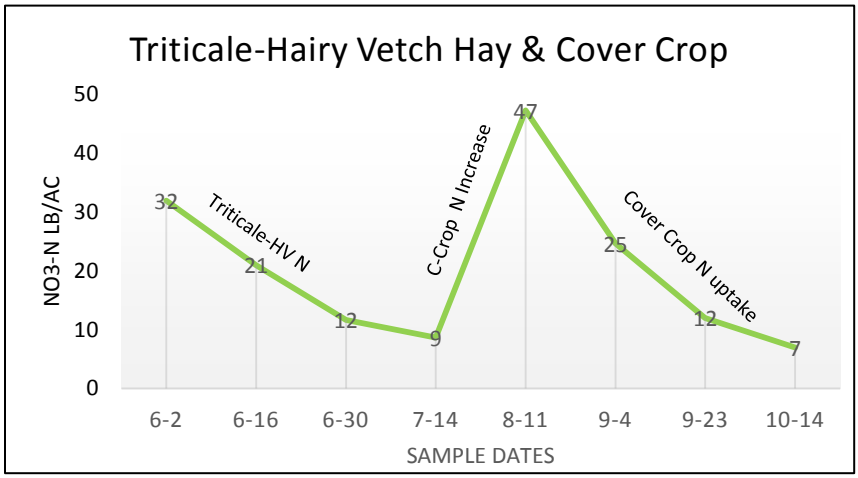

Figure Labels: **T-HV-CC** Double Crop – Triticale Hairy vetch hay harvest in the spring and cover crop seeded mid-late June

Figure 2. End of season soil nitrate (NO_3-N) values for each crop component.