Evaluation of Sensor-Based Technologies and Nitrogen Sources for Improved Recommendations for Dryland and Irrigated Spring Wheat Production in Montana

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JUSTIFICATION

- ✓In general, N fertilizer rates for cereal crops in Montana are determined as following: NR = YP x 2.5-3.0, (NR=N fertilizer rate (lbs/a), YP=yield potential (bu/a)
- ✓When wheat yield potential (YP) is higher-than-average, early-season N application may not be adequate for sufficient protein accumulation
- ✓Traditional yield goal approach does not account for temporal of spatial variability

SENSOR-BASED TECHNOLOGY

- ✓Quantitatively measures vegetation indices such as the Normalized Difference Vegetation Index (NDVI)
- ✓A non-destructive methodology developed for precise estimation of crop's YP mid-season
- ✓Utilize spectral measurements which are used to develop an algorithm for mid-season topdress N fertilization
- ✓Allow to accurately access the crop's nutrient status and account for spatial and temporal variability
- ✓Enable fertilization based on crop need/yield potential
- ✓adjusting fertilizer application rates according to site-specific conditions
- ✓Result = more efficient, profitable, and sustainable crop production

MATERIALS AND METHODS

- ✓5 site-years: 2011 - WTARC (dryland), WARC - irrigated
- ✓Choteau spring wheat variety
- ✓4 preplant N rates (22, 45, 67, and 90 kg N ac^{-1})
- ✓2 topdress N fertilizer sources (granular – urea, 46-0-0, and liquid – urea ammonium nitrate (UAN), 28-0-0)
- ✓1 unfertilized check and 1 non-limiting N-Rich plots(246 kg N ac^{-1} preplant) per replication
- ✓ Topdress N fertilizer rate determined using NDVI obtained using GreenSeeker and Pocket Sensor at Feekes 5 growth stage

OBJECTIVES

- ✓To evaluate two sensors (GreenSeeker and Pocket Sensor) for developing NDVI-based topdress fertilizer N recommendations in spring wheat in Montana
- ✓To determine whether sensor-based recommendations have to be adjusted depending on what N fertilizer source (liquid UAN, or granular urea) is used

Collecting Pocket Sensor NDVI readings

RESULTS and DISCUSSION

Table 1. Treatment structure and spring wheat grain yields.

Trt	Preplant N Fertilizer Rate, kg N ha^{-1}*	Topdress N Fertilizer Source**	Spring wheat grain yield, $kgha^{-1}$ 2011 WTARC	2011 WARC	2012 WTARC	2012 WARC	2012 MARTIN
1	0	-	928 (f)	2041 (f)	5861 (d)	4572 (e)	2910 (c)
2	247	urea	2663 (a)	3735 (abc)	6198 (d)	6500 (d)	3164 (bc)
3	22	urea	1533 (e)	2787 (d)	6690 (c)	6713 (cd)	3386 (ab)
4	45	urea	1555 (e)	3428 (bc)	6988 (abc)	6914 (bcd)	3330 (abc)
5	67	urea	1861 (cd)	3867 (abc)	7078 (abc)	7451 (ab)	3430 (abc)
6	90	urea	2156 (b)	3985 (a)	7286 (a)	6849 (bcd)	3613 (a)
7	22	UAN	1454 (e)	3256 (cd)	6664 (c)	7244 (abc)	3377 (abc)
8	45	UAN	1641(de)	3512 (abc)	6725 (bc)	7406 (abc)	3491 (abc)
9	67	UAN	1984(bc)	3364 (bc)	6961 (abc)	7650 (a)	3283 (abc)
10	90	UAN	2167(b)	3595 (abc)	7162 (ab)	7654 (a)	3419 (abc)

Collecting GreenSeeker NDVI readings

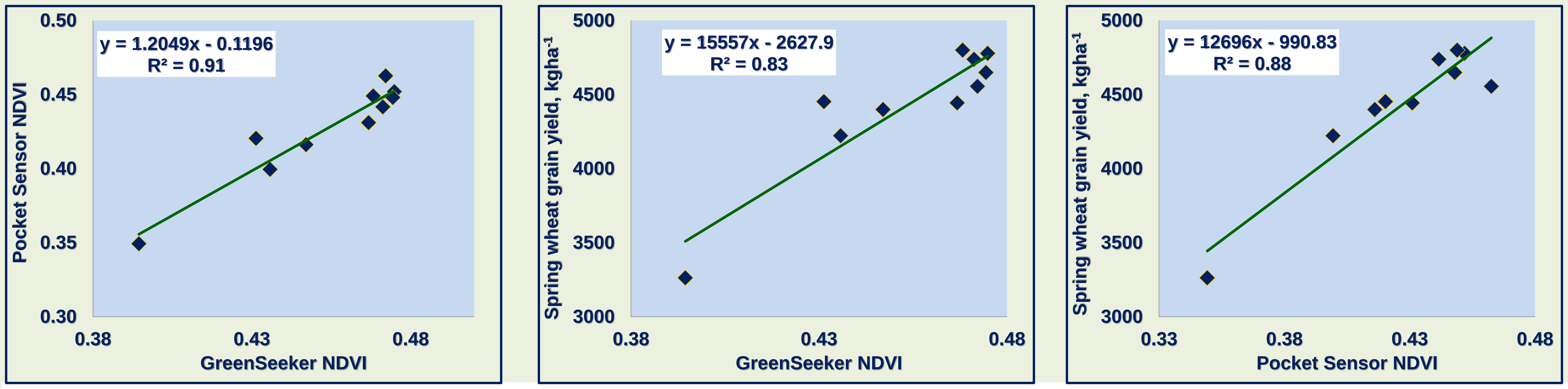
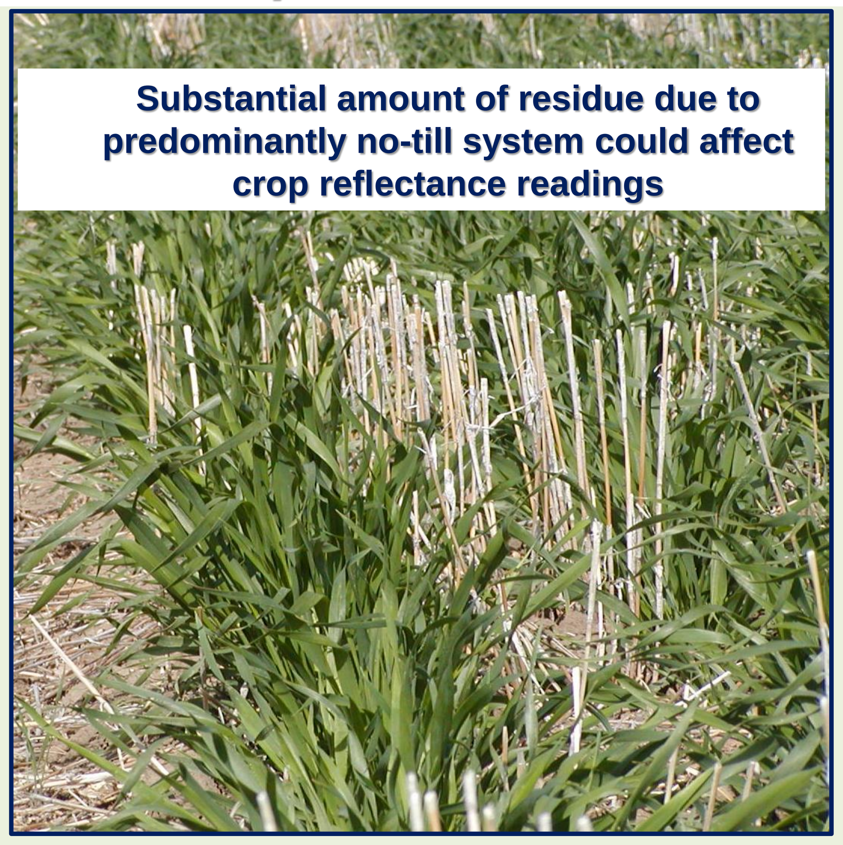


Figure 1. Relationship between GreenSeeker NDVI and Pocket Sensor NDVI (1a), and between GreenSeeker NDVI and spring wheat grain yield (1b), and between Pocket Sensor NDVI and spring wheat grain yield (1c). The NDVI values and mean grain yields are averaged by treatment for 5 site-years.

Table 1. GreenSeeker NDVI, Pocket Sensor NDVI and topdress N rates.

Trt	2011 WTARC GS	PS	N	2011 WARC GS	PS	N	2012 WTARC GS	PS	N	2012 WARC GS	PS	N	2012 MARTIN GS	PS	N
1	0.3	0.3	-	0.4	0.4	-	0.5	0.4	-	0.5	0.4	-	0.3	0.2	-
2	0.5	0.5	20	0.5	0.5	21	0.3	0.3	70	0.5	0.4	98	0.3	0.3	0
3	0.3	0.3	20	0.5	0.5	29	0.5	0.4	14	0.5	0.4	111	0.4	0.3	18
4	0.4	0.4	20	0.6	0.6	7	0.5	0.4	14	0.5	0.4	111	0.4	0.3	18
5	0.4	0.4	20	0.6	0.5	15	0.5	0.5	14	0.5	0.5	111	0.4	0.3	0
6	0.4	0.4	10	0.6	0.6	21	0.5	0.4	27	0.5	0.4	111	0.4	0.4	19
7	0.3	0.3	30	0.5	0.5	29	0.5	0.5	22	0.5	0.5	111	0.4	0.3	16
8	0.4	0.4	20	0.6	0.6	7	0.5	0.5	14	0.5	0.5	98	0.4	0.4	16
9	0.4	0.5	10	0.6	0.6	7	0.5	0.4	19	0.5	0.4	111	0.4	0.3	21
10	0.4	0.5	10	0.6	0.6	15	0.5	0.4	19	0.5	0.5	98	0.4	0.3	6



Substantial amount of residue due to predominantly no-till system could affect crop reflectance readings

- ✓ Spring wheat grain yields varied substantially from one site-year to the other. The lowest grain yield was observed at WTARC in 2011 (unfertilized check plot) and the highest – at WARC in 2012 (treatment 10) (Table 1).
- ✓There was a strong linear correlation observed between NDVI values obtained with GreenSeeker and with Pocket Sensor (R^2 = 0.91) (Figure 1a)
- ✓Strong linear relationship was observed between GreenSeeker NDVI values obtained at Feekes 5 growth stage and spring wheat grain yields (R^2 = 0.83) (Figure 1b)
- ✓Pocket Sensor NDVI values collected at Feekes 5 growth stage were able to predict 88% of variation in spring wheat grain yields (Figure 1c)
- ✓ The Sensor-Based Nitrogen Optimization Algorithm (USA/Canada/Mexico) recommended application of 0 kg N ha^{-1} at Martin in 2012 to 111 kg N ha^{-1} at WARC at 2012, depending on the NDVI values (Table 2)
- ✓ Significant response to preplant fertilizer N was apparent at all 5 site-years evaluated ($p<0.05$)
- ✓There was no significant differences in grain yields associated with topdress fertilizer N source (urea vs UAN) at any of 5 site-years ($p<0.05$)
- ✓ This study will continue for one more growing season at 3 experimental locations to expand database and to summarize results.

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