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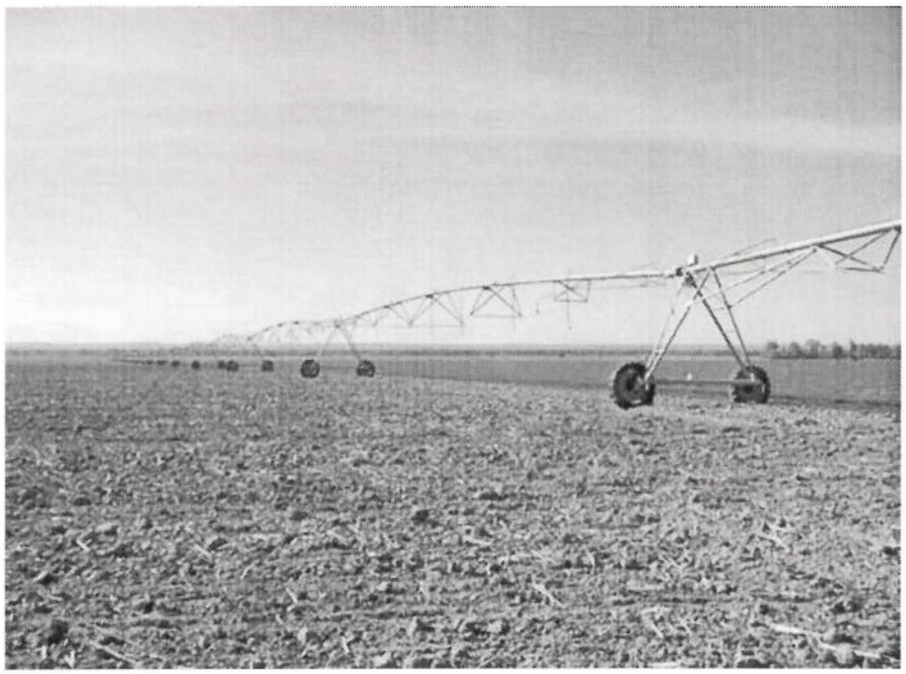
FROM THE GROUND UP

Agronomy News

Limited Irrigation Management – Getting the Most Crop per Drop



Principles and Practices

by Joel Schneekloth, Extension Northern Region Water Resource Specialist

Colorado producers irrigate approximately three million acres of pasture, hay, and row crops yielding receipts worth more than five billion dollars per year. However, irrigation water availability for these enterprises is declining. Dwindling agricultural water supplies due to drought, compact compliance requirements, urban transfers, alluvial well pumping restrictions, and declining ground water from non-renewable aquifers has reduced the water available to irrigated agriculture. These water shortages have been occurring in almost every irrigated watershed and

Estimated Yield of Some Alternative Crops Under Varying Irrigation in Northeast Colorado

by David C. Nielsen, Research Agronomist, USDA-ARS, Central Great Plains Research Station

Much of the irrigated acres in northeastern Colorado are devoted to corn grain production. Diversifying irrigated agricultural production in this region could result in water savings if alternative crops were grown that have lower water requirements than corn. Making such crop choice decisions initially requires knowledge of how yields of new crops respond to water.

Over a number of years, water use/yield production functions have been developed at the Central Great Plains Research Station near Akron. Such functions predict yield based on a linear relationship between total water use and crop yield. Water use is considered to be the sum of soil water extracted from the soil by the crop, growing season precipitation, and irrigation applied during the growing season. Production functions for three oilseeds, four legumes, three forages, and corn grain are shown in Table 1. These 11 production functions (along with six others) are available for easy use in a simple Excel spreadsheet (the Central Great Plains Yield Calculator, available from the author) that also includes average growing season precipitation for 15 locations in eastern Colorado, western Nebraska, and western Kansas. The calculator assumes that water is the controlling factor for yield, and that other factors (such as date of planting, fertility, weed control, insect control, timing of precipitation and irrigation, and harvest efficiency) are optimal. The calculator also assumes that there are no significant weather influences such as hail, frosts, or excessive wind that would adversely affect yield.

Using the Yield Calculator can give a farmer an idea about the yield response of an alternative crop to the irrigation water that he would apply. Table 2 shows estimated yields for the crops whose production functions were given in Table 1 for four irrigation levels and assuming 6 inches of water was used from the soil. Average growing season precipitation was assumed for three locations in northeastern Colorado (Briggsdale, Limon, and Wray).

Oilseed Response to Irrigation

Of the three oilseed crops shown in Table 1, canola exhibits the largest response to water (175 lb/a/inch) while safflower shows the smallest response (121 lb/a/inch). Predicted yields at Briggsdale range from 1568 lb/a with 3 inches of irrigation to 3145 lb/a with 12 inches of irrigation. Yields at all irrigation levels are lower for safflower and sunflower compared with canola, and greater in Limon and Wray compared with Briggsdale as precipitation increases moving west to east. The highest predicted yield (3548 lb/a) comes from canola grown at Wray with 12 inches of irrigation.

Legume Response to Irrigation

Legume seed response to water ranges from 148 lb/a/inch for soybean to 240 lb/a/inch for chickpea (Table 1). With 3 inches of irrigation, the greatest legume seed yield at Briggsdale was predicted for pea (2598 lb/a) and the least from dry bean (1823 lb/a). With 12 inches of irrigation, the greatest seed yield was predicted for chickpea (4645 lb/a). As with predicted oilseed yield,

Table 1. Production functions used in the Central Great Plains Yield Calculator for three oilseed crops, four legumes, three forage crops, and corn.

Crop	Production function
Oilseeds	
canola	lb/a = 175.2*(inches water use – 6.22)
safflower	lb/a = 121.4*(inches water use – 3.02)
sunflower	lb/a = 150.6*(inches water use – 6.88)
Legumes	
pea	lb/a = 181.4*(inches water use – 0.85)
chickpea	lb/a = 240.4*(inches water use – 5.80)
soybean	lb/a = 148.1*(inches water use – 0.68)
dry bean	lb/a = 193.0*(inches water use – 5.50)
Forages	
forage triticale	lb/a = 748.4*(inches water use – 3.39)
foxtail millet	lb/a = 664.4*(inches water use – 3.07)
corn silage	lb/a = 548.8*(inches water use – 5.31)
Starchy Grain	
corn	lb/a = 582.2*(inches water use - 9.13)

Table 2. Yields predicted with the Central Great Plains Yield Calculator assuming 6 inches of soil water use and average growing season precipitation at three northeastern Colorado locations.

	Irrigation	canola	safflower	sunflower	pea	chickpea	soybean	dry bean	forage triticale	foxtail millet	corn silage	corn
	---in---	----------------------------lb/a----------------------------							------------T/a------------			**lb/a (bu/a)**
Briggsdale	3	1568	1497	1315	2598	2491	2531	1823	4.81	3.66	3.10	**5032 (90)**
	6	2093	1861	1767	3142	3212	2975	2402	5.94	4.66	3.92	**6778 (121)**
	9	2619	2225	2218	3686	3933	3420	2981	7.06	5.66	4.74	**8525 (152)**
	12	3145	2590	2670	4230	4654	3864	3560	8.18	6.65	5.57	**10271 (183)**
Limon	3	1690	1575	1393	2725	2678	2611	1993	5.18	3.95	3.35	**5346 (95)**
	6	2216	1939	1845	3269	3400	3055	2572	6.30	4.95	4.17	**7093 (127)**
	9	2742	2303	2297	3813	4121	3500	3151	7.42	5.95	5.00	**8839 (158)**
	12	3267	2667	2749	4357	4842	3944	3730	8.55	6.94	5.82	**10586 (189)**
Wray	3	1971	1743	1508	3015	3070	2809	2113	5.91	4.10	3.63	**6126 (109)**
	6	2496	2108	1959	3559	3791	3254	2692	7.03	5.10	4.45	**7873 (141)**
	9	3022	2472	2411	4103	4513	3698	3271	8.15	6.09	5.27	**9619 (172)**
	12	3548	2836	2863	4647	5234	4142	3850	9.28	7.09	6.09	**11366 (203)**

predicted yields of legumes are greater at Limon and Wray because of greater average growing season precipitation. Soybean yield at Wray with 12 inches of irrigation is predicted to be 4142 lb/a (69 bu/a).

Forage Response to Irrigation

Forage dry matter response to water ranges from 549 lb/a/inch for corn to 748 lb/a/inch for triticale (Table 1). Predicted dry matter yields range from 3.10 T/a for corn grown at Briggsdale with 3 inches of irrigation to 9.28 T/a for triticale grown at Wray with 12 inches of irrigation.

Comparisons with Corn Grain Predictions

Table 2 shows predicted corn grain production with four irrigation levels at the three eastern Colorado locations assuming 6 inches of soil water use and average growing season precipitation. Corn grain yields at all irrigation levels and all three locations are predicted to be much greater than oilseed or legume seed yields because of the much greater production function response of grain yield to water use for corn (582 lb/a/in) compared with the other crops (Table 1). This is due to the much more efficient photosynthetic mechanism in corn that turns carbon dioxide, water, and sunlight into carbohydrates compared with oilseeds and legumes. Much more energy is required to produce the proteins and oils in legumes and oilseeds than to produce the starches in corn.

The predicted yields in Table 2 give farmers a starting place to determine the consequences of growing a crop other than corn under irrigation in their quest to grow a profitable crop while lowering water use. The current high prices for corn, however, do not promote the production of any of these alternative crops.

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