LIMITED IRRIGATION CROPPING SYSTEMS FOR CONSERVING WATER RESOURCES IN THE PUMPKIN CREEK WATERSHED

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PROJECT BACKGROUND

Declining ground water is not a new dilemma in Nebraska, however, the drought across the high plains and inter-mountain west the last eight years has magnified the problem. In Nebraska law, surface water is regulated by the Department of Natural Resources (DNR) and ground water is regulated by the 23 Natural Resources Districts (NRDs). In 2002, the North Platte NRD (NPNRD) requested a DNR study to examine the interaction of hydrologically connected ground and surface water in the Pumpkin Creek Watershed (Fig. 1). The report was completed in early 2004 (Patterson, 2004).

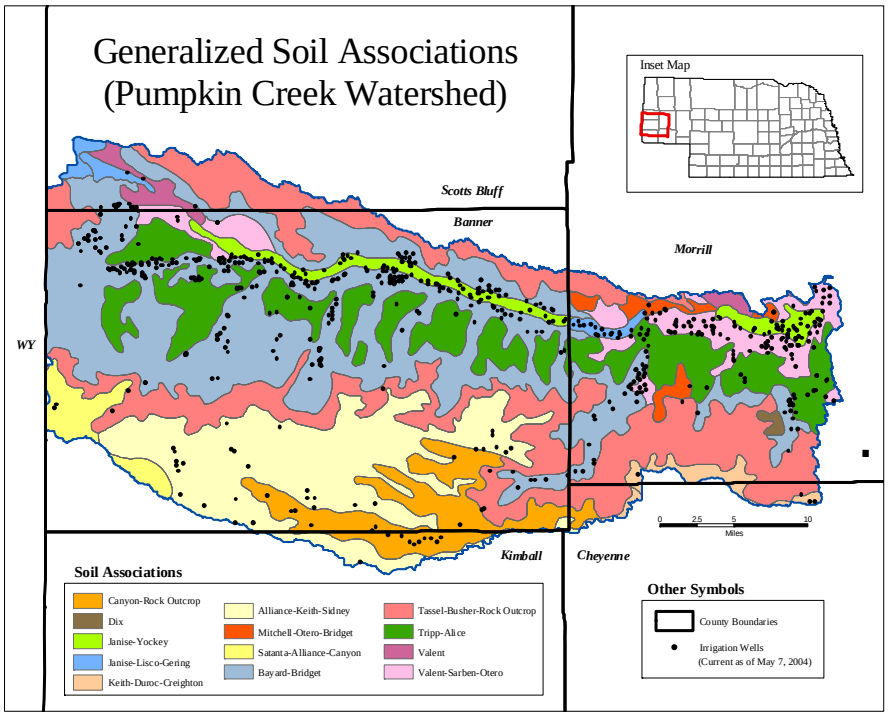


Figure 1. Major soil series and GPS referenced irrigation wells (black dots) in the

Pumpkin Creek Watershed.

The Pumpkin Creek Watershed (PCW) is located in the southern tablelands of the NPNRD. Pumpkin Creek flows into the North Platte River near Bridgeport, NE and on average delivered 20,000 acre feet of water per year until levels began to decline in the 1970's due to ground water development. Pumpkin Creek was closed to new surface water development over 20 years ago due to low stream flow. In 2001 the NPNRD established the Pumpkin Creek ground water management area and ceased new well drilling. Existing wells were metered in 2003 and pumping has been reported since 2004. The NPNRD approved a14 inch allocation in 2004 which has remained in effect.

Reservoir construction in the Rocky Mountains plus diversions of surface flow created irrigation districts in Nebraska beginning in the 1920's. Irrigation from ground water developed slowly in major river valleys through the 1940's until the 1970's, but expanded rapidly in the 1970's due to introduction of center pivots and continued into the 1980's. Research on limited irrigation in Nebraska began in the 1970's at the former UNL Sandhills Ag Lab where Gilley et al., (1980) used line-source sprinkler irrigation to study the effects of water-stressing corn. They found no significant yield reduction when the crop was moderately stressed during the vegetative stage, but significant yield reductions were noted when stress occurred during pollination and grain fill.

Under limited irrigation, less water is applied than is required to meet full evapotranspiration demand. As a result, the crop will be stressed. The goal is to manage cultural practices and irrigation timing such that the resulting water stress has less of a negative impact on grain yield.

The concepts of moisture conservation from dryland no-till ecofallow (Burnside et al., 1980) and the timing of limited irrigation (Gilley et al., 1980) were combined in a project initiated in 1982 at North Platte, NE (Hergert et al, 1993, Schneekloth et al, 1991). Over a 10-year period, this cropping systems approach for stretching limited irrigation (6-inch application per crop) on a silt loam soil showed winter wheat yields were 99% of full irrigation, corn yields were 86% and soybeans were 88% of fully irrigated yields. This area has annual precipitation near 20 inches per year. These concepts have also been successfully tested on producers fields (Klocke et al., 2004). This study showed the obvious--less water means less income, but the good news is that proper management showed that 25-50% reductions in water application only reduced income by 10-20%.

In the Nebraska Panhandle limited irrigation of sugar beet and dry bean showed that late season water stress reduced yield only 7 percent (Yonts, et al., 2003). In a different study (Yonts, 2002), delaying the first irrigation of the season for a one week period, reduced dry bean yield by 5 percent. There had been no major research on no-till limited irrigation cropping systems in the NE Panhandle until

2005, although dryland no-till research had been conduced since the 1960's.

PROJECT OBJECTIVES

The overall goal of this project was to initiate a demonstration project to educate growers about the advantages of using no-till cropping systems to stretch limited irrigation supplies in the Pumpkin Creek Watershed. This project was funded by a USDA NRCS Conservation Innovation Grant with matching support from the NPNRD and the University of Nebraska. The idea was to transfer information from the North Platte research to an area that receives only 15 to 17 inches of annual precipitation.

Individual project objectives were: 1. to demonstrate limited irrigation no-tillage cropping systems that make the best use of natural precipitation and limited ground water supplies 2. to educate area farmers, natural resource groups, local and state government agencies and agricultural businesses about the effect of different management scenarios on production, cultural practices, economics and natural resource impacts, and 3. to develop economic scenario case studies for limited irrigation.

The project built on previous Nebraska limited irrigation research (Hergert et al., 1993, Klocke et al., 2004 Schneekloth et al., 1991). However, part of the innovation and unknown of this project was adapting those concepts to the sandier soils, a different cropping mix (inclusion of dry beans, sunflower, canola, millet) and lower rainfall in western NE compared to North Platte.

PROJECT DESCRIPTION AND RESULTS

A Steering Committee of University specialists, NPNRD and NRCS personnel met to discuss goals and procedure and to help select demonstration sites and cooperators. Cooperators need to currently be practicing no-till and be willing to put up with the extra time required to be a part of a demo project. We also wanted to select representative operations according to size. Cooperators also needed to be willing to host field days and discuss their operations at other educational meetings. Demonstration sites were located to provide easy access during future field days.

Three producers were selected: one in the western part (Alton Lewick), one in the middle (Land and Gary Darnall) and one in the eastern portion (Kirk Laux) of the watershed. The operations also varied in size (Table 1). Current crops grown by the producers were used. We selected one or two halves of a center pivot for the demonstration. Although there is a 14-inch irrigation allocation within the Pumpkin Creek watershed, western portions of the watershed (Lerwick) can only supply 4 to 6 inches of irrigation before water is depleted in early August (it recharges over winter). Irrigation levels of 10 to 11 inches are

available in the center (Darnall) whereas the eastern part of the watershed has the deepest aquifer (Laux) and no water limitations. An Extension Educator was hired as the Project Manager.

Table 1. Cooperators, crops and operation description.

Cooperator (irrigation size)	# Pivots	Dry land acres	Crops*	Cows	Range land acres	Feedlot head
Alton Lerwick (small)	2	2,400	WH, SF, Cn, Ml, Fr	300	7,500	0
Kirk Laux (medium)	9	--	C, WH, DB, Fr	300	4,000	3,500
Lane Darnall (large)	15	4,000	C, WH, Cn, Fr	500	8,000	20,000

*C=corn; WH=winter wheat; SF=sunflower; Cn-spring canola; Ml-millet; Fr=forage

Alton Lerwick's site represents a medium size no-till farm and livestock operation and a small irrigated operation located in the western part of the watershed. Alton uses a continuous cropping system with no fallow to maximize crop residue to conserve soil and moisture. Alton Lerwick applies less than 6-inches water per acre to produce various 'conventional' and 'alternative' crops, which require less moisture. These include corn, winter wheat, sunflowers, canola, forage sorghum and millet. Alton's yields were 1,650 lb/ac spring canola in 2005, 60 bu/ac winter wheat (hailed) in 2006 and 1650 lb/ac sunflowers in 2007.

Lane and Gary Darnall's site represents a large no-till farm and livestock operation with a large feedlot in the central part of the watershed. Lane Darnall utilizes his water allocation to grow more conventional crops such as corn and alfalfa for his feeding operation and also grow alternative crops such as winter wheat, irrigated pasture and canola which require less moisture. Lane's yields were 1,100 lb/ac spring canola (high weed infestation) in 2005, 1,200 lb/ac winter canola (winter kill) in 2006 and 52 bu/ac winter wheat in 2007.

Kirk Laux's site represents a medium size no-till farm and livestock operation with a medium feedlot in the eastern part of the watershed. Kirk utilizes a similar water allocation plan as Lane, but with a different cropping system. He uses water from irrigated acres he has 'retired' back to dryland to gain additional water for use on his crops. Kirk grows corn, alfalfa, winter wheat, dry beans and forage turnips for fall / winter grazing for his livestock. Kirk's yields were 48 bu/ac dry beans plus approximately 3.8 tons/ac forage turnips for grazing in 2005 and 40 bu/acre dry beans in 2006; applying approximately 10-inches water each year.

Kirk is also trying something new to the Panhandle - no-till dry beans. He has planted no-till dry beans into corn stalk residue, in 15-inch and 30-inch row spacing's along with drilling. To maintain a no-till system (no undercutting of the dry beans at harvest), he has tried swathing and direct harvest methods. Currently, Kirk has also gone to planting 20-inch row corn and dry beans. The narrow row spacing provides quicker canopy cover to help compete with weeds and help shade the soil surface sooner for moisture conservation. Kirk is also developing a method to direct harvest his dry beans with a Shelbourne Reynolds stripper-header, to maximize crop residue left on the soil surface for soil and moisture conservation.

LESSONS LEARNED

The project has demonstrated that no-tillage can be adapted for the sandy soils in the Pumpkin Creek basin. The three cooperators are using no-till for common and alternative crops and making it work. There is still much work to do to match crops and cropping systems due to the wide range of water availability. Producers practicing limited irrigation must think like a dry land producer who has some irrigation water for only part of the season.

There are also many agronomic and production factors we must 'perfect' before making no-till and limited irrigation production systems common practice. There is also the need for additional research information for a wide range of cropping systems to look at conventional and alternative crops that fit the Panhandle plus economics before more producers adopt this system. Work also needs to be done to 'fine' tune irrigation systems for improved pumping efficiency.

Field days and tours have demonstrated to neighbors what can be done with less water. Additional field days and / or meetings need to be held to inform more growers and the agricultural community (fertilizer-chemical, implement, financial) to promote the benefits and potential problems with these systems so they can understand them better and work through them.

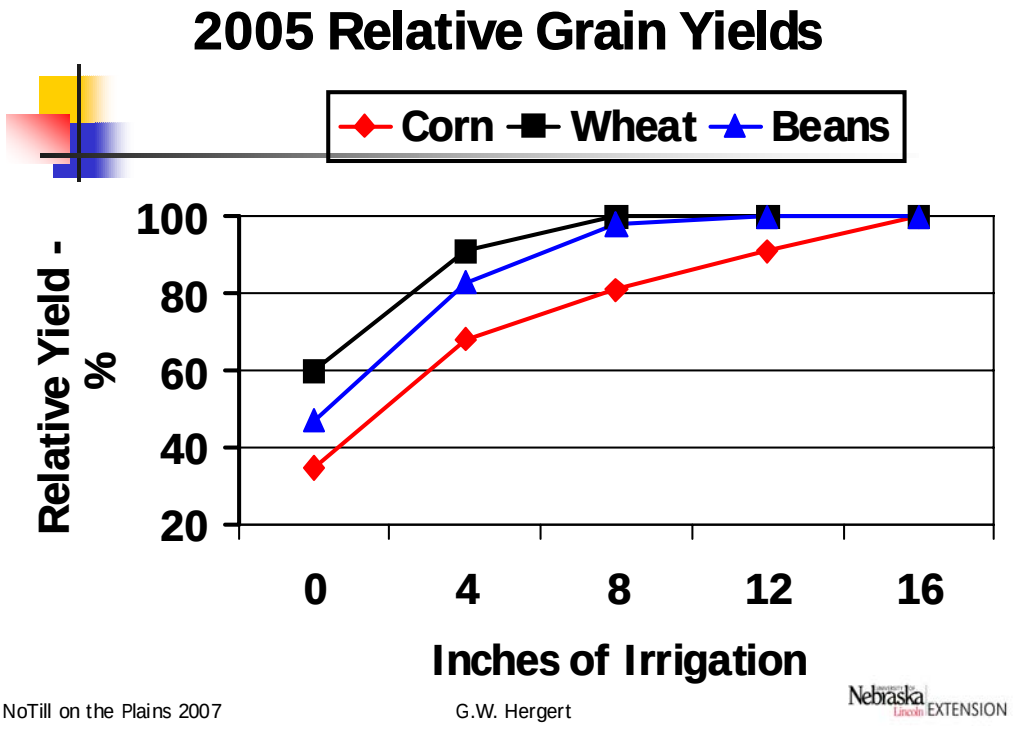
Using limited irrigation cropping and no-till systems can be successfully accomplished if the producer is willing to be patient when switching to these practices. Cropping practices / systems need to be determined and refined by the individual producer for their operation as they become more flexible in their management and marketing practices.

Much of the information about his project ca be found at the following web site: http://www.panhandle.unl.edu/pumpkin_creek/index.htm

SMALL PLOT RESEARCH

Because there were no existing no-till plots at PHREC, complimentary research was started in 2005. A crop rotation including winter wheat-corn-dry bean-spring canola is being used. Irrigation levels are 4, 8 and 12 inches per cropping season except corn which receives 5, 10 and 15 inches. Treatments are replicated four times with each crop present each year in a one-acre block under a linear move system at the Panhanlde R & E Center at Scottsbluff. The soils is a Tripp fine sandy loam (Coarse-silty, mixed, superactive, mesic Aridic Haplustolls) with a pH of 8.4, 1.2% OM and1.3-1.6 inches of plant available water per foot. Rooting depth is usually 4 to 5 feet for a total available root zone water holding capacity of 6 to 8 inches.

Three years of research have been conducted and confirm that the principles applied in the earlier limited irrigation work fit the NE panhandle. The 3 years of the project represented a year with above average precipitation (2005) and tow with below (2006) and much below normal (2007) precipitation. The information will provide the basis to do detailed water balance calculations plus provide information for economic analysis for crops that fit the high plains region and hopefully will be presented next year at this conference.



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