

# No-till

- \* *economically sound*
- \* *agronomically superior*
- \* *environmentally safer*

On The Plains



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### Profitable No-till Systems Designed for Producers in the North American Great Plains and Prairies

In an effort to save trees (and time) we have chosen to limit our remarks in these proceedings to some brief comments. The in-depth information that normally would be included is more easily and comprehensively accessed from our home page ([www.dakotalakes.com](http://www.dakotalakes.com)). It is hoped that this approach will allow the user to tailor the information for their specific needs.

The title of this presentation "Profitable No-till Systems Designed for Producers in the North American Great Plains and Prairies" was purposely chosen rather than a title such as "Conservation Farming on the North American Great Plains and Prairies". On the surface there does not appear to be a great deal of difference between these titles. The geographic region of interest is the same. Both imply that farming practices are to be discussed. However one title uses the words "Conservation Farming". This refers to soil and water conservation. In reality, this needs to be done in order for agriculture to be a renewable industry rather than (as it predominately is now) an extractive industry such as mining, petroleum, etc. Conserving soil and water resources should be a primary goal for every producer. However, the present economic system does not directly reward a farmer for conserving the soil and water with which he works. In fact with numerous "conservation farming" techniques the opposite occurs. The producer is often faced with the decision whether to conserve the resource or maximize profit. If he doesn't do the latter, someone else will be farming his land in the future; mining the soil that he conserved. For this reason, conservation **cannot be the only goal**. Maximizing short-term profitability also cannot be the only goal if a producer hopes to remain (or have his family remain) on the land he farms.

The Dakota Lakes Research Farm has both a research and a production enterprise. The production enterprise must produce sufficient profits to fund a majority of the operational expenses of the research enterprise. For this reason, the first priority of the production enterprise is to be profitable.

This dual enterprise structure was established in 1983 in an attempt to provide an independent source of funding that was less prone to influence by special interests and politics. This required substantial change in what was then a conventional tillage based research operation. Substantial expansion in the amount of land managed was required to provide a sufficient base to operate both a production and a research enterprise. If conventional farming practices were to be used on both the production and research enterprises a large investment in machinery and manpower would be required. This did not appear to be a prudent course. Consequently, it was decided that the production enterprise would be designed to utilize the manpower available and require only minimal investment in new machinery. The plan was to accomplish this through the use of diverse crop rotations. Weak-link analysis indicated that moisture would be a limiting factor for many of the potential rotational crops. Consequently, a key component of this plan was adoption of moisture conserving practices to

allow growing of high water use crops in a region where their production was marginal with conventional tillage.

A holistic or systems approach was taken. This meant that component and technique choices were based on evaluation of how that choice would impact other components in the system. It was evident that (in 1983) there was not an adequate amount of knowledge available on the type of farming system needed for this situation. This meant that many of the component choices required to build the system could not be based directly on research data or producer's experience as is commonly done in agriculture. Consequently, many choices were based on fundamental agronomic principles using natural cycles and native vegetation as a guide. Research projects were initiated concurrently to better define components and techniques for areas where knowledge was lacking.

The present operation at the Dakota Lakes Research Farm is substantially different than what was begun in 1983. Only part of this difference is due to technological changes that have occurred in the last 17 years. A majority of the difference stems from developing a better understanding of what happens when crops are grown in a manner which places heavy emphasis on developing a healthy and biologically active soil ecology and uses cultural practices (rotation, sanitation, competition) as the primary methods of pest control.

An example of this philosophy sees weed problems as a symptom that the farming system does not contain sufficient diversity (the weed is Mother Nature's way of trying to add diversity). With conventional thinking attempts would be made to control this weed with herbicides or tillage. The systems approach adds a crop to provide the diversity that was lacking. With this philosophy, attempts are made at preventing problems by addressing the cause rather than merely treating the symptoms as they appear.

Many of the farmer practitioners of this technique refer to accepting this approach as having a "brain transplant" since it requires developing new skills and a different attitude. Most important among these is the need to realize that to be sustainable and profitable on a long-term basis the farming system must be designed such that natural cycles and principles become an ally rather than an enemy. Inputs such as fertilizers or pesticides then become methods to augment or initiate natural cycles rather than being tools designed to stop processes that are natural.

Tillage selection is a primary example of this different approach. In natural systems, **tillage is a catastrophic event** (associated with glaciers, erosion, volcanoes, etc.) that occurs only rarely. Both macro and micro fauna are profoundly impacted. Soil dwelling species are disrupted to an even greater degree than those which can migrate to more suitable habitat. With frequent and repeated tillage, the soil ecology becomes predominated by species that require tillage in order for residue and nutrient cycling to occur. Since tillage generally occurs prior to plant growth being initiated, nutrients have been placed in a mobile form before they are needed, making them vulnerable to loss. If tillage is not performed, lack of aeration (caused by the poor soil structure that results from repeated tillage) causes nutrient cycling and crop growth problems. In undisturbed natural systems, nutrients and residues are cycled by a complex web of macro (grazing animals, earthworms, mites, spring tails, etc.) and micro (fungi, VAM) fauna. In this system, residues are maintained to protect the soil until new plant growth occurs. Canopy conditions created by this new growth allow residue decomposition rates to accelerate. This residue decomposition releases nutrients for use by the subsequent crop when they are needed. If this system were not properly balanced, the prairies of North America would either be deserts or hay stacks. In farming systems designed to mimic undisturbed natural systems, fertilizers are utilized to replace nutrients exported from the system and are applied in a manner to provide an early competitive advantage to the crop that is to be harvested.

This complex web does not reappear quickly when a soil that has been tilled for a number of years is managed without tillage. The soil structure and organic matter lost during the tillage period does not reappear quickly either. For this reason, initiating low-disturbance techniques requires careful planning in regard to how the

transition can be made without sacrificing short-term profitability. Many of the struggles and failures associated with producers adopting low disturbance methods traces to inadequately addressing this issue.

Similar analysis can be performed in relation to the impact tillage choice will have on weed pressure, insects, diseases, etc. Nutrient and residue cycling was chosen to provide an example of the thought processes involved.

The Dakota Lakes Research Farm did not initially choose to use reduced tillage techniques because of the soil and water conservation benefits; or due to the fact that soil health and nutrient cycling would be improved; or for wildlife benefits; or for carbon sequestration potential; or any of the other benefits brought to light in the last 10 to 15 years. The decision was made on the basis of the potentially improved profitability that the moisture conservation and workload spreading characteristics provided. The ultra-low disturbance, diverse crop rotations system that has evolved also owes much to the desire to maximize the utilization efficiency of manpower and machinery resources. It has also resulted in lower pesticide use and higher yield levels than anticipated. It is believed that much of this is due to a better understanding of the use of natural cycles. It is also quite possible that soil health and soil ecology play a much greater role than has been realized in the past.

It is almost certain that no producer will utilize exactly the same system components used at the Dakota Lakes Research Farm. Their physical (soil, climate, etc.) and fiscal (machinery, capital, manpower) resources differ from ours. Their choice of components should reflect these differences. The fact that the basic laws of nature function the same independent of these differences does indicate that the "SYSTEMS" approach successfully used at the Dakota Lakes Research Farm (and more importantly by producers in this and other parts of the world) may provide insight in potential approaches to be used in developing improved farming systems.

### **Customizing the "SYSTEM"**

The Dakota Lakes Research Farm enterprise presents a good example of how basic principles are used to create systems suited to differing physical resources. At the present time, the operation manages slightly over 1,200 acres of land. Some of this land is classed as a short-grass prairie due to the fact that it has shallow, clay, soils that limit available water holding capacity. Some of the land is short-grass prairie because of sandy soils that limit available water holding capacity. Some land is classed as mixed-grass prairie because the soils have good water holding characteristics. Some of the land is irrigated. This removes water availability as a primary constraint. Some land is close to the headquarters. Other land is as much as 40 miles away and requires moving machinery through the city and across the Missouri River Bridge in order to reach it. Some of this land has over 10 years of no-till history; some has just been acquired. Some has a history of over 50 years of wheat-fallow management with tillage; some has never been tilled since it was brought into production from native sod without tillage. Some land is owned; some land is rented. Differences in addition to these exist as well. It would be unwise to attempt to manage each of these situations with the same components. They are, however, all managed using the same approach to create a system designed to optimize the contribution that property makes to the operation. This approach is based on the application of fundamental agronomic and biological principles. **These principles do not change.**

One of these basic principles is that water utilization intensity must be **proper**. In other words the water use must match the water available. If the system is not sufficiently intense problems such as water logging, saline seep formation, nutrient loss, traffic ability problems, etc. are common. If the system is too intense, poor yields due to water stress or stand establishment problems are likely. Under irrigated conditions at Dakota Lakes the intensity of water use is limited only by the amount of growing season and heat received in the summer and by the availability of capital, manpower, and equipment to pump water from the Missouri River when it is needed. The choice to limit intensity under irrigation therefore is based on fiscal (manpower, equipment costs, energy) resources. On the dryland portion of the operation, intensity of water use is controlled by physical resources (soil type, rainfall, climate, etc.). In both cases, improper intensity results in management problems and less than optimum profitability. No-till management allows (requires) more water use by the crop (transpiration)

since less water will be wasted by the direct and indirect impacts of tillage (evaporation and runoff).

Another basic principle is that diversity must be **adequate (appropriate)**. As mentioned before, lack of diversity provides an opportunity for weed and disease organisms to build to harmful levels. The cost of controlling these opportunistic species and the capability to do so needs to be evaluated in each situation as it compares to what can be accomplished by using more diverse crop rotations. Under irrigated conditions at the Dakota Lakes Research Farm, corn (field and popcorn) and beans (edible and soybean) are the crops capable of returning the most increase in yields from the fixed costs associated with the irrigation development. If all acres were devoted only to these crops much of this increase would be offset by increased variable costs (pesticides), reduced efficiency in use of fixed machinery resources, and reduced yields. In addition, energy costs would rise on both a per acre and per unit of production basis. Some of this is caused by lower yields but most is due to a reduction in electricity price if the supplier is allowed to control (turn off) the irrigation pumps during periods of peak electrical demand. By devoting part of the acreage to rotational crops which do not share the same peak water use characteristics as corn and beans this can be done without limiting the ability to supply all crops with their full water needs. Consequently, on the irrigated portion of the operation, adding diversity has more impact in reducing variable costs than on reducing fixed costs although both are benefited. Conversely, on the dryland portion of the operation adding diversity provides the most benefit to reducing fixed costs (land, family labor, and machinery) per unit of production (not necessarily per acre). Variable costs are also reduced dramatically (especially pesticide inputs) once the system is in place and working properly. This may not be true during transition periods. Seed and fertilizer costs change very little on a per unit of production basis.

The bottom line of this approach is to view each farming operation as unique. The goal is to optimize the utilization of the resources (land, labor, capital, and machinery) available to that operation in a profitable and environmentally compatible manner. This requires devising a unique system for each operation, owner, parcel of land (and even portions of a piece of property), etc. rather than attempting to devise a farming recipe that fits all fields of all producers in all situations.

### **Common Characteristics**

This is not meant to imply that there are no common characteristics amongst the most successful no-till systems being used at Dakota Lakes and by real producers throughout the plains and prairies. Foremost among these is the inclusion of three or four crop types (cool-season grass, cool-season broadleaf, warm-season grass, and warm-season broadleaf) in the rotations used. Where cool-season crops are traditionally grown, addition of the warm-season grass component provides more benefit (adds more diversity) than adding a warm-season broadleaf because of the commonality of some diseases (such as white mold) and herbicide programs among warm and cool-season broadleaf crops. Rotations that are not consistent in terms of either **interval or sequence** provide the best protection against species shifts and biotype resistance. In other words rotations such as wheat-canola or wheat-canola-wheat-pea are consistent in both interval and sequence. Wheat always occurs in alternate years and always follows a cool-season broadleaf. Rotations such as s.wheat-w.wheat-pea-corn-millet-sunflower are not consistent in either interval or sequence. Rotations should have crop type to crop type intervals of a minimum of two years somewhere in the rotation. Extended perennial phases (grass seed, alfalfa) minimize agronomic problems associated with the low diversity rotations in the annual cropping portion of the rotation. This approach is useful in some situations but does not normally lead to optimization of machinery and labor resources. Perennial sequences are an excellent way to "jump start" the system. Another trend that is obvious especially in the Dakotas, Kansas, Nebraska, and Colorado is a move to the use of lower disturbance techniques as rotations improve. This trend is stymied at times by limited choices in seeders that have the capability to properly place fertilizer while accurately seeding with low-disturbance. Dormant seeding of spring cereals (especially wheat) has become a predominant practice for many producers. This technique shifts workload from the busiest time of the year to a non busy time. When this is properly done, benefits for many operations far outweigh the risks. Dormant seeding of canola is not as well proven and consequently is not as widely employed. Producers in higher rainfall areas and those with irrigation are beginning to utilize cover

crops as a means of adding diversity and intensity to their systems.

### **Wrapping it up**

Soil and water conservation are a consequence or side benefit of utilizing properly designed no-till systems. Sustainable profitability must be the primary goal in order to assure that conservation continues long-term. The best systems attempt to mimic native vegetation in terms of intensity (water use) and employ as much diversity as needed to optimize the system. Each resource (land, machinery, labor, etc.) is managed to optimize its contribution to the operation without overtaxing its capability. More in depth information on these subjects can be found at the [dakotalakes.com](http://dakotalakes.com) web site and related pages. Of specific interest would be "No-Till Guidelines".