

Site Specific Issues

A Precision Agriculture Newsletter

Harvest 2004

Dennis Hancock, *Extension Associate for Precision Agriculture*

Design Teams Tackle Precision Tillage Problems

*Larry Wells, Professor
Biosystems & Ag. Engineering Dept.*

Senior students in Biosystems and Agricultural Engineering at the University of Kentucky take part in a capstone design course in which the students form teams to develop solutions to problems suggested by professionals from various fields. One such team has developed and tested a control system for site-specific control of subsoiling depth. Their mechanism adjusts gage wheel position on a 2000 Case-IH Ecolo-till® subsoiler using a hydraulic cylinder and a mechanical linkage. A control system was designed to sense gage wheel position and adjust the hydraulic cylinder on-the-go (see Figure 1). The system uses software developed by the students to execute changes of tillage depth based on GPS position and a GIS shape file generated to prescribe site-specific tillage depth. This system has performed well in preliminary tests and work will continue to verify its reliability in more applications. The team's members were Mac Cammack, Blair Duguid, Brandon McDonald and Matt Peake.



Figure 1. Design team modifications to the subsoiler enables prescriptive, site-specific tillage depths.

Another team worked on developing an automated system for measuring and recording soil compaction. The soil cone penetrometer is a widely used tool to assess the state of soil compaction, however, manual measurements are time consuming and can be inconsistent. Existing mechanical systems are expensive and pose problems for use in many field scouting applications. The team, with consultation from Phil Needham and Steve Bice of Miles Opti-Crop® in Owensboro and designed a system to be used in conjunction with ATVs typically used by agronomists such as those with Opti-crop®. Their solution was a penetrometer system mounted on a trailer that is also used to haul the ATV from site to site (see Figure 2). To make measurements, the ATV tows the trailer around a field and a hydraulic cylinder powered by a small gasoline engine forces the penetrometer into the soil. Resistance is measured by sensing oil pressure as the probe moves downward and is combined with depth sensed by a displacement gage. An electronic control system allows an operator to take a measurement in ~2 minutes while remaining on the ATV. Soil cone index is measured from the soil surface to a depth of 24 in. and the results are recorded with GPS position in a spreadsheet. The design team members were Ryan Figgins, Lee Knasel, Laurie Meszaros and Jonathan Waits.



Figure 2. This self-contained system enables agronomic consultants a quick and easy method for measuring soil compaction.

Around the Corner: Precision Grazing

Dennis Hancock

The advantages of intensive rotational grazing systems have been well documented - greater forage yield and increased animal productivity per unit of land. Yet gauging pasture mass and quality, physically moving grazing animals from spent to lush paddocks, and the construction and maintenance of fences, can sometimes lead to a substantial increase in the management cost that must be put forward in planning, implementing, and analyzing intensive grazing systems.

Predicting what the future might hold is certainly a bit risky, but advances in technology that may soon be available have the potential to radically change the way that we manage grazing animals. Two major areas are being evaluated: i) the use of crop reflectance to estimate available dry matter and forage quality, and ii) employing a virtual fencing method.

The premise for using crop reflectance is that as plants fill in to form a crop canopy the color and intensity of the light that is reflected changes. Dr. Charles Dougherty, Professor of Grassland Management and Utilization at the University of Kentucky, has found that these changes in canopy reflectance, when expressed as a Normalized Difference Vegetative Index (NDVI), may be used to track changes in vegetative mass or grassland condition (Figure 1). NDVI is but one non-destructive measure that may be determined by hand-held or vehicle mounted instruments or by satellite imagery.

These changes in spectral reflectance also occur as a plant matures or when it is stressed by poor nutrition, disease, or environmental conditions. On-going work seeks to determine if it can be used to indicate forage quality and site-specifically manage inputs in forage production.

Researchers have also developed a new precision guidance technique, but instead of guiding equipment, it

is being used to guide grazing animals. Dr. Dean Anderson and other researchers at the USDA-ARS's Jornada Experimental Range in Southern New Mexico have developed collars for cattle that may take the place of the traditional fence. Using an integral GPS receiver to determine position, the high-tech collar senses if it is near a virtual fence or "Virtual Boundary™" and can provide a series of audible and physical stimuli to guide the animal appropriately. More recent research suggests that perhaps the collars may only be needed on the so-called "boss cow" to be effective.

Combining real time assessments of paddock mass and quality with virtual fencing methods may lead to more flexible rotations - Precision Grazing, if you will. Such opens the door to the management of stocking densities in real time. Under such systems, grazing could be intensified with much less management effort and perhaps be even more efficient and productive.

Clearing the Air: An Introduction to Wireless Technology

Dennis Hancock

Pick up any new piece of technology or read any article on "High-Tech" farming and you are likely to come across the latest trend in networking - Wireless. Certainly, communicating by radio waves is not new, but advances in their data transfer rates and inexpensive technology have opened the door to high speed wireless networking that is limited only by the imagination of the user.

For the beginner, it is easy to get overwhelmed by the terminology - Wi-Fi®, 802.11, Bluetooth™, etc. Hopefully, this article will highlight the potential of wireless networking in agriculture, debunk some of the intimidating terminology, and thus aid those who may be looking at riding the wireless wave.

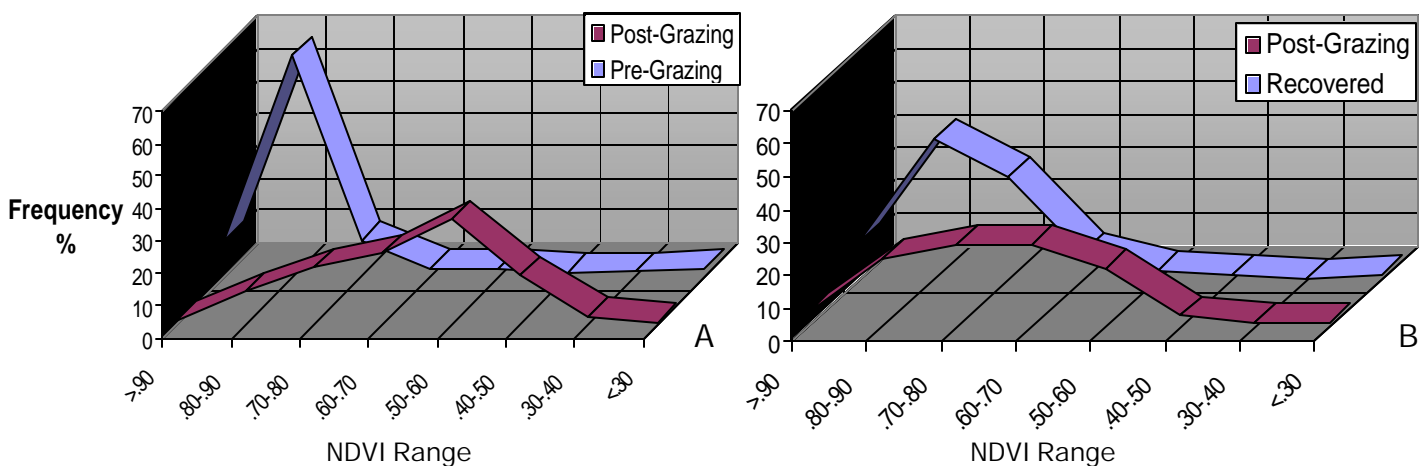


Figure 1. The distribution of Normalized Difference Vegetative Index (NDVI) measurements in two bermudagrass and white clover paddocks: A) prior to and following intensive grazing and B) following intensive grazing and after recovery.

Source: Dougherty, C.T. 2004, personal communication.

Fortunately, we'll be seeing more and more wireless devices in the next few years. In fact, the rat's nest of wires and cables that during the past we've twist-tied together, tripped over, and swore at may soon be a mere memory. That's because wireless connectivity is quickly replacing many of the more traditional, hardwired connections. Laptops, handheld PDA's, PDA/cell phone combos, cameras, weather stations, and even some GPS devices are capable of wireless networking - in many cases, all networked together.

The advantages of wireless networks are very apparent "down on the farm." Unlike the clean, neat, and uniform conditions of the typical business office, agriculturalists have to deal with all kinds of conditions that stress the traditional wire and cable connections. Dust, moisture, vibration, strain, twists, and kinks can all lead to connection failure. These are much less of a concern when there isn't a physical connection.

As with anything, though, there are a number of disadvantages. Of course, cost is the first one that comes to mind. But, the cost of this technology is declining rapidly and, in some cases, is equivalent to hardwire networks. Plus, more and more devices are being sold with Wi-Fi® or Bluetooth™ (or both) as a standard option. One of the major limiting factors, though, is the intimidation factor. Many folks are confused by wireless terminology. So, let's demystify some of the most common terms.

Wireless simply means that the binary language of computers - 1s and 0s (on/off) - is transmitted over short distances using radio waves. Think of it as a set of "walkie-talkies." "Walkie-talkies" use radio waves of a

certain frequency to transmit to any number of other "walkie-talkies," as long as they use the same frequency. In contrast to the frequencies used by "walkie-talkies" (around 27 MHz), the 802.11 Wi-Fi® standards currently run at 2.4 or 5 GHz, yielding data transfer rates up to a blazing 54 megabits per second.

But what do "802.11" and "Wi-Fi®" stand for? It refers to the Institute of Electrical and Electronics Engineers' (IEEE) standard on wireless networking. Wi-Fi® is the name of an alliance between 802.11 wireless manufacturers, which is used synonymously for 802.11. IEEE develops standards for the electronics industry and the particular section of their standards that deals with these types wireless devices is 802.11. There are also many subsections that cover specific types of wireless networks - 802.11b, 802.11a (which actually came after b), and a virtual alphabet soup of others (d, e, i, g, h, and n). I know - confusing, right? Well, the bottom-line is that most Wi-Fi® devices currently use or are compatible with 802.11b. Having IEEE standards helps to make sure that as the technology and speeds increase, compatibility is maintained. I've included more specifics in Table 1 to summarize the most common types and their basic specs. But, if you're really into self-torture, you can check out the specific standards posted by the IEEE's various 802.11 working groups at <http://grouper.ieee.org/groups/802/11/index.html> for more information.

Wi-Fi® systems are ideal for wirelessly communicating between several devices at a time, especially if they are relatively widely dispersed (say, in a Wide Area Network, or WAN, for example). A common example is that of an

Table 1. A brief comparison of common wireless communication systems.

	Bluetooth™	802.11b	802.11a	802.11g
<i>Relative Cost</i>	Lowest	Low	High	Low
<i>Speed</i>	721 kbps*	11 Mbps	54 Mbps	54 Mbps
<i>Frequency</i>	2.4 GHz	2.4 GHz	5 GHz	2.4 GHz
<i>Range</i>	20-30 ft	100-50 ft	25-75 ft	100-50 ft
<i>Compatibility</i>	Bluetooth only	802.11b only	802.11a only	802.11g & 802.11b

agro-security, livestock, or greenhouse monitoring system of sensors and surveillance cameras that are wirelessly communicating with internet access points, thus posting to the web and accessed remotely. Other examples are wireless weather stations, data collection from field sampling and scouting, or even transmitting scale weights from the elevator's scale house to the truck driver.

Another common wireless technology is Bluetooth™. The major practical difference between Wi-Fi® and Bluetooth™ is their range of operation. Since most Wi-Fi® setups are more powerful, they have a transmission range of about 150 ft and are relatively unaffected by obstructions such as the typical interior wall or the cab of vehicle. In contrast, Bluetooth™ can extend to only 20-30 ft (less if there are obstructions). But, since it requires less power, it is the preferred short range communication system for battery operated devices such as cell phones, hands-free headsets, GPS receivers, or PDAs.

The beauty of Bluetooth™ is that it is cheap and easy. Unlike more sophisticated and powerful Wi-Fi® systems, Bluetooth™ adds very little to the cost of the device. The connectivity of Bluetooth™ enabled devices is also very simple. The devices can actually detect each other and strike up their own "conversation" with little or no input from the user. It's like "Plug & Play," except there's nothing to plug in.

The short range of Bluetooth™, however, makes it less practical in many agricultural operations. Still, several agricultural Bluetooth™ applications exist. For example, Bluetooth™ GPS receivers are now common and are an excellent alternative to their hardwired cousins whose cords often come off or get snagged at inopportune times. Another example is a cattle working facility wherein a Bluetooth™ enabled PDA is used to collect weights from the digital scale and animal identification from the electronic id tag reader, all while the worker is making notes about the animal.

One of the key frustrations that farmers, agribusinessmen, and researchers have had in the use of technology is wiring and cabling difficulties. Fortunately, wireless communication is helping to simplify device to device communication.

Why is it called "Bluetooth"™?

In the 10th century Danish King Harald Blatand – known as Harold Bluetooth in English textbooks – united various factions in what is now Norway, Sweden and Denmark. The trade association, which worked on developing this system that was to unify wireless devices, chose to adopt the name Bluetooth as a code name in homage to his unification efforts.



Quotables: *Futurists*

"I never think of the future - it comes soon enough." - Albert Einstein

"Where a calculator on the ENIAC is equipped with 18,000 vacuum tubes and weighs 30 tons, computers in the future may have only 1,000 vacuum tubes and perhaps weigh 1.5 tons." - **unknown**, in *Popular Mechanics*, March 1949, referring to the world's first computer: the *Electronic Numerical Integrator and Computer*.

"I have seen the future and it doesn't work." - Robert Fulford