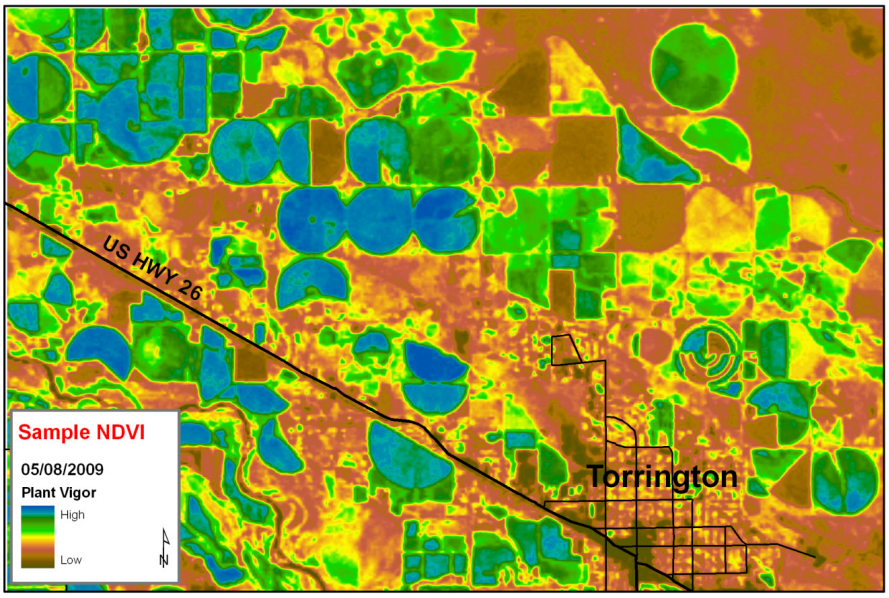
Deconstructing Precision Agriculture

Sensors, Robots, and Normalized Difference Vegetation Index (NDVI)

Nitrogen is an essential plant nutrient and, next to water, is the most limiting factor in crop yields. Better nitrogen management not only helps growers get more value for their investment, but also reduces the risk of environmental pollution. Growers and agricultural researchers use sensors to determine the nutrient needs of crops. These sensors use Normalized Difference Vegetation Index (NDVI) technology to measure chlorophyll levels that are strong indicators of health in plants.



The earliest reported use of NDVI was in 1973 by Dr. John Rouse, who was the Director of the Remote Sensing Center of Texas A&M University for the **NASA** and **Dept. of Interior U.S. Geological Survey (USGS)** Earth Resources Technology Satellite, later renamed Landsat-1, for a study of the Great Plains. Each of the ten Great Plains study sites are established research areas of a state agricultural experiment station or the **U.S. Department of Agriculture (USDA)**. At the Center, PhD student Donald Deering, his advisor Dr. Robert Haas, and mathematician Dr. John Schell developed a method correlating the biophysical characteristics of the rangeland vegetation of the region to the satellite spectral signals using the ratio of the difference of the red and near-infrared radiances over their sum.

Top: NDVI image near Torrington, WY. Above: Trimble GreenSeeker sensor invented at Oklahoma State Univ.

NDVI is the most successful of many attempts to simply and quickly identify vegetated areas and their condition, and it remains the most well-known and used index to detect live green plant canopies in multispectral remote sensing data. The GreenSeeker handheld sensor reads average nitrogen levels using NDVI. The sensors can be mounted on the top of a spray boom to detect the health of the crop and adjust the variable rate application of inputs in real time then apply the correct amount of nitrogen fertilizer needed.

A recent development in the application of sensors in agriculture is the concept of high-throughput plant phenotyping (HTPP). Plant breeders and geneticists are keen to increase the speed at which they can evaluate genetic plant lines to improve them with respect to characteristics like yield, speed of growth, drought tolerance, and pest resistance. Engineers are developing sensors to measure these "phenotypic" traits very quickly and in high volume, increasingly enabling breeders and geneticists to consider many more plants – thousands vs. today's dozens – with genetic differences as they seek the most beneficial varieties. Steady advances in sensing and automation for precision agriculture will enable farmers and the agricultural industry in the U.S. to maintain an advantage in efficiency and profitability.

Continued on reverse—

Science and technology helps feed the world

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Biographies

Dr. Raj Khosla is a Professor of Precision Agriculture at Colorado State University. In 2009, he was named the Colorado State University distinguished Monfort Professor. In 2012, he was selected as the Jefferson Science Fellow by the National Academy of Sciences and is currently working as the Senior Science Advisor in the Bureau East Asia Pacific, U.S. Department of State, Washington D.C. Prof. Khosla is the founder and Past President of the International Society of Precision Agriculture. He is also on the National Space-Based Positioning, Navigation, and Timing (PNT) Advisory Board.

David Hula set the world corn yield record in the 2013 National Corn Growers Association yield contest. Renwood Farms is in Charles City County Jamestown, Virginia. Renwood Farms started their seed business in 1937. David, John and Jeff Hula, third generation producers, continue the long tradition of providing high-quality cereal and soybean seed to the Mid-Atlantic and Southeastern farming communities.

Dr. Bill Raun is a soil scientist, Regents Professor and Endowed Walter R. Sitlington Chair in Agriculture in the Department of Plant and Soil Sciences at Oklahoma State University. **Dr. Marv Stone** is an agricultural engineer, has taught and conducted research at Oklahoma State University and has played a significant role in the development of precision farming. Both Raun and Stone are members of a team of researchers at Oklahoma State University that developed GreenSeeker.

Dr. Alex Thomasson is a Professor in the Department of Biological & Agricultural Engineering at Texas A&M University, a registered Professional Engineer and a *retired Lieutenant Commander after 22 years in the U.S. Navy Reserve, where he served first as an Engineering Duty Officer and later as a Civil Engineer Corps Officer*. His research in precision agriculture focuses on identity preservation in crops, bioenergy, and agricultural mechanization and automation.

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