

# Impact

Sharing the difference CSU Extension makes in people's lives and their communities.

## New technologies boost crop yield, save money, time and resources

*Innovations in precision agriculture help farmers adopt productive, profitable, efficient and sustainable production strategies.*

### Issue

Crop yields fluctuate across agricultural fields due to variations in soil types and changes in topography. Despite this, growers often approach crops with a one-size-fits-all approach by planting seed and applying water, nutrients, pesticides and other crop inputs at a uniform rate. This practice has the potential to not only waste time and resources but have negative effects on soil and water quality, crop productivity and often may not address landscape variability.

### Extension's Response

CSU's multi-disciplinary program in precision agriculture was established in 1999 by Raj Khosla, Colorado State University Extension specialist in the department of crop and soil sciences. Since then, Khosla and his research team have fine-tuned strategies that help Colorado farmers make better soil, water and crop management decisions. These techniques, developed specifically for Colorado conditions on the farm equipment used here, have shown to increase crop productivity, profitability, input use efficiency and sustainability of farming systems.

Over the years, Khosla and his team have used geographic information systems (GIS) to analyze data—generated by farm machinery equipped with global positioning systems (GPS) and sophisticated sensors—and map site-specific management zones. These zones are defined by topography, historical yield data, farmer's experience of the field, and bare soil imagery using geostatistics. More recently, his research is helping farmers improve nitrogen use in irrigated corn cropping systems. Khosla and his team use collected data to develop algorithms that interact with equipment-mounted sensors that tell variable rate applicators how much seed or nutrient is actually needed. This information help farmers better understand that consistent low yield due to poor soil cannot be overcome by just adding more nutrients. Over time, instead of saturating inherently low-producing areas, they can maximize the potential of high-producing areas by reallocating inputs.

Khosla has led nearly 40 on-farm trials since coming to CSU. In addition to bringing farmers new precision agriculture technologies through on-farm trials, Khosla conducts field days, farm tours and Extension workshops. Additionally, as global food security becomes an increasing concern, Khosla's expertise is extended to developing countries that need sustainable, cost-effective precision agricultural strategies.



### The Bottom Line

- CSU Extension is helping farmers adopt precision agriculture strategies and technologies that maintain or even increase crop productivity, save time, increase financial returns and benefit the environment.

### By the Numbers

- Colorado acres impacted by extension education in precision agriculture: 600,000
- Average size farm, in acres, using precision agriculture: 2,200
- Percent of Colorado farmers who report using auto pilot systems: 60
- Year that the first autopilot systems were sold: 2004

## Impact

CSU Extension, through Khosla's on-farm trials, have shown farmers how precision agricultural strategies and technologies can maintain or even increase crop productivity, save time, increase financial returns and benefit the environment. Based on data collected from post-workshop evaluations, precision agriculture extension activities have impacted over 600,000 acres of production agriculture in Colorado.

Khosla's combined research and extension have shown that farmers who adopt precision nitrogen management generate significant financial gains for compared to farmers who uniformly apply nutrients to fields. On farm research has shown that farmers who use precision nitrogen management alone have reported increased net returns that vary from \$17 per acre to \$54 per acre.

Returns on precision agriculture investments differ greatly from operation to operation and partly depend on the amount of acreage in production. In fact, not all farmers can afford to purchase the equipment and devices that make precision agriculture possible. Nor are they interested in learning the skills required to implement precision agriculture technology. However, Khosla's work has shown that precision agriculture can improve production systems and bottom lines. For instance:

- Variable rate application of seed and nutrients, based on inherent soil properties, can increase yield in high producing areas, maintain yield in low producing areas, and reduce costly inputs.
- Auto pilot guidance systems and accurate placement of crops can reduce the number of overlaps tractors make across the land.
- Production management efficiencies, particularly auto pilot guidance systems on tractors, reduce fatigue and labor costs and can expand hours of operation.

Precision agriculture also generates several environmental benefits. According to Khosla, precision nitrogen management can balance soil nutrient content, preventing unwanted nitrate leaching that can impair surface and ground water quality. The same applies to reduced pesticide use.

In 2011, Khosla was appointed by National Aeronautical Space Administration (NASA) to serve on the U.S. Presidential Advisory Board for Space Based Policy. In 2011 he also:

- Expanded his international Extension work to India and China through three-year USDA-funded project to study their production systems, identify gaps, and disseminate technology that is mutually beneficial.
- Received the International Service award from the Colorado Zeta Chapter of Epsilon Sigma Phi, the Extension Professional's Organization.

Khosla is the 2012 Jefferson Science Fellow with the U.S. State Department. (See [www.news.colostate.edu/Release/6180](http://www.news.colostate.edu/Release/6180).)

*“We in agriculture are among the people who use the highest resolution GPS systems. The only other industry that does is construction.”*

– Raj Khosla, CSU Extension specialist in precision agriculture

*“Many farmers are recognizing the yield robbing impact of weed, plant disease, and insect pests as well as the soil environmental constraints limiting their crop yields and quality through their yield monitors. Some of these are taking the additional step of creating yield maps to document these changes by year over several years of production.”*

– Bruce Bosley, CSU Extension cropping and natural resources agent in Logan and Morgan Counties

## Trimble Partnership

Colorado farmers aren't the only beneficiaries of Khosla's research and extension. In 2011, Trimble, the world's largest navigation equipment company, struck a partnership with CSU to base a national training center for dealers of its precision agriculture equipment at CSU's Agricultural Research, Development and Education Center (ARDEC). Dealers learn about Trimble's sensors, auto pilot systems, variable rate controllers and display modules which have been installed on more than a dozen ARDEC tractors, implements and other machinery. Khosla's students now apply precision agriculture strategies at ARDEC's fields with Trimble's latest precision technologies.

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