Cooperative Extension
Colorado State University

SPRING 2002
VOLUME 22
ISSUE 1

FROM THE GROUND UP
agronomy news

Research and Outreach Summaries

INSIDE THIS ISSUE

Projects in the Department of Soil and Crop Sciences Range from Trace Metals to Gene Mapping

Generally, issues of this newsletter are focused on one topic or several burning contemporary issues. This newsletter is deliberately unfocused. Our intent with this issue is to provide our readers with a sampling of the many research and outreach projects ongoing in the Department of Soil and Crop Sciences and affiliated research stations and provide contact information for those projects. Because of length considerations, this newsletter is not intended to be a definitive list of all departmental or station activities, only a sampling to provide you with an idea of the work conducted by faculty and staff here and by collaborating departments and agencies. Most of the projects summarized here are partially or fully funded by the Colorado Agriculture Experiment Station. Faculty and staff are continually appreciative of this funding as they strive to serve the citizens of Colorado in finding improved methods of producing food and fiber while better understanding and protecting our environment. Feel free to contact the primary researcher to get more information on their project.

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Colorado State University
Knowledge to Go Places

Cropping Systems Management Projects

Managing Mountain Meadows for Sustainable Forage Production

Joe Brummer and Dan Smith

Hay production for the long winter feeding period is a major cost for high elevation livestock producers and a logical area in which to cut costs. One problem producers face during the haying season is the difficulty in putting up high quality hay due to frequent afternoon thundershowers. Not only does forage quality decline under these conditions, but some ranchers are faced with paying large haying crews for extended periods without the benefit of actually putting up any hay. One potential solution to this problem is to put hay up as big round bale silage or baleage. Essentially, putting up hay as baleage takes weather out of the equation because baling can take place at moisture levels up to 70%. The objective of this study was to evaluate the performance of steers that were fed either baleage only, dry hay only, or a combination of baleage in the morning and dry hay at night. During this study, steers were fed free choice hay with no other supplements from early December to late March. Gains over the entire feeding period averaged 1.06, 0.90, and 0.86 lb/head/day for the steers fed a combination of hay, baleage only, and dry hay only, respectively. The real advantage of feeding the combination of baleage and dry hay came during March when the steers fed the combination of hays gained 1.74 lb/head/day compared to 1.41 and 1.08 lb/head/day for the baleage and dry hay only groups, respectively. Based on results to date, it appears that preserving and feeding mountain meadow hay as baleage offers a viable alternative to normal dry hay. Even though there is a cost associated with preserving hay as baleage (plastic wrap and additional equipment), part of that cost can be offset by the improved weight gains on calves that are possible from feeding a combination of baleage and dry hay.

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FROM THE GROUND UP
agronomy news is a monthly publication of Cooperative Extension, Department of Soil & Crop Sciences, Colorado State University, Fort Collins, Colorado.

Web Site: http://www.colostate.edu/Depts/SoilCrop/extension/Newsletters/news.html

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Managing Arthropod Pests on Irrigated Crops of the Arkansas Valley

Frank Schweissing

The use of Bt corn varieties have given growers in southeastern Colorado an important tool to reduce or eliminate the losses caused by the southwestern corn borer (SWCB) to corn production. Due to the requirement for borer refuges and areas where the SWCB is not a yearly problem, the use of an effective insecticide is important. Average damage to corn in the insecticide treatments was measured by percent broken and lodged (B/L) stalks and grain yield in two tests 2000 and 2001. When insecticide application becomes necessary, one application of lambda-cyhalothrin (3.3B/L, 11,930kg/ha), bifenthrin (5.4B/L, ll,633kg/ha) or carbofuran (6.0B/L, 11,290kg/ha) provides as good or better yields than esfenvalerate (12.7B/L, 10,258kg/ha), permethrin (12.0B/L, 9,828kg/ha) and chlorpyrifos (21.7B/L, 9,400kg/ha) at either one or two applications. Reducing the amount of insecticide introduced into the cropping system also reduces costs to the growers. This study aids growers and consultants in making more informed pest management decisions.

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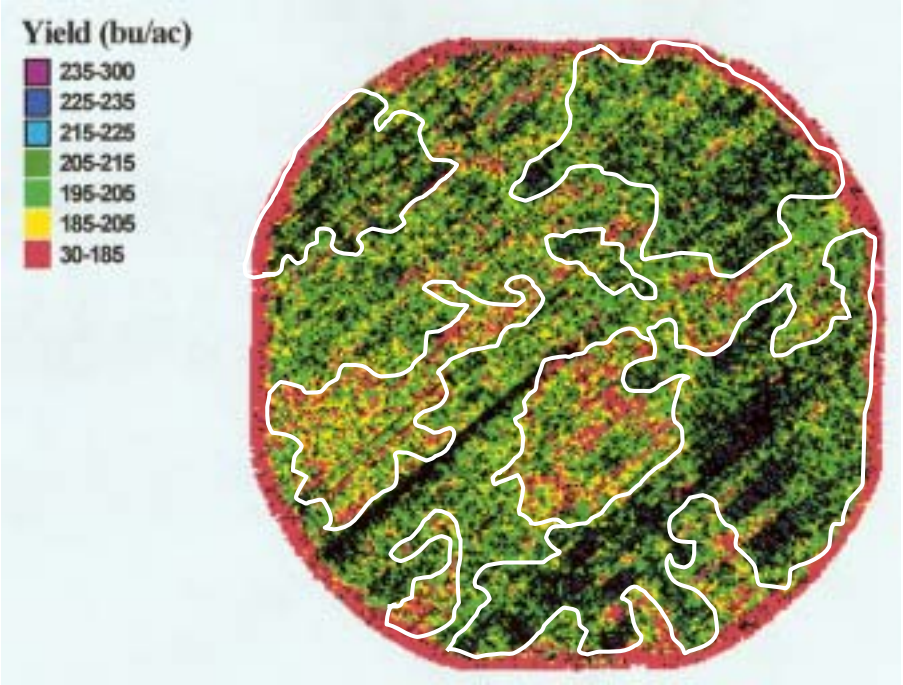

There are areas within the same field that produce different levels of grain yield.

Precision Farming Strategies to Increase Profitability and Sustainability in Irrigated Agriculture

Raj Khosla, DwayneWestfall, Frank Peairs, Phil Westra, Dale Heermann, and Kim Fleming

Development and adoption of productivity level management zone systems to help farmers better manage the inherent variability of farm fields could reduce environmentally sensitive agricultural inputs, maintain or increase grain production, increase net profit, and enhance efficiency of agricultural inputs. Managing farms site-specifically, based on spatial distribution of weed-seed bank, insect populations, or spatial soil color, topography and farmer's experience, has potential to improve the efficiency of the whole agricultural system in a profitable and environmentally responsible manner.

During the first year (2001) of this study, productivity level management zones were developed using techniques delineating management zones at 4 different field locations in NE Colorado for corn and onions measuring nutrients, weeds, insects, diseases, and irrigation management within each zone.

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Improving Crop and Soil Management in Dryland Agroecosystems

Gary Peterson and Dwayne Westfall

Historically, wheat-fallow has been the predominant dryland cropping system in Eastern Colorado. However this system has a high erosion potential and marginal profitability.

Data collected from 1986-1997 indicates that cropping systems with three and four year rotations were superior to two year wheat-fallow systems increasing 70% in annualized grain production and 25-40% in return to land, labor, capital, and management. Dryland corn acreage has increased 14-fold and total summer crop acreage has increased by 500,000 in Colorado since 1986. However, three years of recent study determined that soybean is not a feasible crop for these systems with currently available varieties and Proso millet replace soybean next year. Joint experiments with entomologists studying the effects of cropping systems on populations of beneficial and bio-control of pest insects are in their 4th year.

This project has had an enormous impact on dryland farming in Colorado. Assuming summer crops are grown in a 3-year rotation (wheat-summer crop-fallow), there are now about 1,500,000 acres in more intensive cropping systems compared to 75,000 in 1986, resulting in an increase in net return of $18,750,000 per year, based on an increased return of $12.50/acre. Producers attending annual field days have also publicly testified that they have used findings of this research project to move from wheat-fallow to more continuous cropping. The net environmental effect is positive because Peterson and Westfalls' new systems provide high amounts of year round cover that reduce soil erosion by 80 to 99%.

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Performance of Hybrid Poplar in Agroforestry at Fruita

Calvin H. Pearson

Hybrid poplars are suitable for a number of uses including pulp, lumber and plywood, fuel, conservation, and ornamental plantings. A hybrid poplar clone evaluation study consisting of eight hybrid entries was initiated in 2000 at the Western Colorado Research Center (WCRC) at Fruita. Initial interest in hybrid poplar under agroforestry was the result of decreased access to timber resources on public lands in Western Colorado and surrounding areas and increased hauling costs to transport logs over long distances from harvest sites to manufacturing facilities. Growth of hybrid poplars in 2001 after two years of production was exceptional. Of the total number of trees measured, most hybrid clones had only one or two missing trees. Growth of the hybrid poplars for the two years of production has been exceptional. Tree height, averaged across all hybrids was 22 feet, diameters ranged from 2.4 to 4.0 inches. There was significant variability among the poplar hybrids for range in measurements for tree height, trunk diameter at the soil surface, and at a one-meter height. The impressive growth of the poplars to date in this study at Fruita has created substantial interest from the public.

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Crop Improvement and Biotechnology Projects

Improving the Quality and Performance of Colorado Wheat

Scott Haley

The primary objective of this research is to develop and release improved wheat cultivars and germplasm with enhanced grain yield, multiple pest resistance traits, and desirable end-use quality characteristics. Development of improved wheat cultivars will reduce costs of wheat production, minimize the use of chemical pesticides, and allow more successful marketing of wheat to improve farm profitability for wheat producers and the wheat industry in Colorado. Three advanced lines were released to seed producers as improved cultivars in fall 2001. ABOVE and AP502 CL are hard red winter wheat (HRW) cultivars that carry non-transgenic tolerance to the new imidazolinone herbicide BEYOND from BASF Corporation. These will allow selective control of winter annual grasses (e.g., goatgrass, brome and cheat, and feral rye) and broadleaf weeds that are problematic in Colorado and other wheat production areas. The third cultivar, AVALANCHE, is a hard white winter wheat (HWW) with high yield and superior milling and bread making characteristics. Adoption and production of HWW cultivars may provide Colorado wheat producers with additional marketing options to increase farm profitability. Two lines similar to AKRON but carrying Russian wheat aphid (RWA) resistance were advanced for further field testing and potential release of one line as an improved cultivar in Fall 2002. Experimental HWW lines with RWA resistance and good dual purpose (bread and Asian noodles) were advanced to replicated yield testing in state variety trials in 2002. Herbicide tolerant experimental lines with RWA resistance and improved milling and baking quality were advanced to state variety trials in 2002. Spring wheat experimental lines will be evaluated in replicated field trials in 2002 for potential release in spring 2004. Availability of adapted spring wheat cultivars carrying RWA resistance will provide growers with additional spring cropping options for reduced tillage production systems. These collaborative research projects were continued or initiated in 2001 to provide basic information and tools to enhance the breeding efforts: inheritance and chromosomal location of a novel wheat streak mosaic virus (WSMV) resistance gene; determination of breeding potential of gibberellic acid-sensitive semidwarfing genes; determination of genotypic and environmental influences on HWW quality characteristics; characterization of antioxidant properties of wheat grain; inheritance and allelism of RWA-resistance in Iranian landrace accessions.

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Developing Superior Hybrid and Inbred Quinoa Varieties for Colorado

Sarah Ward

Grower adoption of quinoa, a promising alternative grain crop, will be enhanced by the development of early-maturing zero-saponin varieties suitable for the western U.S., which will not require post-harvest processing to remove bitter tasting saponins from the seed coat**.** Preliminary data for heterosis obtained in 2001 suggest that F1 quinoa hybrids may yield substantially more than the inbred lines currently grown in Colorado. Forty-eight F1 hybrids were grown together with the parental lines at two sites in Colorado and Montana. Seed set was reduced for all lines by unusually hot dry weather, but data for plant height, panicle length and dry weight, and total above-ground plant biomass showed F1 lines ranging from 97.7% to 388.6% of the high value parent. Twenty-six new zero-saponin inbred lines have been developed following screening of F2 progeny from three crosses between low-saponin and early-maturing South American quinoa varieties. Theses lines are being advanced to the F5 generations and will be field-tested in Colorado and Montana in 2002.

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Meeting Diverse Educational Needs in Agricultural Biotechnology

Sarah Ward, Susan Fritz, Pat Byrne, NancyLewis*, Deana Namuth*, and Julie Albrecht**

The availability of accessible, understandable and unbiased information on transgenic crops will help the public to make better informed decisions about this controversial technology and its applications. The transgenic crops public information project is pursuing three fronts: maintaining a web site for the general public, offering workshops to information disseminators, and evaluating the results of our efforts with survey instruments that provide data for statistical analysis.

The public-access informational web site "Transgenic Crops: an Introduction and Resource Guide" includes animations of genetic engineering methods, news briefs, risk and concerns discussions, transgenic varieties on the market and being developed, U.S. government regulations for transgenic crops, book and scientific journal references and an extensive list of links to other websites. A Spanish-language version is now under construction.

In cooperation with the University of Nebraska-Lincoln*, public education projects include lesson modules for on-line distance education courses, free workshops on transgenic crops to science teachers, extension agents, and nutritionists, and printable/ downloadable materials available on the web site. This collaborative effort between CSU and the University of Nebraska-Lincoln may result in a more informed public debate on the subject of transgenic crops.

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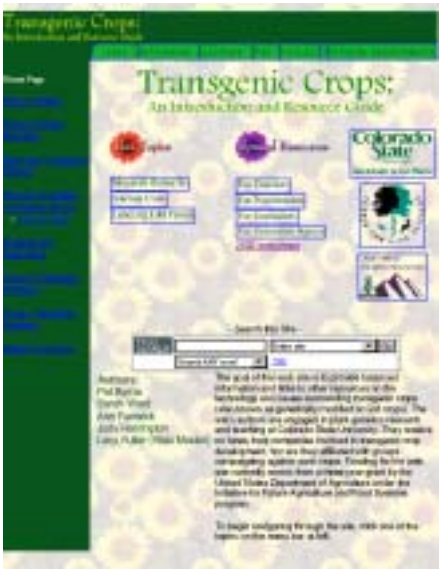

The goal of this website is to provide balanced information and links to other resources on the technology and issues surrounding transgenic crops (also known as genetically modified or GM crops).

http://www.colostate.edu/programs/lifesciences/TransgenicCrops/

Breeding Beans for Yield and Pest Resistance

Mark A. Brick, J. Barry Ogg, and Howard F. Schwartz

The Dry Bean Breeding project at Colorado State University concentrates on breeding pinto, black and light red kidney bean varieties and incorporation of new genes that provide resistance to rust and Fusarium wilt (FW). Fort Collins is the primary site for breeding activities, Fruita for seed increase and dryland variety development at Yellow Jacket. Several promising lines with resistance to FW based on greenhouse evaluations are being increased at Fruita for field-testing. Field trials to screen for FW will continue to determine if the green house evaluations is representative of field reaction to the pathogen. A selection nursery for white mold is being developed at Fort Collins to develop white mold resistant lines. Over 10, 000 early generation and elite lines were evaluated for root rot, rust, growth habit and adaptation each year. Recent variety releases from this program include: Montrose pinto bean (1999), Shiny Crow black bean (2000) and Grand Mesa pinto bean (2001).

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Genomics of Economically Important Traits in Wheat and Barley

Nora Lapitan

Wheat is one of the most important cereal crops in the world. Its large genome size presents difficulties in cloning of important genes in this species. This project's long-term goals are to provide DNA markers for marker assisted-selection of agronomic traits, and to make cloning of genes feasible and practical in wheat and barley. Our current focus is to map genes for Russian wheat aphid (RWA) resistance in wheat and clone resistance genes. DNA markers for tagging three RWA resistance genes in wheat have been developed and are being tested for their use in breeding. A wheat DNA fragment containing markers spanning an RWA resistance gene (*Dn4*) has been isolated. This result indicates that we may have already cloned the resistance gene. The identification of the coding sequence will represent the first insect resistance gene cloned from a plant, and the first agronomically important gene cloned from wheat. These results will provide insights on the molecular mechanism of resistance to the RWA and may lead to the cloning of genes that are useful for genetically engineering resistant genotypes. To facilitate cloning of wheat genes, our lab has been involved in mapping of expressed DNA sequences known as "expressed sequenced tags" or ESTs. Thus far, we had mapped over 300 ESTs to chromosomes of wheat.

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Gene Mapping for Stress Tolerance in Spring Wheat

Pat Byrne, Scott Haley and Cecil Stushnoff

This project focuses on mapping of genes for agronomic and stress tolerance traits in a spring wheat population. Currently spring wheat is not a common crop in Colorado, but it could become more important if higher yielding, stress tolerant cultivars are developed. The authors developed a population from two stress tolerant cultivars, one with resistance to the Russian wheat aphid (RWA). The lines were evaluated in 2001 at Akron (rainfed) and Fort Collins, Colorado (irrigated) and data were collected on a large number of morphological and yield component traits. In greenhouse trials the lines were evaluated for RWA resistance. DNA from each line was evaluated for microsatellite markers located throughout the genome. Results to date of our marker-trait analyses include the following: (1) Grain number per square meter was the yield component most highly correlated with grain yield. (2) Average kernel weight was a less important yield component. (3) Two chromosome regions, corresponding to the dwarfing loci accounted for a large proportion of the variation for plant height in both locations. The same regions also had major effects on biomass, test weight, and days to physiological maturity. (4) An apparently novel locus for RWA resistance was detected at the distal end of the long arm of chromosome 7D. Results of this study will enhance understanding of the genetic factors contributing to improved yield under stress, which will lead to better yielding wheat cultivars for the western Great Plains. The newly detected RWA resistance locus, if confirmed, will provide another tool for breeders developing resistant cultivars.

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Soil and Water Management Projects

Improving Tradition Soil Salinity Measurements

Grant Cardon

The main objective of this project is characterizing salinity's extent and severity in current soil, surface, and ground water in order to determine strategies for salinity control in irrigated fields along 40 miles of the lower Arkansas River basin. This region of the basin is currently estimated to be losing an average of 10 to 20% in yield due to soil salinity, or about 900,000 bushels of corn, and 24,000 tons of alfalfa. The correlation of laboratory, labor-intensive measures of soil salinity with more rapid indirect methods will provide a critical salinity control tool for growers and resource managers. Rapid indirect measures provide a means of mapping soil salinity, as well as temporally and spatially monitoring changes, enabling fast, accurate, and cost effective evaluation of salinity control strategies. Cardon used the indirect soil salinity assessment tools Electromagnetic Induction meter (EM meter) and Hach Company's in-field, quick salinity test kit. With about a third of the samples processed, preliminary analysis showed correlation between soil saturated paste extract EC and commercial quick test EC.

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Improving Prediction of Forage Water Use

Danny Smith

Accurate water use inventories are essential for administration of interstate compact agreements among states and individual water rights within all western states. In many remote areas, crop water use estimates are subject to significant errors because they are based on maximum and minimum daily temperature alone. Improved expressions of temperature and other easily monitored weather variables are needed to adjust existing models to account for local weather conditions. Use of these adjusted models to compute water use estimates, combined with installation of low-cost weather-monitoring devices, would result in more accurate accounting of crop water use throughout the western US. A locally adapted version of the Hargreaves radiation method should be more accurate in assessing consumptive water use in irrigated mountain meadows than Blaney-Criddle methods, even with crop coefficients adjusted to local conditions. Previous results have demonstrated that water use is poorly correlated with average daily temperature regardless of the temperature expression used. Thus, the conventional approach of adjusting Blaney-Criddle crop coefficients to local conditions was inadequate because it failed to account for climatic variability associated with years and sites. Previous analyses indicate that radiation accounts for a much greater proportion of crop coefficient variability than any expression of average daily temperature. During the current reporting year, more detailed analysis of the data demonstrates that variability in solar irradiance on a daily basis can be estimated using the difference between maximum and minimum daily temperature. Data from 2001 and two additional growing seasons will be used to refine existing models using the Hargreaves approach.

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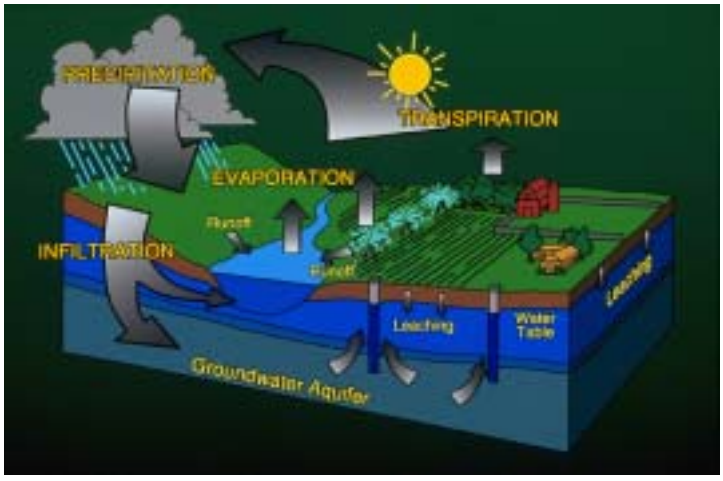

High-Value Utilization of Manure to Improve Soil Quality and Protect Water Quality

Jessica Davis

Using manure for high-value uses that improve soil quality and soil fertility will increase affordable transportation distances away from concentrated livestock producing areas. Soil quality will be improved, while water quality is protected. Manure can improve soil quality through variables including soil carbon (C), microbial activity, and earthworm populations.

Applying 30 tons manure per acre at three field sites over two years showed that active biomass C was not significantly different in any of the sites, but total biomass C was higher in manured plots at one location (a sandy loam with a history of manure application). Biomass N was significantly higher in manured plots at a site with clay soil and no recent manuring history. Earthworm populations were typically very low in all of the study sites. There were trends regarding greater earthworm populations in manured plots, but no statistically significant differences.

The higher the nutrient levels in manure, the greater the value of the manure. However variability of manure nutrient levels within and across farms makes manure sampling and development of reliable tabular values challenging. Farm variability was evaluated by analyzing 10 sub-samples from each of nine manure sources and determining the necessary sample numbers for 10% probable error. The project found about 25 sub-samples are necessary for N, phosphorous, and potassium characterization, but NH_4-N and NO_3-N require over 100 sub-samples. Manure tends to be drier in Colorado and have lower NH_4-N levels and higher P_2O_5 and K_2O levels than those reported in the Midwest. We have combined data with Utah and New Mexico to form a Mountain West Manure Database that will generate more reliable manure nutrient values for our region.

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Colorado State University Cooperative Extension

Horse Manure Management Workshop

***Free** Workshop, but you must call to register.*

April 13
Grand Junction
970-249-3935

8:30 am – 12:00
Mesa County Fairgrounds
2785 U.S. Hwy 50

April 18
Castle Rock
303-232-6242

8:00 am – 12:00
Douglas County Fairgrounds
500 Fairgrounds Dr.

April 20
Durango
970-247-3231

8:30 am – 12:00
LaPlata County Fairgrounds
2500 Main Ave.

May 4
Fort Collins
970-491-6201

8:30 am – 12:00
Pickett Equine Center (CSU)
Overland Tr. between Mulberry & Elizabeth St.

Is your horse manure piling up? Do you have a plan for its use? Come to the Horse Manure Management Workshop to learn about alternatives and make a plan for your manure! You'll learn how to

- compost using worms, pipes, or by turning
- understand regulatory requirements for horse owners
- protect water quality from manure nutrients and pathogens
- calculate whether you have enough land to use the manure at home
- determine optimal manure application rates
- market composted manure to sell (or give away)

Improving Water Management in Southwest Colorado

Abdel Berrada, Grant Cardon, Mark Stack, and Thomas M. Hooten

The irrigation management study in the Full Service Area (FSA) of the Dolores Irrigation Project in southwestern Colorado objective is to give growers important information on effective water management tools and practices that will help sustain current farm success and provide for water conservation and use efficiency. Research is composed of four main aspects: a 1996 mail survey; calibrating irrigation management equipment for use in the FSA; analyzing irrigation management equipment in situ; and field demonstrations of new irrigation systems.

The survey revealed several opportunities for water management outreach and results are available at: http://www.colostate.edu/Depts/AES/Pubs/tr01-6.pdf.

The amount of water used per irrigated acre exceeded the allocated amount in 6 out of 10 years, three of which were exceptionally dry years. Land in irrigated alfalfa has been much higher than anticipated, but poor management may also be to blame for the high water usage in the FSA. Active interstate markets, high quality hay, and good prices in recent years contribute to the focus local growers give alfalfa in their rotations. In the future, extra water from undeveloped parts of the FSA will not be available requiring significant changes in crop selection and water management. Results from this study can serve as the basis for implementing a water management assistance program in the FSA and current follow up research is determining the effects of limited water supplies on alfalfa hay production and quality to develop the best management strategies to address water shortages. Watermark sensors and Etgage atmometer were demonstrated in 1997, 1998 and 1999 in the FSA. Watermark sensor readings and water content of the predominant soil type in the FSA had a strong correlation. At Yellow Jacket there was close agreement between alfalfa reference evapotranspiration (ETr) values and ETr measured with an Etgage. Sub-surface drip irrigation (SDI) demonstration project began at the Southwestern Colorado Research Station. A reduction in alfalfa water requirement may be obtained using SDI, providing growers in the FSA a way to maintain alfalfa production with less water. The study will begin in Spring 2002.

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Characterizing Flow and Transport Processes in Soils at Different Scales

Greg Butters

Soil hydraulic properties are important in many soil processes but the measurement of these properties is usually tedious and often difficult. At Colorado State University, work continues on testing and applying a continuous flow method for rapid and accurate measurement of soil hydraulic conductivity and moisture retention functions including hysteresis. The continuous flow method is ideally suited for researchers evaluating fundamental soil water flow problems like temporal variation and spatial scaling/averaging of soil hydraulic properties. The method employs simultaneous tensiometry, air pressure, and water flow measurements that are easily automated and uncommonly rapid. Complete characterization of soil hydraulic conductivity and moisture retention over the tensiometer range of soil water potentials, including wetting and/or draining scanning curves, can be accomplished usually in two days or less. Applications for continuous flow include water quality (e.g. salinity) effects on hydraulic properties, the impact of microbial processes on soil water flow and management models with temporal effects in hydraulic properties.

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Environmental Quality Projects

Recycling Finished and Waste Water Bioproducts to Improve Environmental Quality

Ken Barbarick and Jim Ippolito

Water-treatment residuals (WTR), often called alum, are a waste product of treating municipal water supplies. This material can adsorb large quantities of phosphorus (P) may lessen P input into fresh-water systems from over application of sewage biosolids or from runoff from large feedlots. Barbarick's studies suggest solid octacalcium phosphate formation absorbs P from solution and is stable in WTR. Surface P chemisorption as an amorphous surface mineral phase also might occur to stabilize P.

Land application of biosolids provides a less expensive means of biosolids recycling for cities. Barbarick shows that long-term recycling of biosolids on dryland wheat and wildfire-burn areas is socially, environmentally and economically sustainable. To determine effects on the agronomic rate of long-term, continuous application of biosolids over seven years, biosolids and nitrogen (N) fertilizer were applied to dryland wheat on Weld loam soils. In summer 1999, incorporation of biosolids on no till crop rotations of wheat-fallow, wheat-corn-fallow and wheat-wheat-corn-sunflower-fallow began on Littleton and Englewood land near Byers, CO. In 1997, research in the Buffalo-Creek wildfire burn area in Jefferson County, CO Barbarick applied and incorporated composted biosolids followed from Denver Metro by seeding with an US Forest Service approved mixture. Biosolids significantly increased biomass production and plant canopy cover; however, production levels were smaller then the first year following initial addition due to another unusually dry growing season.

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For past issues of the Agronomy News on agricultural topics such as:

- **Biotechnology**
- **Dry Bean Production**
- **Variety Trial Results**
- **Nitrogen Fertilizer**
- **Precision Agriculture**
- **Salinity**
- **Phosphorus and Runoff**

Visit our website:
http://www.colostate.edu/Depts/SoilCrop/extension/Newsletters/news.html

Studying the Release of Mn and Trace Metals from Acid Mine Drainage in Soils Under Reducing Conditions

Dean Heil

Irrigated soils in the Alamosa River Basin, Colorado are impacted by water from acid mine runoff which results in acidification and metal accumulation. The current research objective is to determine if trace metals associated with these Mn oxide minerals are released after soils are saturated (soil reduction) from irrigation. Identification of the processes responsible for manganese (Mn) and trace metal solubilization will provide information to develop agricultural management practices for these soils, which will help protect water resources in this region. Results indicated that copper, palladium, nickel, and zinc (Zn) solubilities were greatly increased following reduction. The soluble concentration of Zn was significantly correlated with Mn in all four of the soils studied.

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Assessing Spatial and Temporal Variability of Soil Processes and Properties in Natural and Agricultural Ecosystems

Eugene Kelly, Ingrid Burke, Caroline Yonker, Jack Morgan, and David Schimel

Understanding the systematic variations in soils allows soil information extrapolation helping with regional assessments of soil conditions. One of our major areas of research has been extending biogeochemistry studies over longer timescales to assess the influence of soil age on ecosystem properties. We sampled and characterized soils in six alluvial terraces spanning the last 600,000 years. Mass balance calculations of soils along the terrace chronosequence indicate substantial changes in chemical constituents over geologic timescales. Carbonate accumulation over time from Stage I to early Stage III reveals a morphological sequence that positively associates soil development with age. Atmospheric deposition resulted in net accumulations of Ca, Fe, and Al, and losses of Si (Loadholt, 2002). Total P decreased over time, with the primary calcium-phosphate fraction declining over time; this fraction has not been exhausted in soils from the late Pleistocene, indicating a slow rate of primary mineral weathering. The occluded P fraction increases from around 7% of the total to 10%, while organic P increased approximately 23% over time, with the highest value present in soils approximately 350,000 years old. Organic P increased 14% in the first 10,000 years of soil formation while the non-occluded P remained a very small percentage of the total P.

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Soil Fertility Projects

Developing Site Specific Management Zones

Raj Khosla, Robin Reich, and Dwayne Westfall

Managing in-field variability using the management zone approach will lead to more efficient management of crop production inputs and reduce the need for intensive soil sampling (grid sampling approach). This approach may also optimize environmentally sensitive chemical application and enhance overall farm profits. Variable rate precision farming technologies can help develop and evaluate those in-field productivity level management zones designed to optimize nutrient application, grain yield, and nitrogen use efficiency. Low, medium and high potential productivity in-field management zones were developed for center pivot and furrow irrigated cornfields in NE Colorado. Treatments include: variable rate nitrogen (N) application based on intensive grid sampling; variable rate N application based on the management zone approach; and conventional uniform application of N based on the currently recommended algorithm. Fertilizer rate was determined by the farmer's discretion. Managing a field for inherent soil variability can be done with GPS and GIS technologies without expensive and time-consuming grid based techniques. By managing a field using productivity zones and N treatments that account for spatial soil variability, biomass productivity, N uptake, and N use efficiency is increased compared to conventional N application treatments.

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Root Characteristics of Colorado Crops as Related to Efficient N Fertilizer Use

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Using crop varieties that require less nitrogen (N) and other nutrient inputs will reduce the cost of these inputs to Colorado farmers and will reduce the potential pollution by farming in Colorado surface and ground water. Current experiments are testing if potato varieties with larger root surface areas associated with larger root volumes increase the uptake efficiency of N by measuring root surface area and N uptake rates for two varieties, one with a smaller root volume and top then the other. We are also trying to develop a faster and less expensive method for measuring root surface area. Results will potentially enable plant breeders to assess their lines for root characteristics that increase the nutrient uptake efficiency leading to a lower level of leachable nitrate and protection of water quality.

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Strategies for Zinc Fertilization of Dryland Corn and Sorghum

Kevin Larson and Frank Schweissing

Grower profitability is the key to economic stability in rural communities that rely predominately on agriculture. Reducing zinc (Zn) fertilizer rates, while maintaining high production levels of dryland corn and grain sorghum, will increase profitability. Soil test recommendations for SE Colorado typically recommend banding Zn at 2 lb/acre to both dryland corn and grain sorghum. In this area, classic Zn deficiency symptoms are often encountered in corn without Zn fertilization and adding Zn corrects the symptoms. Grain sorghum in SE Colorado displays no visible Zn deficiency symptoms, but growers report yield increases with Zn. Larson and Schweissing seedrow applied Zn chelate with the corn and grain sorghum at planting in a sandy loam soil. Corn yields increased with seedrow Zn up to 0.4 lb/acre ($^1/_5$ recommended rate); 9 bu/acre over the control. Grain sorghum did not respond to applied Zn and yields fluctuated no more than 2 bu/acre from the mean with Zn fertilization. Over three years corn responded to seedrow Zn with optimum rates ranging from 0.3 to 0.6 lb/acre. In five of six years, grain sorghum yields did not increase with applied Zn, except for an exceptionally high rainfall year. Larson and Schweissing recommend seedrow applied Zn at 0.3 to 0.6 lb/acre for dryland corn, but not for dryland grain sorghum production. Using low-rate seedrow applications of Zn to dryland corn and eliminating Zn fertilizers from dryland grain sorghum would reduce the amount of Zn needed and thus fertilizer cost, and the potential heavy metal contaminates in the environment.

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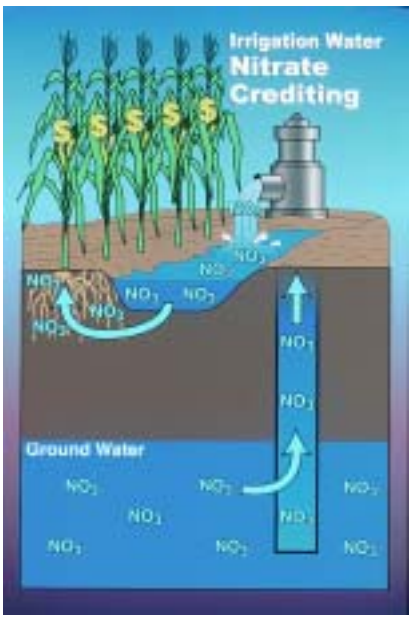
Refining Nitrogen Credits from Irrigation Water

Troy Bauder, Reagan Waskom, and Jerry Alldredge



Many irrigated areas of Colorado have elevated (>10 ppm) ground water nitrate-nitrogen levels. Frequently, this nitrate-enriched water is used as an irrigation source. Crediting water nitrate is part of Colorado nitrogen (N) fertilizer recommendations and nutrient management plans, but growers and consultants are often not confident in crediting this significant N source. We conducted replicated demonstration strip and small plot field trials to verify the benefit of high nitrate irrigation water to production and quantify a fertilizer credit. Nitrogen fertilizer rates were adjusted at 10 sites years to represent from zero to 100 percent of potential water N credit based upon the CSU N fertilizer algorithm. Cooperating farmers applied irrigation water and grew grain or silage corn according to their usual methods. Grain and silage yield results from 1997 to 2001 showed that crediting 100 percent of consumptive use prior to R3 (milk stage) did not significantly reduce yields unless the field produced above the yield goal used to calculate the nitrogen need. Yield responses to additional fertilizer N were obtained when potential exceeded yield goals. Farmers met or exceeded their estimated N credit with irrigation water nitrate applied each year. Results suggest that growers can credit up to 60 percent of seasonal consumptive use (15 of 24 inches) of water nitrate-nitrogen and still maintain their yield goal while removing nitrate from ground water. We are continuing this work in 2002 and would like to conduct irrigation nitrate crediting research on other crops such as small grains and potatoes.

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web pages

http://www.colostate.edu/Orgs/ARDEC/
Agricultural Research, Development and Education Center website

http://www.colostate.edu/Depts/SoilCrop/extension/Newsletters/news.html
Past issues of Agronomy News

http://www.ext.colostate.edu/
Cooperative Extension Home Page at Colorado State University

http://www.colostate.edu/Depts/AES/index.html
The Colorado Agricultural Experiment Station website

http://www.colostate.edu/programs/wcrc/
Western Colorado Research Center website

http://www.akron.ars.usda.gov/
Central Great Plains Agricultural Research Center website

http://www.colostate.edu/programs/lifesciences/TransgenicCrops/
Balanced information on the technology and issues surrounding transgenic crops

http://www.csuag.com
Links to most agricultural programs at Colorado State University