# Agricultural Experiment Station

## 1990 Annual Report

Colorado State University

## Colorado State University

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# Contents

# Director's Report

1990 provided me with many lessons, especially since assuming the role of Interim Director in April. A number of visits have been made to different parts of the state and to various facilities that are part of the Colorado Agricultural Experiment Station. Each visit has taught me a great deal about Colorado agriculture and has given me opportunity to meet more of the people who contribute so much to this state. I am grateful for these acquaintances.

The high productivity of American agriculture has led to a paradox which also prevails in Colorado: only a few people are needed to produce the raw commodities that provide our sustenance; yet, everyone enjoys the fruits of agriculture's productivity. Thus, many fewer voices represent the producers than represent consumers. The strength of these collective voices becomes important to the generation of resources that support the agricultural research program.

The Colorado Agricultural Experiment Station receives most of its funding from the State of Colorado and the federal government. A study developed in response to Footnote 43 of the 1989-90 Appropriations Bill revealed that this experiment station is funded at barely half the level of comparator states. Comparator states were those with an agricultural industry of similar size and diversity. The size and diversity of Colorado's agriculture are major determinants of the experiment station's program in agricultural research.

The General Assembly, in the appropriation for the current fiscal year, provided an additional 2 percent increment. While this leaves us far short of our ultimate objective, we are grateful for this step in recognition of our deficient funding level. These funds provided (a) one-time monies for the plant biotechnology laboratory, (b) two positions at outstate sites: a vegetable crops scientist to serve the Southeast Regional Research/Extension Program (to be located at the Arkansas Valley Research Center, Rocky Ford) and a horticulturist to be associated with the San Luis Valley Research Center, (c) some matching funds for equipment needed to study jointed goatgrass, a major problem for wheat producers, and (d) a small allocation for product development and processing. We appreciate Dr. Robert Heil's efforts on behalf of the recommendations emanating from the Footnote 43 study.

We were fortunate during the last few weeks of Dr. Heil's tenure as Director of the Agricultural Experiment Station to have his leadership also in moving forward with the development of a strategic plan for the station. Dr. Heil had placed a high priority on such a plan and we appreciated his willingness to guide our moving ahead with the undertaking. The task is not yet complete but we believe considerable progress has been made. A brief statement of progress appears elsewhere in this report.

In our travels we have been made aware of situations as they exist in rural Colorado and the challenges on the horizon for agriculture in this state. This information is taken into account as we guide program development efforts and as we develop budget requests to go before the legislature.

During these months I have gained a deep appreciation for the accomplishments of all those associated with the Colorado Agricultural Experiment Station: the scientists and support staff at the off-campus locations as well as here in Fort Collins and, of course, the excellent staff here in the Director's Office. The cooperating farmers and ranchers contribute immeasurably to our program. The advice and counsel provided by the many who serve on the advisory committees for our research centers around the state enables us to focus our programs more meaningfully. Various commodity groups have provided support to specific scientists and/or research projects. All of these elements have made a difference in our research productivity which is described in this report.

While a number of topics deserving investigation are beyond the limits of our current resources, we continue to pursue various avenues for additional funding. We are pleased to share with you summaries of a number of significant studies.

Helen F. McHugh
Interim Director

## Notes from the Long Range Strategy Plan

In 1989-1990, the CAES began developing a long-range plan for agricultural research in Colorado. The conceptual phase of this plan is nearing completion. Research is identified in six program areas: environment and natural resources; human nutrition and food safety; adding value, processing, marketing and distribution systems; economic and social issues; animal systems; and plant systems. Six topical committees have identified issues, research objectives, scientific disciplines, and priorities. Their analyses have resulted from surveys received from governmental agencies, commodity organizations, agribusiness firms, research center advisory committees and researchers.

The conceptual plan has yet to be reviewed internally and externally. Assuming a consensus on the issues, objectives and priorities is reached, an implementation plan will be developed to reach the CAES program goals by 1997.

## Plans for the North Agricultural Campus

In 1990, the legislature approved funding to initiate the development of an agricultural research facility northeast of Fort Collins. In addition to planning funds, monies were provided to install the irrigation system at the 200 acre site. Funds to complete this project were requested for 1991-92 and we are very optimistic that funding will be forthcoming in this legislative session.

This facility provides an exciting and unique opportunity to conduct short- and long-term field research in an integrated interdisciplinary environment. Units that will conduct research at the site include the departments of Agricultural and Chemical Engineering, Agronomy, Entomology, and Plant Pathology and Weed Science. Collaborative research will also be conducted with the USDA Agricultural Research Service.

Architectural and engineering plans are being developed and are nearing completion. The irrigation system is expected to be installed by late summer, 1991 with building construction completed in Fall, 1992.

## Summaries of Major Projects

### Biology and Control of Russian Wheat Aphid in Colorado

Russian wheat aphid (RWA), Diuraphis noxia, was first reported in the United States in 1986. From that time through 1989 it has caused an estimated $75 million loss to Colorado small grain producers in terms of increased production

costs and diminished yields. Regional losses have been estimated at $251 million during the same period. Winter wheat producers in Colorado are confronted with spending about 2/3 of their pre-aphid profit margins on an insecticide treatment or switching to an alternative crop with similar lowered income per acre. The Colorado Russian wheat aphid project has made significant progress toward: a) improved insecticide application technology; b) establishment of economic thresholds; c) modification of cultural practices; d) population monitoring; e) basic RWA biology and ecology; f) improved biological control of RWA; g) varietal resistance to RWA; and h) RWA technology transfer and cooperation. Cooperative projects have been established with USDA-ARS (Stillwater, OK; Ithaca, NY) (biological control, varietal resistance); with USDA-APHIS (information transfer); and with other states and Canada through regional cooperation and coordination. Russian Wheat Aphid News is distributed to more than 300 individuals in the United States and several other countries.

## Improving the Competitiveness and Profitability of Colorado's Beef Cattle Producers Through Integrated Resource Management

The beef cattle industry is essential to the economic well being of Colorado. Annual sales of cows and calves off Colorado ranches is approximately $230 million. The problems ranchers face seldom involve a single disciplinary. The interrelationships among various ranching activities need to be recognized when making management decisions. To improve the competitiveness and profitability of Colorado beef cattle producers, objectives have been to utilize the team approach to identifying problems and developing possible solutions through effective resource management. By disseminating the IRM program to many rural communities, a spirit of cooperativeness and team work has been fostered among local ranchers and others involved in the food production chain. Local expertise, such as soil conservation specialists, local veterinarians, local ag lenders and county extension personnel. In the end, the consumer benefits the most by having access to a competitively priced, nutrient dense and palatable product--beef. Through IRM a healthy rural economy is a result of profitable ranching through optimum utilization of all resources for better efficiency.

## New Potato Cultivars for Colorado

The Colorado potato industry markets a great majority (95%) of its crop as fresh potatoes. Potato varieties adaptable to Colorado conditions prior to the mid 1970s did not permit a sufficiently high percentage of marketable tubers to enable Colorado producers to profitably compete in a dynamic and challenging national produce market. Tuber yield and quality were also being limited by several seed-borne diseases. During the past 15 years, four new named potato varieties have been developed and released for commercial production. Concurrently a seed improvement research program, closely coordinated with the variety development program, has resulted in routine use of tissue culture propagated seed that undergoes intensive lab testing prior to field production on seed growers' farms.

The combined effort of vastly increased marketable yields due to new varieties plus the overall superior performance of improved seed stocks has benefitted Colorado fall crop potato producers. When data for 1974-1977 is compared with that for 1986-1989, it shows that acreage increased by 71%; yields by 27%; and production by 117%. During the past six years, CSU-developed potato varieties have accounted for 75% of the acreage of certified seed grown in Colorado. During the same period, according to data supplied by the Colorado Crop Reporting Service, an estimated average of 72% of all fall crop potatoes grown in Colorado consisted of varieties developed by the CSU Agricultural Experiment Station.

## Long-Term Ecological Research: Shortgrass Steppe

The shortgrass steppe long-term ecological research project led by scientists in Range Science and Forest and Wood Science is funded by the Colorado Agricultural Experiment Station and the National Science Foundation (NSF). As part of a Long Term Ecological Research Program, the project is one of only 17 in the nation. The work being conducted has enormous potential to contribute to decisions about the management of semiarid grasslands. Further, studies of the shortgrass steppe contribute to understanding the response of Great Plains grasslands to global climate change. The Great Plains is one of the regions of the North American continent expected to be most affected by climate change. Information gained from this research will be critical to management of agricultural, ecological, as well as socioeconomic systems.

## Land Rehabilitation and Soil Erosion

Revegetation projects can benefit from basic ecological research which addresses multifactor interactions inherent in plant community establishment. Resultant plant community composition may be sensitive to initial conditions and unpredictable within narrow ranges because of the variability of the interactions. It is important to design models which are flexible and which contain sufficient information about the underlying factors. Weather, soil, plant and animal factors will vary and interact to adjust the form of the plant community. The cooperation of experts in these areas can be useful to design realistic revegetation plans.

## Enhanced Program in Animal Biotechnology

The advances made in animal biotechnology at Colorado State University have occurred primarily in reproductive biology at the molecular level and in treatment and prevention of disease. Not only have these developments enhanced the capabilities of our researchers but also graduate students, especially those at the doctoral level, have been taught the latest molecular biological techniques. Areas in which work has been focused include (1) preventing disease transmitted by insect vectors, and (2) elucidation of the molecular bases for the postpartum anestrus in beef cattle and sheep. The quality of the program has resulted in a USDA training grant.

# Notes from CAES Research Centers

## Arkansas Valley Research Center - Rocky Ford

Research at the Arkansas Valley Research Center in 1990 covered the areas of conservation tillage, cultural practices, irrigation, variety trials, disease, insect and weed management. Regular sampling of three irrigation canals in the area indicate significant amounts of nitrogen can be added to the soil from irrigation at certain times of the season. Use of nitrogen fertilizer on alfalfa slightly, but significantly, increased yields. Alfalfa variety trials indicate that yields of available cultivars under good management systems will produce 2 to 4 tons more annually than the average for the area. Occurrence of peak alfalfa weevil populations appear to be related to degree-days, but cannot be determined from such things as calendar date or alfalfa growth. Available herbicides, properly used, can provide adequate weed control in alfalfa, dry beans, and onions.

Results show that nitrogen and water can be overused on onions which can add to groundwater pollution and grower expense. Yields in no-till corn are equal to that grown under standard tillage methods, but the increased crop residue interferes with furrow irrigation and cultivation practices. Data show that with the light greenbug infestations encountered in 1990, available greenbug resistant cultivars eliminate any need for additional control measures in sorghum to produce maximum yields.

Research at the Center in 1991 will continue to focus on the efficient use of fertilizer and irrigation water, conservation tillage systems under furrow irrigation, cultural practices to reduce production costs, prediction of disease and insect problems, and management of disease, insect and weed problems. The addition of a vegetable crop scientist will allow us to increase research on these important crops.

## Eastern Colorado Research Center - Akron

The annual field day was held on May 15, 1990. Results of research projects were presented by Dr. Cheryl Nockels on the effect of source of copper on performance of copper deficient calves. Mr. Jim Doubet talked on the effect of MGA level when synchronizing estrus with MGA-lutylase. Dr. Tim Stanton gave a feedlot update and presented the results of research completed on the effect of time of feeding on performance in finishing cattle. Ms. Sandra Burns spoke on the use of ultrasound for evaluating body condition score in beef cows. Mr. Mike Holland spoke on factors influencing calving difficulty. Ms. Julie Godfredson talked about parentage proofing with DNA finger printing. Dr. Ken Odde talked about the terminal sire program presently being used at the research center.

Currently research being conducted at the research center or with research center resources are:

- Efficacy evaluation of erodible norgestomet implants in growing heifers.
- Effect of pre-partum energy nutrition on basal metabolism in bovine neonates.
- Effect of calving difficulty on metabolic function in newborn calves.
- Evaluation of protein supplements on the performance of grazing gestating-lactating cows.
- The effect of roughage processing upon finishing cattle performance.
- The use of self feeders in finishing cattle performance.
- Effect of type of roughage on finishing cattle performance.
- Effect of lipid in cow diets on post-partum reproduction.

## Fruita Research Center - Grand Junction

Research conducted during 1990 at the Fruita Research Center focused on several crops and agronomic research topics. Annual cultivar performance tests were conducted in small grains, corn grain and forage, alfalfa, dry beans, and soybeans. Herbicide efficacy tests were conducted in dry beans and soybeans. In cooperation with Dr. Paul Nordquist, University of Nebraska, seed production was evaluated for numerous grain sorghum breeding lines. The second year of a dry bean row spacing x plant population x variety study was conducted to learn more about how these factors interact.

Two nitrogen fertility studies were conducted during 1990. Information was obtained that will help farmers improve nitrogen use efficiency in corn by improved timing of application and type of nitrogen fertilizer used.

The Russian wheat aphid (RWA) research program noted highly significant differences in overwintering of the RWA in east-west versus north-south bedded fields in the Grand Valley. Aphids survived the winter on the south facing slopes of the irrigation furrow of the east-west bedded fields because of the dramatically higher temperatures within that narrow zone. Research efforts also include determination of the critical crop growth stage for RWA damage and host plants important in the RWA life cycle. Off-station plots are located at Craig and Yellow Jacket.

A long term conservation tillage study was initiated during 1990 at the Fruita Research Center to compare conventional and conservation tillage of corn, wheat, dry beans, and soybeans grown under furrow-irrigation. Data to be collected will include irrigation water advance rates and infiltration, soil erosion, soil moisture, organic matter accumulation, weed and pest population dynamics, crop yields, and economics of these two systems.

Nineteen asparagus varieties are being studied at the Research Center by Curtis Swift of the Tri-River Area Cooperative Extension. Yields of the second year of harvest were favorable, although the harvest period was shorter than anticipated.

Dryland wheat variety plots in northwest Colorado, again, were included as a part of our research efforts to meet the needs of producers in that part of the State.

Surge irrigation under furrow-irrigation systems common to western Colorado counties of Mesa, Delta, and Montrose showed promise of improved water application distribution and reduced leaching, without adversely affecting corn yields.

Activities of the Dry Bean Foundation Seed Project during 1990 at the Research Center included foundation seed production, processing, and sale of pinto beans, and for the first time included a black bean recently released by the University of Idaho. Seed of several advanced lines from the Dry Bean Breeding Project located at Fort Collins were increased at the Research Center, including one line that is being considered for release as a new CSU pinto variety.

Plans are being developed to conduct future research on production problems in western Colorado associated with a corn ear stunting phenomenon, alfalfa stem nematode, and evaluation of irrigations systems.

## Mountain Meadow Research Center - Gunnison

A 579-page project report on water use and soil/plant responses in formerly-irrigated meadows having naturally fluctuating groundwater levels and in deep lysimeters having controlled water levels was published. The research involved the Agricultural Experiment Station at Colorado State University, the University of Wyoming, the City of Denver and Denver's consulting water engineering firm. The report documented winter soil moisture build-up and use of ground water, precipitation and irrigation water. It documented these agronomic responses to water: total forage yield, yield and dominance by plant species, growth of Juncus (rush) plants and changes in soil chemistry - notably soil salinity (i.e. electrical conductivity). Exploratory research confirmed the fairly widespread occurrence of seeded tall fescue in intermountain Colorado, but it found only limited veterinary observations of fescue toxicity. Seeding legumes directly into native meadows was met by good success or dismal failure, demonstrating especially the crucial importance of good management of irrigation water and plant competition.

## Orchard Mesa Research Center - Grand Junction

Cryoprotection, reduced deficit irrigation, pest and disease control trials, peach inking, orchard replant problems, and a multidisciplinary study of X-disease incidence, detection, and vectors were the focus of fruit research. Fruit variety and

rootstock testing and some work on peach mosaic were also continued. The cryoprotectant spray study demonstrated the difficulty in achieving frost protection through a spray application; no protection was observed for apricots or peaches treated prior to a severe late spring freeze May 9th. Reduced deficit irrigation reduced peach shoot growth, but did not increase fruit size as observed in prior years.

Good control of codling moth, two-spotted mite, pear rust mite, and grape mealybug was obtained on pear with a spray program based on paraffinic oil; control of these pests was equivalent to that provided by the standard program based on Guthion. Two or three post-shuckfall sprays with an ergosterol biosynthesis inhibitor fungicide, myclobutanil, provided good control of peach rusty spot on "Loring" and "Jim Wilson" peaches (63% and 74% control, respectively); when registered for use on peaches, this material could provide an outstanding alternative to the present sulfur and/or benlate-based spray programs for this disease.

A peach fruit blemish known as peach inking severely impacted several peach varieties from several orchard areas in Mesa County. Studies determined it to be linked to fruit skin pH reactions (and fruit waxes used in the packing process); recommendations were made to pre-treat the fruit with a dilute citric acid spray just ahead of the wax application to minimize development of the disorder in packed fruit.

Outstanding growth response of peach to pre-plant soil fumigation continued to be evident in 1990; fruit production on three-year old trees is expected in 1991 (weather permitting) in contrast to the typical initial fruit production on four- to six-year old replant peach trees. Similar growth responses were observed for apricot at a cooperating grower's orchard, but response by apple to soil fumigation under field conditions remains mediocre at best.

DAPI staining of X-disease symptomatic trees found a decline in occurrence of the X-disease mycoplasma (X-MLO) in 1990. Samples from some previously DAPI-positive trees were totally DAPI-negative; this suggests the X-MLO populations within these trees either died out or declined to non-detectable levels between 1988/89 and 1989/90. Two additional leafhopper species known to vector X-disease were documented from Mesa County, but none of the most common vector species, the Flor leafhopper, transmitted X-disease in celery bioassays during 1990.

Viticulture research was revitalized with funding established through the Colorado Wine Industry Development Act and the Colorado Wine Industry Development Board. The research focus for 1991 will be vine hardiness, vineyard irrigation, establishment of a new research vineyard, and development of an enology laboratory.

The Plainsman Research Center expanded an additional quarter section. The Plainsman Agri-Search Foundation, the growers association which owns the land on which the Plainsman Research Center operates, now owns or leases 720 acres of land.

Because of the need for quality, weed-free wheat seed in the Southeast area, the Foundation entered the certified and registered wheat seed market. To support this decision, the Foundation constructed two wheat storage bins on the Plainsman's north farm.

With the rising fuel cost of pumping irrigation water, water conservation became an important issue. To evaluate the water efficiency of a center pivot system, the Foundation purchased a conventional center pivot and converted three-fourths of the towers to the latest technological advancement in sprinkler application - Low Energy Precision Application (LEPA). The LEPA system will be compared to conventional sprinkler system beginning this spring.

The bulk of grain sorghum production in Colorado is grown primarily in the Southeast area of the state. With this recognition, the responsibility of the statewide Sorghum Testing Program was shifted from Fort Collins to the Plainsman Research Center. This was accompanied by changes in trial locations and information gathered, both have been favorably received by sorghum growers.

The Plainsman Research Center hosted two field days last year, one in the spring and one in the fall. The spring field day was held in cooperation with Jim Echols of the Crop Testing Program, and Cynthia Walker, Regional Russian Wheat Aphid Entomologist.

The spring field day focused on wheat:

- Dryland and Irrigated Wheat Variety Trials
- RWA Economic Threshold
- Date and Plant Density Effects on RWA
- Release of RWA Predatory Insects

The fall field day focused on spring crops:

- No-till Crop Rotation Systems
- Row Spacing, Plant Density, and Weed Control in Sunflower
- Dryland and Irrigated Grain and Forage Sorghum Tests
- Limited Irrigation on Sorghum and Corn
- Weed Control in Sorghum and Corn
- Soil Water Measurement with Gypsum Blocks

## Rogers Mesa Research Center - Hotchkiss

Two treatments aimed at reducing heat stress disorders of apples, by modifying physical properties of fruit surface, were evaluated on two varieties. The bentonite treatment inhibited development of so called blush by 45% on 'Golden Delicious' apples. None of the treatments, though, significantly reduced the most serious heat stress disorder - fruit sunburn. In another experiment, for the third year, pre-harvest pruning and defoliation/pruning treatments increased incidence of blush on 'Golden Delicious' apples, a desirable marketing characteristic, without increasing incidence of fruit sunburn. The decision support system for apple crop load management was successfully tested for the third fruit thinning season. The framework for an object oriented data base was adapted to facilitate evolution of the crop load management system into an integrated orchard management decision support system. The significant finding from peach rootstock evaluation trial is related to the bloom date of 'Redhaven' peach trees on 'Damas 1869' rootstock. These trees bloomed earlier than trees on any other rootstock in 1990, thus reversing the previous bloom date trend. The new apple variety/rootstock trial was established. The planting consists of replicated plots of 7 varieties on 5 rootstocks.

## San Juan Basin Research Center - Hesperus

Major research emphasis involves the crossbreeding of composite sires mated to purebred cows. Objectives of the study is to select and mate composites with genetically diverse breeding but comparable biological type and form a new composite from three initial composites. The composite sires mated to Hereford cows are CASH, MARC3 and RX3 to establish system one. In system 2, Brangus, Beefmaster and Barzona Sires are mated to Angus and Red Angus cows. F1 and F2 females are mated to the composite sire that is least related. F3 females are mated to F3 sires to obtain the new composite for each system. These composite systems are being evaluated for maternal, growth and carcass traits. Results from this project are published in the Annual Beef Cattle Report.

Twenty mule deer were trapped and fitted with telemetry collars to determine migration activity, feeding habits, diet composition and damage to alfalfa fields. Field count on 80 acres of alfalfa has been in excess of 200 deer at certain times of the summer. Data is being analyzed for the 1990 season.

Irrigated Regar brome grass and a mixture of Regar brome and cicer milkvetch is being evaluated under continuous and rotational grazing. Cicer milkvetch in the pasture did not increase the carrying capacity or animal performance. Beef production was improved slightly by using a four pasture rotation grazing system. Bloat blocks fed at the recommended level to steers grazing a solid stand of alfalfa was not effective in the control of bloat. At the conclusion of a 50 day grazing period death losses from bloat amounted to 13 percent.

Three hundred young bulls representing 13 breeds and crosses from 40 ranches and 6 states were evaluated for growth and reproductive performance.

One hundred ten Suffolk and white faced rams were performance tested for 24 Colorado purebred breeders.

Permanent transects were established at 3 different densities of Ponderosa Pine to determine long term changes in vegetation.

## San Luis Valley Research Center - Center

Several studies were conducted in 1990 on potato breeding, potato disease, post harvest quality, potato growth, weeds, small grains and new crops. Frontier Russet (A74114-4) was released jointly by the Colorado, Idaho, Washington and Oregon AESs and the USDA-ARS. Frontier Russet is a dual purpose potato with fresh market and processing qualities.

Seed tubers produced at a site near Gilcrest, Colorado and at the San Luis Valley Research Center were included in yield tests conducted at Saskatoon, Saskatchewan, Becker and Gilcrest during this past year. This provided an opportunity to test the response of seed grown at a higher elevation with the other test sites. Preliminary analyses suggest that seed tubers from the San Luis Valley out-yielded the Becker seed and compared favorably with other sites.

The russet nugget variety was most tolerant of herbicide treatments, followed by centennial russet and sangre. Sangre sensitivity was expressed in deep epidermal cracks, most often from the assert treatments. Russet burbank was most sensitive to all herbicide treatments, and readily developed cracked, knobby, or folded tubers which would not be marketable. The potatoes were most sensitive to damage when treatment occurred at the pre-bloom stage. Most obvious effects included a reduction in normal tuber number, a reduction in potato yield, and a reduction in average tuber weight. Assert applied at 0.47 lb. ai/a at the early postemergence stage caused appreciable tuber damage to both the sangre and russet burbank varieties. This research reemphasizes the importance of exercising caution when applying these herbicides near growing potatoes, and the importance of proper spray tank cleaning procedures following use of these herbicides.

The data collected from a potato plant growth study clearly show how the three cultivars differ in development of foliage growth, time of tuber initiation and rate/duration of subsequent tuber growth. The information suggests that the most recently released Colorado cultivar, the late maturing Russet Nugget, needs to be very carefully managed under San Luis Valley conditions to reduce the risk of potential low yields due to early fall frost. The growth cycle of Sangre seems to be ideally suited to San Luis Valley conditions; in fact Sangre could serve as a model for gauging the growth stage pattern of future new cultivars being developed for this area. The results strongly suggest that data of this type will be an

essential prerequisite for successfully implementing reduced chemical use pest control strategies; crop management to reduce the risk of ground water contamination; and alternative crop production methods.

A collection of 900 endophytic bacteria was obtained from potato stems collected from fields in the San Luis Valley and Weld County, Colorado. Sap from diseased and symptomless plants, collected throughout the 1990 growing season, were spread onto King's B medium, nutrient broth-yeast extract medium, and NCP. Two isolates from each plate were selected at random, purified, and stored at -80°C in glycerol. A plant bioassay to screen for biocontrol agents is in progress. Tissue cultured, pathogen-free potato plantlets of various cultivars have been inoculated by root and stem inoculation techniques. Preliminary results indicate screening of the biocontrol agents will be accomplished in the spring and summer of 1991.

## Southeastern Colorado Research Center - Springfield

Results of a two year clipping study of warm season grasses indicate that Cheyenne indian grass, Cimarron little bluestem, Ironmaster old world bluestem and Elida sand bluestem hold promise as forage sources for Southeast Colorado. We continued to monitor the impact of fertilizer on succession of go-back rangeland. Phosphorus appears to have no effect on plant succession. Nitrogen appears to be moving plant succession towards a higher plane.

Stocker steers grazing native range provided with Rumensin blocks did not gain any more weight than control steers. Stocker steers grazing summer pasture were supplemented with pelleted grain or pelleted grain with either a live or dead yeast product. Steers receiving pelleted grain gained better than controls. Those receiving 4 lb/day gained no better than those receiving 2 lb/day. Neither yeast product resulted in improved performance over grain alone. Weight response of cows and calves supplemented with zinc methionine was the same as controls.

This was the eighth year to evaluate the effect of continuous and short duration grazing on gains by stocker steers and on the plant community. Stockers managed under continuous grazing gained more per animal than those managed under short duration grazing, regardless of stocking rate. Species composition of the continuous and short duration grazed pastures appeared to remain similar.

## Southwestern Colorado Research Center - Yellow Jacket

Weather exerted more influence on the research program at the Southwestern Colorado Research Center than any other factor in 1990. The year 1989 and the first six months of 1990 were extremely dry. In 1990, spring winds lowered irrigation efficiencies and mid-to-late summer hail storms seriously damaged the crops. The 1990 dryland dry bean crop was reported to be ten percent of normal.

The research at the Southwestern Colorado Research Center in 1990 included (1) the development of higher yielding, drought tolerant, and pest resistant edible dry beans adapted to the semi-arid Southwest; (2) the identification and testing of dryland crop management systems that optimize yield, minimize environmental degradation, and maximize soil moisture storage; and (3) irrigation management strategies to improve water use efficiency.

# Statement of Revenues and Expenditures

| | Actual 1989-90 | Budget 1990-91 |
|---|---|---|
| **Revenues:** | | |
| State General Fund | $ 7,236,486 | $ 7,747,212 |
| Less: 2% State Recision | | 154,944 |
| Adjusted General Fund | | 7,592,268 |
| Federal Appropriations | 1,495,534 | 1,552,907 |
| Cash Sales | 240,000 | 240,000 |
| Cash Transfer from State Board of Agriculture | 160,000 | |
| *Total* | *$ 9,132,020* | *$ 9,385,175* |
| **Expenditures:** | | |
| Administration - Director's Office | $ 263,201 | $ 292,954 |
| Research Program | 7,183,569 | 7,479,827 |
| Less: 2% State Recision | | 154,944 |
| Program Enhancements | | 145,514 |
| Adjusted Research Program | | 7,470,397 |
| Russian Wheat Aphid | 415,395 | 442,780 |
| Utilities | 361,046 | 361,046 |
| Colorado State University Plant and Administration | 908,809 | 830,767 |
| Less: 2% State Recision | | 12,769 |
| Adjusted Plant & Admin. | | 817,998 |
| *Total* | *$ 9,132,020* | *$ 9,385,175* |

# Three Year Analysis of Revenue and Expenditures

| | Actual 1988-89 Amount | % | Actual 1989-90 Amount | % | Rescinded Budget 1990-91 Amount | % |
|---|---|---|---|---|---|---|
| **Source:** | | | | | | |
| General Fund | $7,265,239 | 79.8 | $7,236,486 | 79.2 | $7,592,268 | 80.9 |
| Hatch & McIntire Stennis | 1,602,784 | 17.6 | 1,495,534 | 16.4 | 1,552,907 | 16.5 |
| Cash-Residual Sales from Research | 240,000 | 2.6 | 240,000 | 2.6 | 240,000 | 2.6 |
| Transfers from SBA | | | 160,000 | 1.8 | | |
| Total | $9,108,023 | 100.0 | $9,132,020 | 100.0 | $9,385,175 | 100.0 |
| **Application:** | | | | | | |
| AES Administration, Program and Russian Wheat Aphid | | | | | | |
| Exempt Salaries | $4,002,309 | 44.0 | $4,037,204 | 44.2 | $4,485,113 | 47.8 |
| State Classified & Hourly Salaries | 1,601,701 | 17.6 | 1,488,916 | 16.3 | 1,531,617 | 16.3 |
| GRA Salaries & Tuition | 842,424 | 9.2 | 887,801 | 9.7 | 914,172 | 9.7 |
| Total Personnel | 6,446,434 | 70.8 | 6,413,921 | 70.2 | 6,930,902 | 73.8 |
| Travel | 162,335 | 1.8 | 132,771 | 1.5 | 130,542 | 1.4 |
| Operating Expense | 775,638 | 8.5 | 985,536 | 10.8 | 906,465 | 9.7 |
| Capital Outlay | 435,796 | 4.8 | 329,937 | 3.6 | 238,222 | 2.5 |
| Total Administration & Program | 7,820,203 | 85.9 | 7,862,165 | 86.1 | 8,206,131 | 87.4 |
| CSU Plant & Administration | 875,960 | 9.6 | 908,809 | 9.9 | 817,998 | 8.7 |
| Utilities | 411,860 | 4.5 | 361,046 | 4.0 | 361,046 | 3.9 |
| Total | $9,108,023 | 100.0 | $9,132,020 | 100.0 | $9,385,175 | 100.0 |

# Expenditures by Line Item/Unit

## State General, Federal (not requiring matching), and Cash Funds

| | Actual 1989-90 Amount | % | RESCINDED Budget 1990-91 Amount | % |
|---|---|---|---|---|
| AES Administration & Program Support | | | | |
| Director's Office | $ 263,201 | 2.9 | $ 292,954 | 3.1 |
| Direct Program Support (communications, statistical services, etc.) | 260,542 | 2.8 | 333,090 | 3.5 |
| Program Enhancement | | | 129,944 | 1.4 |
| Indirect Costs: | | | | |
| CSU Plant & Administration | 908,809 | 9.9 | 817,998 | 8.7 |
| Utilities | 361,046 | 4.0 | 361,046 | 3.9 |
| Total | 1,793,598 | 19.6 | 1,935,032 | 20.6 |
| Research Centers | | | | |
| Program and Russian Wheat Aphid - | 2,707,174 | 29.7 | 2,731,228 | 29.1 |
| Main Station | | | | |
| Program and Russian Wheat Aphid - | | | | |
| College of Agricultural Sciences | 2,557,299 | 28.0 | 2,585,336 | 27.5 |
| College of Engineering | 571,874 | 6.3 | 578,460 | 6.2 |
| College of Forestry & Natural Resources | 548,592 | 6.0 | 624,353 | 6.6 |
| College of Applied Human Sciences | 177,880 | 1.9 | 187,524 | 2.0 |
| College of Veterinary Medicine | 512,888 | 5.6 | 498,004 | 5.3 |
| College of Arts, Humanities & Social Sciences | 42,250 | .5 | 42,902 | .5 |
| College of Natural Sciences | 220,465 | 2.4 | 202,336 | 2.2 |
| Total Program and Russian Wheat Aphid - Main Station | 4,631,248 | 50.7 | 4,718,915 | 50.3 |
| Total | $ 9,132,020 | 100.0 | $ 9,385,175 | 100.0 |

## Summary by Station of 1989 State General Appropriated Funds

| Western Region | General Fund ($1,000's) |
|---|---|
| Alaska | $ 2,584 |
| ***Arizona*** | ***18,289*** |
| California | 99,562 |
| ***Colorado*** | ***7,236*** |
| Guam | 780 |
| Hawaii | 8,709 |
| Idaho | 7,446 |
| ***Montana*** | ***6,355*** |
| Nevada | 3,653 |
| New Mexico | 6,512 |
| N Mariana Islands | 177 |
| ***Oregon*** | ***15,646*** |
| American Samoa | 0 |
| Utah | 5,973 |
| ***Washington*** | ***14,472*** |
| Wyoming | 3,496 |
| **North Central Region** | |
| Illinois | 12,765 |
| Indiana | 17,846 |
| Iowa | 15,062 |
| Kansas | 18,238 |
| Michigan | 19,214 |
| Minnesota | 32,687 |
| Missouri | 12,819 |
| ***North Dakota*** | ***11,341*** |
| Nebraska | 15,504 |
| Ohio | 23,804 |
| South Dakota | 4,662 |
| Wisconsin | 21,983 |

| Southern Region | General Fund ($1,000's) |
|---|---|
| Alabama | 17,146 |
| Arkansas | 15,943 |
| Florida | 58,724 |
| Georgia | 35,308 |
| Kentucky | 14,906 |
| Louisiana | 18,755 |
| Mississippi | 20,436 |
| North Carolina | 34,750 |
| ***Oklahoma*** | ***13,921*** |
| Puerto Rico | 5,751 |
| South Carolina | 16,032 |
| Tennessee | 14,606 |
| Texas | 41,014 |
| Virginia | 23,250 |
| Virgin Islands | 297 |
| **Northeast Region** | |
| Connecticut-NH | $ 4,120 |
| Connecticut-S | 3,447 |
| District of Columbia | 297 |
| Delaware | 3,680 |
| Massachusetts | 3,767 |
| Maryland | 10,951 |
| Maine | 4,391 |
| New Hampshire | 2,337 |
| New Jersey | 9,430 |
| New York-I | 19,497 |
| New York-G | 6,181 |
| Pennsylvania | 15,970 |
| Rhode Island | 1,507 |
| Vermont | 1,871 |
| West Virginia | 2,674 |

Highlighted states are peer states as determined by the Footnote 43 Study, prepared by the State Board of Agriculture, the Office of State Planning and Budgets, the Colorado Commission on Higher Education and the Joint Budget Committee. Factors analyzed and compared by state included similar major agricultural commodities, level of agricultural receipts, per capita tax burden, and agricultural receipts per square mile.

# Research Departments

**College of Agricultural Sciences**
Merle H. Niehaus, Dean

**Agricultural & Resource Economics**
S. Lee Gray, Head

**Agronomy**
Lee E. Sommers, Head

**Animal Sciences**
David R. Ames, Head

**Entomology**
Thomas O. Holtzer, Head

**Horticulture**
Kenneth M. Brink, Head

**Plant Pathology and Weed Science**
Gary A. McIntyre, Head

**College of Applied Human Sciences**
Elnora M. Gilfoyle, Dean

**Design, Merchandising & Consumer Sciences**
George A. Morgan, Head

**Food Science & Human Nutrition**
Peter J. Bechtel, Head

**Human Development & Family Studies**
Raymond K. Yang, Head

**College of Arts, Humanities, & Social Sciences**
Thomas J. Knight, Dean

**Sociology**
David M. Freeman, Chairman

**College of Engineering**
Francis A. Kulacki, Dean

**Agricultural & Chemical Engineering**
Vincent G. Murphy, Head

**Atmospheric Science**
Stephen K. Cox, Head

**Civil Engineering**
John D. Nelson, Head

**College of Forestry & Natural Resources**
Jay M. Hughes, Dean

**Forest & Wood Sciences**
A. Allen Dyer, Head

**Natural Resource Ecology Lab**
James Ellis, Director

**Range Science**
Harold Goetz, Head

**College of Natural Sciences**
John C. Raich, Dean

**Biochemistry**
Norman P. Curthoys, Chairman

**Biology**
Bruce A. Wunder, Chairman

**Chemistry**
Oren P. Anderson, Chairman

**College of Veterinary Medicine & Biomedical Sciences**
James L. Voss, Dean

**Microbiology**
Carol D. Blair, Head

**Physiology**
Rupert P. Amann, Head

# Research Centers

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Gary Greathouse, Animal Sciences Coord.
Kenneth W. Knutson, Horticulture Coord.

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**USDA Central Great Plains Research Station**
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# Research Center Advisory Committees

## Arkansas Valley Research Center

Allen Aldred
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Joaquin Huntington
Lawrence Huntington
Lou Jarmon
Brice Lee
Michael Olquin
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Betty Shahan
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Bill Whyman
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### San Luis Valley Research Center

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Francis Strnad
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### Southeastern Colorado Research Center

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Don Fowler
Tom Hagans
Victor Hancock
Loyd Haney
Chip Hines
Kent Johnston
Rick Leone
Bob Patterson
Kit Pharo
Mike Schnaufer
John A. Smartt

# Technical Bulletins and Technical Reports

## Technical Bulletins (TB's)

| | Title | Authors | Dept/s. |
|---|---|---|---|
| TB 90-1 | Crop and Soil Management in Dryland Agroecosystems. | Peterson, McGee, Westfall, Wood, Sherrod | Agronomy |
| TB 90-2 | Seed Quality and the Richards Function: A User's Program. | Nath, Cahn, Moore, Roos | Horticulture |

## Technical Bulletins - Limited (LTB's)

| | | | |
|---|---|---|---|
| LTB 90-1 | Stocking Rates for Gambel-Oak Rangelands in Southwestern Colorado. | Rittenhouse, Denham, Bartlett | Range Science, Animal Science |
| LTB 90-2 | Selenium Levels found in Soil, Water, Vegetable and Field Crop Samples in Western Colorado. | Follett, Kendall, Doherty | Agronomy, Food Science & Nutrition, Cooperative Extension |
| LTB 90-3 | Alternate Crop Production and Marketing in Colorado. | Johnson, Croissant | Agronomy, Cooperative Extension |
| LTB 90-4 | Molybdenum Supplement to Technical Bulletin 134 'Selection of Standard Free Energies of Formation for Use in Soil Chemistry.' | Reddy, Wang, Lindsay | Agronomy |
| LTB 90-5 | 1990 Colorado Field Crop Insect Management Research and Demonstration Trials. | Peairs, Pilcher, | Entomology, Cooperative Extension |

## Technical Reports (TR's)

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| TR 90-2 | Performance of Sorghum Hybrids in Eastern Colorado, 1989. | Youngman, Schweissing, Ristau, Thompson, Larson, Clay | Agronomy |
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| TR 90-4 | Cultivar Performance Test 1987-89, Forage Yield History, and Management of Alfalfa in Western Colorado. | Pearson, Golus | Agronomy |
| TR 90-5 | Cultivar Performance Tests, Inoculation and Plant Population of Soybeans in W. Colo. | Pearson, Golus, Judson, | Agronomy |
| TR 90-6 | Application of Anaerobically Digested Sewage Sludge to Dryland Winter Wheat. | Lerch, Barbarick, Westfall, | Agronomy |
| TR 90-7 | Ear Stunting in Corn in Western Colorado. | Pearson, Golus, | Agronomy |

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## College of Agricultural Sciences

### *Agricultural & Resource Economics*

#### Doctorate of Philosophy

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## *Agronomy*

### Doctorate of Philosophy

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# 1991 Research Center Field Day Schedule

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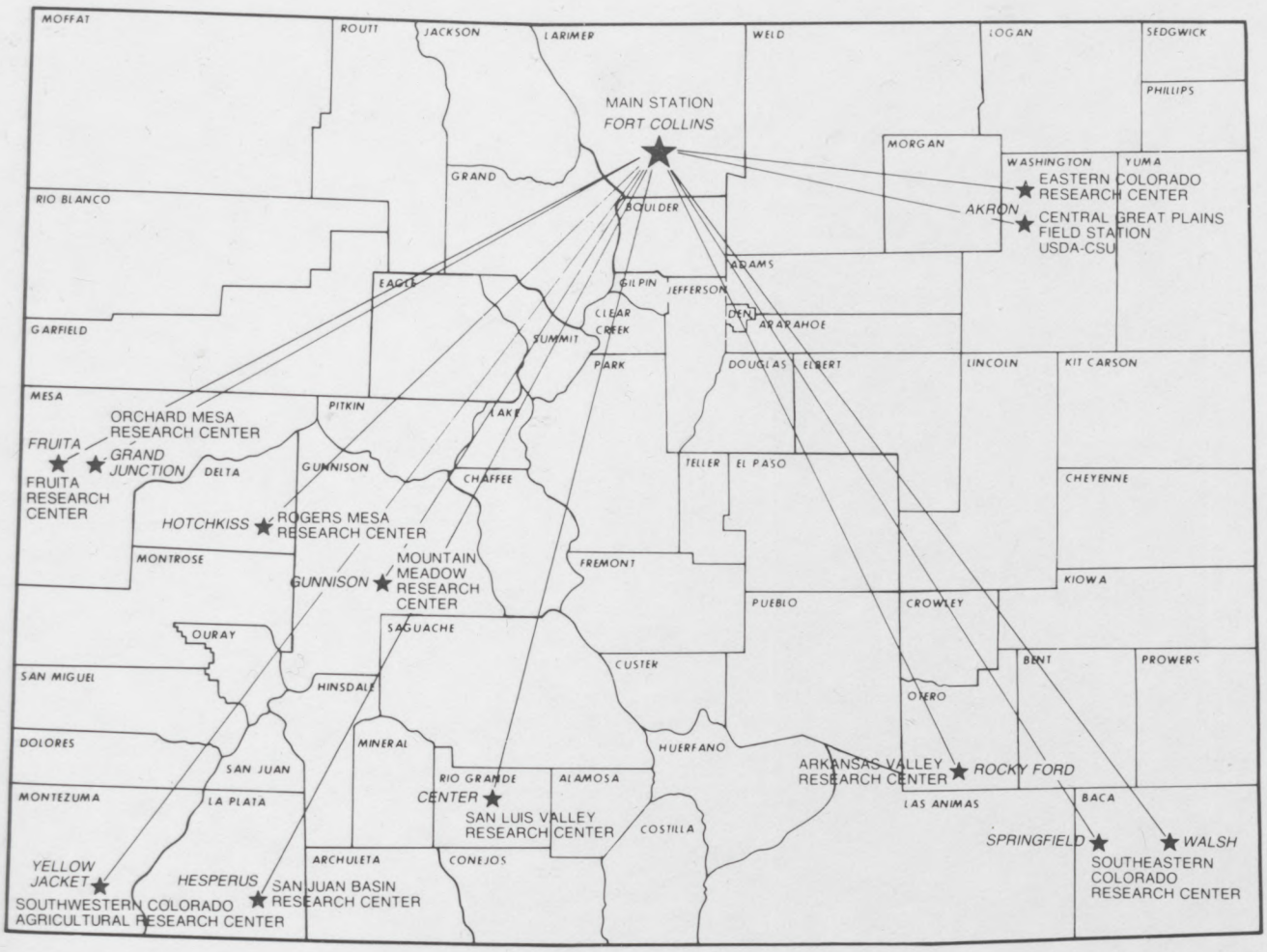
| March 29 | **Colorado State Bull Seminar.** Pathology Building, Colorado State. 7:00 p.m. |
| March 30 | **Colorado State Bull Sale.** Livestock Pavilion, Colorado State. 1:30 p.m. |
| April 13 | **Northeast Colorado Bull Test Association Sale.** Eastern Colorado Research Center, Akron. 12:00 noon. |
| April 15 | **John E. Rouse/Colorado State University Beef Improvement Center.** Saratoga, WY. 12:00 noon. Bull sale. |
| April 21 | **San Juan Basin Research Center.** Hesperus. 1:30-4:00 p.m. Bull Selection Forum - to include pulmonary arterial pressure demonstration, breeding soundness evaluation, and Expected Progeny Differences; inspection of sale bulls. |
| April 22 | **San Juan Basin Research Center.** Hesperus. 12:00 noon. Four Corners Bull Sale. |
| May 21 | **Eastern Colorado Research Center.** Akron. 4:00 p.m. Tour of facilities; presentations and discussion on cow-calf nutrition, feedlot nutrition and reproduction. Complimentary evening meal served. |
| June 13 | **Southeastern Colorado Research Center.** Springfield. 9:00 a.m.-3:00 p.m. Supplement, grass planting, and grazing management studies. Noon meal provided. |
| June 18 | **Wheat Field Day.** Plainsman Research Center, Walsh. 4:00 p.m. Will cover wheat varieties and information regarding the Russian Wheat Aphid. |
| June 25 | **San Juan Basin Research Center.** Hesperus. 10:00 a.m.-3:30 p.m. Summer field day. Cow-calf production and grazing trials. |
| June 25 | **USDA Central Great Plains Research Station.** Akron. 8:30 a.m.-12:00 noon. Crop rotation studies, water management and irrigation studies, weed management studies, soil fertility and winter wheat variety trials. |
| July 3 | **Mountain Meadow Research Center.** Gunnison. 8:30 a.m.-1:30 p.m. Tour of Routt County forage growing sites as part of the Third Intermountain Meadow symposium. Meet at the Steamboat Springs, CO Sheridan Resort and Conference Center. Reserved bus transportation; cost $17.50. Call (303) 641-2515 before June 26th. |
| July 11 | **Orchard Mesa Research Center.** Grand Junction. 10:00 a.m.-3:00 p.m. In cooperation with the Western Colorado Horticultural Society. Performance of apple, apricot, and peach varieties and rootstocks; effects of reduced deficit irrigation and root restriction on peach tree size control; pest and disease control options; X-disease and vector relationships; peach mosaic susceptibility studies; vineyard establishment procedures; vineyard irrigation and vine hardiness. |
| July 16 | **Colorado State University Agricultural Field Day.** Fort Collins. 1:30 p.m. Bay Farm Research Facility. Review of Integrated Pest Management program. 4:00 p.m. Agronomy Research Center. Review of various crop production research. |
| August 1 | **Fruita Research Center.** Grand Junction. 4:00 p.m. Tours of soybeans, dry beans, corn fertility, small grains, alfalfa, asparagus, Russian Wheat Aphid and irrigation research. Complimentary evening meal served. |
| August 2 | **Horticulture Research Center.** Fort Collins (near Anheuser Busch, off I-25 and Mountain Vista Drive). 8:00 a.m.-4:00 p.m. Review of turfgrass and landscape horticulture research projects. Call (303) 491-7018 for registration and information. |
| August 15 | **Southwestern Colorado Research Center.** Yellow Jacket. 3:30-7:30 p.m. Dryland conservation tillage; dryland bean nurseries; irrigated bean and small grain variety trials, irrigated alfalfa and bean demonstration plots. Evening meal provided. |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BOULDER
ADAMS
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